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

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RIVM report 601714018/2012

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Abstract

Environmental risk limits for triphenyltin in water

RIVM has, by order of the Ministry of Infrastructure and the Environment, derived environmental risk limits for triphenyltin. This was necessary because the current risk limts have not been derived according to the most recent methodology. Main uses of triphenyltin were for wood preservation and as antifouling on ships. The use as antifouling has been banned within Europe since 2003. The Dutch Steering Committee for Substances will set new standards on the basis of the scientific advisory values in this report.

Environmental risk limits have been derived for short term concentration peaks and for long term exposure at which harmful effects for water are not expected. The environmental risk limits for long term exposure are derived for annual average concentrations. Monitoring data indicate that these are currently likely to be exceeded in Dutch seawater and in saltwater sediment. For freshwater this cannot be determined because the new environmental risk limits for long term exposure are lower than the current detection level for TPT in the environment.

For the environmental risk limits for long term exposure in surface water, three routes have been examined: direct ecotoxicity, secondary poisoning and consumption of fish by humans. Direct toxicity is the most critical of these and determines the overall long term environmental risk lmit in fresh- and saltwater (0.23 nanogram per liter). The environmental risk limit that protects the ecosystem from effects of short term concentration peaks, is 0.47 microgram per liter for fresh- and saltwater.

Keywords:
triphenyltin; Water Framework Directive (WFD); environmental risk limits; water

Rapport in het kort

Milieurisicogrenzen voor trifenyltin in water

Het RIVM heeft, in opdacht van het ministerie van Infrastructuur en Milieu (I&M), milieurisicogrenzen voor trifenyltin in water bepaald. Dit was nodig omdat de huidige norm voor trifenyltin voor waterkwaliteit niet is afgeleid volgens de meest recente methodiek. Trifenyltin wordt voornamelijk gebruikt als middel om hout te conserveren en om te voorkomen dat onder water op de romp van schepen organismen groeien (aangroeiwerend middel). Het gebruik als aangroeiwerend middel is in Europa sinds 2003 niet meer toegestaan. De Stuurgroep Stoffen stelt de nieuwe normen vast op basis van de wetenschappelijke advieswaarden in dit rapport.

Er zijn milieurisicogrenzen bepaald voor kortdurende concentratiepieken en voor langdurige blootstelling waarbij geen schadelijke effecten te verwachten zijn. De milieurisicogrenzen voor langdurige blootstelling zijn bepaald voor jaargemiddelde concentraties. Meetgegevens geven aan dat deze waarschijnlijk in Nederlands zeewater en in zoutwatersediment worden overschreden. Voor zoetwater is dit onbekend, omdat de nieuwe milieurisicogrens lager is dan de laagste concentratie die met de huidige technieken in het milieu kan worden aangetoond.

Voor de milieurisicogrenzen voor langdurige blootstelling in oppervlaktewater zijn drie routes onderzocht: directe effecten op waterorganismen, indirecte effecten op vogels en zoogdieren via het eten van prooidieren, en indirecte effecten op mensen via het eten van vis. De eerste van de drie levert de laagste waarde voor trifenyltin en bepaalt daarmee de milieurisicogrens voor langdurige blootstelling voor zoet- en zoutwater (0,23 nanogram per liter). De milieurisicogrens die het ecosysteem beschermt tegen kortdurende concentratiepieken, is 0.47 microgram per liter voor zoet- en zoutwater.

Trefwoorden:
trifenyltin; Kaderrichtlijn Water (KRW); milieurisicogrenzen; water

Contents

Summary

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

This report contains ERLs for TPT in surface water and sediment. The following ERLs are derived: Negligible Concentration (NC), Maximum Permissible Concentration (MPC), Maximum Acceptable Concentration for ecosystems (MAC_{eco}), and Serious Risk Concentration for ecosystems (SRC_{eco}). The risk limits are based on data from the public literature and data from the EU risk assessments of TPT as plant protection product.

The methodology used for the derivation of the MPC and MAC_{eco} for water and sediment, is in accordance with the recently published European guidance in the context of the Water Framework Directive. An overview of the derived environmental risk limits is given in Table 1.

The derived ERLs for long-term exposure are lower than the reported limits of quantification from regular monitoring programs. A preliminary screening of monitoring data shows that there are some locations where TPT has been detected and the proposed ERLs may thus be exceeded, depending on the frequency of detection. The derived ERLs for suspended matter and sediment in the marine environment are likely to be exceeded.

When using the ERLs for risk assessment or compliance check, mixture toxicity of the total number of organotin compounds should be taken into account through the added risk approach.

Table 1: Derived MPC, NC, MAC_{eco}, and SRC_{eco} values for triphenyltin.

ERL	**unit**	**value**			
		MPC	NC	MAC_{eco}	SRC_{eco}
fresh water [a]	ng/L	0.23	2.3×10^{-3}	4.7×10^{2}	4.0×10^{2}
susp. matter fresh water [b]	$\mu g/kg_{dwt}$	0.27	2.7×10^{-3}		
salt water	ng/L	0.23	2.3×10^{-3}	4.7×10^{2}	4.0×10^{2}
susp. matter salt water [b]	$\mu g/kg_{dwt}$	0.27	2.7×10^{-3}		
sediment fresh water [c]	ng/kg_{dwt}	2.2	0.022		2.2×10^{3}
sediment salt water [c]	ng/kg_{dwt}	2.2	0.022		2.2×10^{3}

[a] From the $MPC_{fw,\ eco}$, $MPC_{fw,\ secpois}$ and $MPC_{hh,\ food,\ water}$ the lowest one is selected as the 'overall' MPC_{water}.

[b] Expressed on the basis of Dutch standard suspended matter.

[c] Expressed on the basis of Dutch standard sediment.

1 Introduction

1.1 Project framework

In this report, environmental risk limits (ERLs) for surface water and sediment are derived for triphenyltin (TPT). TPT is a herbicide, fungicide and biocide that is considered as a specific pollutant for the Netherlands in the context of the Water Framework Directive (WFD). The compound is listed in the Dutch decree on WFD-monitoring (*Regeling monitoring Kaderrichtlijn Water*). The aim of this report is to present updated risk limits that can be used to set water quality standards in accordance with the WFD. The derivation of the ERLs is performed in the context of the project Chemical aspects of the Water Framework Directive, which is closely related to the project INS (International and national environmental quality standards for substances in the Netherlands). TPT compounds are also mentioned as relevant for the river basin of the Ems (Anonimous, 2009). The following ERLs are considered:

- Maximum Permissible Concentration (MPC) – defined in VROM (2004) and INS (1999) as the standard based on scientific data which indicates the concentration in an environmental compartment for which:
  1. no effect to be rated as negative is to be expected for ecosystems;
  2a. no effect to be rated as negative is to be expected for humans (for non-carcinogenic substances);
  2b. for humans no more than a probability of 10^{-6} per year of death can be calculated (for carcinogenic substances). Within the scope of the Water Framework Directive (WFD), a probability of 10^{-6} on a life-time basis is used.

  The MPC for water should not result in risks due to secondary poisoning and/or risks for human health aspects. These aspects are therefore also addressed in the MPC derivation. Separate MPC-values are derived for the freshwater and saltwater environment.

- 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 MPC by a factor of 100.

- Maximum Acceptable Concentration (MAC_{eco}) for aquatic ecosystems – the concentration protecting aquatic ecosystems from effects due to short-term exposure or concentration peaks. The MAC_{eco} is derived for freshwater and saltwater ecosystems.

- 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.

- Maximum Permissible Concentration for surface water that is used for drinking water abstraction ($MPC_{dw, hh}$). This is the concentration in surface water that meets the requirements for use of surface water for drinking water production. The $MPC_{dw, hh}$ 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 MPC and MAC.

1.2 Current standards for TPT

Current standards can be found in the *Regeling monitoring KRW* and at the website 'Risico's van stoffen' (http://www.rivm.nl/rvs/). For freshwater and marine waters, MPCs of 0.005 µg/L and 0.0009 µg/L are reported, based on total concentration in water. These values are based on the evaluation performed by Crommentuijn et al. (1997).

1.3 Methodology

The methodology for risk limit derivation is described in detail in the INS-guidance document (Van Vlaardingen and Verbruggen, 2007), which is further referred to as the INS-Guidance. The methodology 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 (EC, 2003) and on the Manual for the derivation of Environmental Quality Standards in accordance with the Water Framework Directive (Lepper, 2005). The European technical guidance for the derivation of environmental quality standards in the context of the WFD has been revised recently (EC, 2011). Therefore, the terminology is harmonised as much as possible and the new guidance is followed in the case it deviates from the INS-guidance. This specifically applies to the treatment of data for freshwater and marine species (see section 3.3) and the derivation of the MAC (see section 3.7), for which the new methodology is used (EC, 2011). This also holds for the MPC for surface waters intended for the abstraction of drinking water ($MPC_{dw, hh}$, see section 3.5). In the INS-guidance, this is one of the MPCs from which the lowest value should be selected as the general MPC_{water} (see section 3.1.6 and 3.1.7 of the INS-Guidance). According to the new guidance, the $MPC_{dw, hh}$ is not taken into account for the derivation of the general MPC_{water}, but specifically refers to locations that are used for drinking water abstraction. Another difference is that according to the new WFD-guidance, derived ERLs refer to dissolved concentrations in water, instead of total.

1.3.1 Data sources

Data of existing evaluations were used as a starting point. An on-line literature search was performed using Scopus at www.scopus.com. The last search has been performed on 23 March 2011. In addition to this, RIVM's e-tox base, EPA's ECOTOX database, IUCLID and other data sources as listed in the INS-Guidance were checked. There are curently no REACH dossiers available for TPT compounds.

Information on physico-chemical properties, environmental behaviour and human toxicology, including threshold limits, was retrieved from the information sources as mentioned in the INS-Guidance. The available data on human toxicology were reviewed by a human toxicologist at the RIVM.

1.3.2 *Data evaluation*

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 sections 2.2.2 and 2.3.2 of the INS-Guidance and in the Annex to the EQS-guidance under the WFD (EC, 2011). In short, the following reliability indices were assigned, based on Klimisch et al. (1997):

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.

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

1.3.3 *Specific considerations for TPT*

In the case of TPT, only studies in flow-through systems and studies where endpoints were based on measured concentrations were accepted as reliable. Tremolada et al. (2006) measured TPT during 28 days of exposure of the echinoderm *Antedon mediterrana*. With a density of 1.2 grams of biota per litre of water in a renewal system where 20% of the artificial seawater was replaced daily, average measured concentrations were a factor of 15-20 lower than nominal. Models show that the loss of 92-95% of the added compound is mainly caused by sorption by biota, combined with biotransformation (Tremolada et al., 2006). This is confirmed by Huang et al. (1993), who showed that without biota the concentration of TPT stayed within 90% of nominal over seven days, but with algae present the concentration dropped to 33% of nominal. Fent and Meier (1994) showed that concentrations in a renewal system with embryonic or hatched fish larvae decreased to 53% (range 22-85%) of initial values. The largest reduction in concentration was observed for the lowest exposure concentrations. In contrast, Jarvinen et al. (1988) reported a loss over 96 hours of only 1 to 11%.The details of the test are however not given and therefore it is unknown if biota were available in the test system. Nevertheless, most references given above indicate that the actual exposure concentrations in the test systems are probably much lower than the nominal concentrations. Therefore, endpoints from studies in static or renewal systems where concentrations were not measured are not considered reliable. Studies which are not valid due to the lack of measurements can still be used as circumstantial evidence.

1.4 Status of the results

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

2 Substance information on TPT

2.1 General information

TPT compounds are triphenyl derivatives of tetravalent tin. They are lipophilic and have low solubility in water. Since TPT compounds are salts which dissociate in the environment and the TPT-cation remains unchanged, data available for all TPT compounds (TPT chloride, -acetate, -hydroxide) are evaluated. The ERLs will be expressed in concentration of the dissociated cation.

2.2 Information on production and use

TPT compounds have been used extensively as algicides and molluscicides in antifouling products since the 1960s. Use of triorganotins in antifouling paints has been restricted in many countries because of their catastrophic effects on the oyster industry and more general effects on the aquatic ecosystem. TPT was used as a non-systemic fungicide with mainly protective action. In the Netherlands, the use of TPT is prohibited since 2003. In the EU, there is no authorisation for the use of TPT acetate and TPT hydroxide as plant protection product.

2.3 Identification

Information on the identification of different species of TPT are presented in the tables below.

Table 2: Identification of triphenyltin.

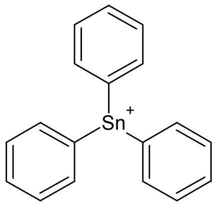
Chemical name	Triphenyltin
Synonyms	Fentin, TPT
Structural formula	
Molecular formula	$C_{18}H_{15}Sn$
SMILES code	c1ccccc1[Sn+](c2ccccc2)c3ccccc3

Table 3: Identification of triphenyltin chloride.

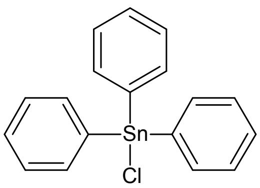
Chemical name	Triphenyltin chloride
Synonyms	Fentin chloride, TPTCl
CAS number	639-58-7
EC number	211-358-4
Structural formula	
Molecular formula	$C_{18}H_{15}SnCl$
SMILES code	Cl[Sn](c1ccccc1)(c2ccccc2)c3ccccc3

Table 4: Identification of triphenyltin hydroxide.

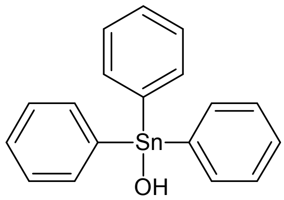
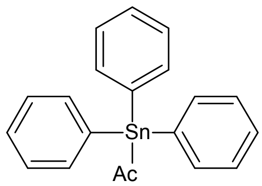
Chemical name	Triphenyltin hydroxide
Synonyms	Fentin hydroxide, TPTH
CAS number	76-87-9
EC number	200-990-6
Structural formula	
Molecular formula	$C_{18}H_{16}SnO$
SMILES code	O[Sn](c1ccccc1)(c2ccccc2)c3ccccc3

Table 5: Identification of triphenyltin acetate.

Chemical name	Triphenyltin acetate
Synonyms	Fentin acetate, TPTAc
CAS number	900-95-8
EC number	212-984-0
Structural formula	
Molecular formula	$C_{20}H_{18}O_2Sn$
SMILES code	O=C(C)O[Sn](c1ccccc1)(c2ccccc2)c3ccccc3

2.4 Physico-chemical properties

Physico-chemical properties of TPT are presented in the following tables for different ionic forms. Bold values are taken forward for ERL derivation.

Table 6: Physico-chemical properties of TPT chloride. Bold values are used for ERL derivation.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	385.5		HSDB (2005)
Water solubility	[mg/L]	40	20°C	HSDB (2005)
		1.2	10°C, pH 7.5, distilled water*	Inaba et al. (1995)
		0.6	10°C, pH 7.5, seawater*	Inaba et al. (1995)
		0.99	estimated from log K_{ow} of 4.19	US EPA (2009)
		1	from experimental database	US EPA (2009)
		0.078	estimated from fragments	US EPA (2009)
pK_a	[-]	n.a.		
log K_{ow}	[-]	3.56	estimated - ClogP	Biobyte (2006)
		4.19	experimental - MlogP	Biobyte (2006)
		4.19		HSDB (2005)
log K_{oc}	[-]	3.89	experimental, calculated from Freundlich log K_d of 1.81 and f_{om} of 1.43%, 1/n = 0.793	Sun et al. (1996)
		3.5	QSAR Sabljic hydrophobics	Van Vlaardingen and Verbruggen (2007)
		5.7	estimated: MCI method	US EPA (2009)
		3.6	estimated: K_{ow} method	US EPA (2009)
		5.09; 4.73	laboratory experiment with field sediment; calculated from log K_d and %OC	Berg et al. (2001)
		4.94; 5.37	field measurements with contaminated sediment; calculated from log K_d and %OC	Berg et al. (2001)
Vapour pressure	[mPa]	0.7		HSDB (2005)
Melting point	[°C]	103.5		HSDB (2005)
Boiling point	[°C]	240	at 1.8 kPa	HSDB (2005)
Henry's law constant	[Pa.m^3/mol]	6.7	MW x VP / WS	Van Vlaardingen and Verbruggen (2007)

* The solubility of TPT chloride is dependent on the salinity, the pH and the temperature of the water.

Table 7: Physico-chemical properties of TPT hydroxide. Bold values are used for ERL derivation.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	367.0		HSDB (2005)
Water solubility	[mg/L]	1.2		HSDB (2005)
		4.72	estimated from log K_{ow} of 3.53	US EPA (2009)
		0.4	from experimental database	US EPA (2009)
		13.8	estimated from fragments	US EPA (2009)
		1.6	± 0.2; saturator system	Jarvinen et al. (1988)
		1		Vogue et al. (1994)
pK_a	[-]	5.20		Biobyte (2006)
log K_{ow}	[-]	3.50	estimated - ClogP	Biobyte (2006)
		3.53	experimental - MlogP	Biobyte (2006)
		3.53		HSDB (2005)
log K_{oc}	[-]	4.4		Vogue et al. (1994)
		3.5		Footprint (2011)
		3.0	QSAR Sabljic hydrophobics	Van Vlaardingen and Verbruggen (2007)
		5.7	estimated: MCI method	US EPA (2009)
		3.1	estimated: K_{ow} method	US EPA (2009)
Vapour pressure	[mPa]	0.047	25°C	HSDB (2005)
Melting point	[°C]	119		HSDB (2005)
Boiling point	[°C]	n.a.		
Henry's law constant	[Pa.m^3/mol]	14	MW x VP / WS	Van Vlaardingen and Verbruggen (2007)

Table 8: Physico-chemical properties of TPT acetate. Bold values are used for ERL derivation.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	409.0		Tomlin (2002)
Water solubility	[mg/L]	9	20°C, pH 5	Tomlin (2002)
		3.17	estimated from log K_{ow} of 4.19	US EPA (2009)
		9	from experimental database	US EPA (2009)
		0.29	estimated from fragments	US EPA (2009)
pK_a	[-]	n.a.		
log K_{ow}	[-]	3.46	ClogP	Biobyte (2006)
		3.43		Tomlin (2002)
log K_{oc}	[-]	3.3		Footprint (2011)
		2.9	QSAR Sabljic hydrophobics	Van Vlaardingen and Verbruggen (2007)
		4.9	estimated: MCI method	US EPA (2009)
		2.6	estimated: K_{ow} method using log K_{ow} of 3.43	US EPA (2009)
Vapour pressure	[mPa]	1.9	60°C	Tomlin (2002)
Melting point	[°C]	122-123		Tomlin (2002)
Boiling point	[°C]	n.a.		
Henry's law constant	[Pa.m^3/mol]	0.86	MW x VP / WS	Van Vlaardingen and Verbruggen (2007)

2.5 Behaviour and distribution in the environment

Selected environmental properties of TPT are presented in Table 9.

Table 9: Selected environmental properties of TPT.

Parameter	Unit	Value	Remark	Ref.
Hydrolysis half-life	DT50 [h]	0.07	TPT acetate, 20°C, pH 7	Footprint (2011)
		30	TPT hydroxide, 20°C, pH 7	Footprint (2011)
Photolysis half-life	DT50 [h]	18	TPT hydroxide, pH 7	Footprint (2011)
Readily biodegradable		No		US EPA (2009)
Relevant metabolites				

Both TPT acetate and TPT chloride hydrolyse to TPT hydroxide in water (HSDB, 2005). For the derivation of MPCs for the water and sediment compartment the physico-chemical properties of TPT hydroxide are therefore preferred.

2.6 Bioconcentration and biomagnification

2.6.1 Normalization

A correlation between lipid content and accumulation of TBT and TPT has not been observed. However, a better correlation for accumulation from sediment was observed if these concentrations were normalized to the organic carbon content of the samples (Stäb et al., 1996). Deviations from simple hydrophobic accumulation were also observed in modelling of food accumulation, and binding to proteins is suggested as an explanation for this (Veltman et al., 2006). It is also observed that the biomagnification of TPT is significant in contrast to TBT, despite the relatively low hydrophobicity of TPT, which indicates another accumulation mechanism instead of simple hydrophobic partitioning (Hu et al., 2006, Murai et al., 2008). No correlation was found between the lipid content of organs and the accumulated amount of TBT and TPT in these organs (Yamada and Takayanagi, 1992). As a consequence of these observations no normalization to lipid content of the organisms has been performed. All data are based on wet weight concentrations.

2.6.2 Bioconcentration

Bioconcentration of TPT has been studied in a variety of organisms (see Appendix 1). When evaluating the available literature, special consideration was given to maintenance and analysis of exposure concentrations and the accomplishment of equilibrium. Studies in which concentrations were not analysed were not considered reliable. Bioconcentration factors (BCFs) estimated from the ratio between concentrations in organisms and water were only accepted as valid when actual concentrations were constant and equilibrium had been reached. BCF-values from studies in which equilibrium was not reached were only accepted as valid when reliable estimates of uptake and elimination rate constants were available. Because TPT kinetics are very slow, almost all valid data result from such kinetic studies.
Valid data on bioconcentration in biota are available for macrophytes, echinoderms, crustaceans, insects and fish. Of these taxa, especially fish are relevant for risk limit derivation. Data indicate that the internal distribution of TPT in fish differs between organs. In general, concentrations in liver and kidney are highest as compared to other parts of the body. For secondary poisoning, a distinction between organs is not relevant, since predators eat the fish as a

whole. For risk limits based on human fish consumption, using whole fish BCFs may overestimate exposure in case only fillet is consumed. Consumption of other parts cannot be fully excluded. Therefore, whole body BCFs for fish are used for further calculations. Accepted data are summarised in Table 10. Kinetic data that were mostly derived from the raw data published in the studies, are plotted in Figure 1.

Table 10: Summary of valid BCF data for the bioaccumulation of TPT in fish. Detailed data are presented in Appendix 1.

Species	**Fresh- or saltwater**	**BCF [L/kg]**							**Reference**
		Minimum	**Maximum**	**Average**	**SD**	**Geomean**	**Median**	**N**	
Carassius auratus	Fresh	1085	1815	1450	517	1403	1450	2	Tsuda et al. (1988), Tsuda et al. (1991)
Cyprinus carpio	Fresh	446	>>6756	6528	6953	2841	4500	7	NITE (2011), Tsuda et al. (1990b)
Gnathopogon caerulascens	Fresh	2734	2734	2734		2734	2734	1	Tsuda et al. (1992)
Lepomis macrochirus	Fresh	7809	7809	7809		7809	7809	1	EC (1996a, 1996b), US EPA-OPTS (1988)
Oncorhynchus mykiss (larvae)	Fresh	566	566	566		566	566	1	Tas et al. (1990)
Oryzias latipes	Fresh	4575	5595	5107	431	5092	5244	5	Zhang et al. (2008)
Pagrus major	Salt	2987	3678	3333	489	3315	3333	2	Yamada and Takayanagi (1992), Yamada et al. (1994)
Pimephales promelas	Fresh	16265	18192	17229	1363	17202	17229	2	EC (1996a, 1996b), US EPA-OPTS (1988)
Poecilia reticulata	Fresh	1337	7941	4733	3306	3739	4921	3	Tas et al. (1990, 1996), Tsuda et al. (1990a)
Rudiarus ercodes	Salt	5198	5198	5198		5198	5198	1	Yamada and Takayanagi (1992)

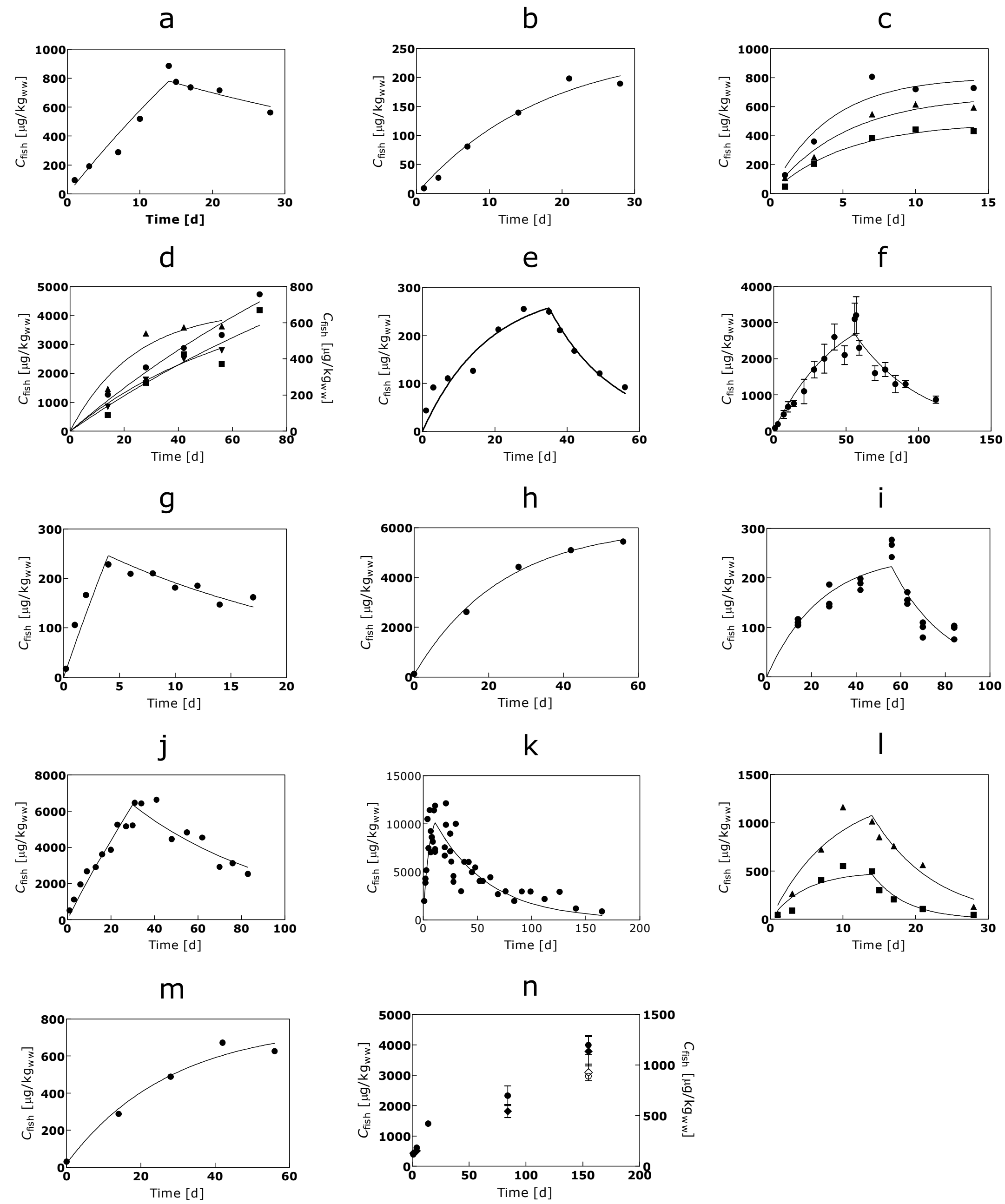


Figure 1: Bioconcentration of different fish species exposed to TPT: a) Carassius auratus at 3.2 µg/L TPTCl and b) at 0.14 µg/L TPTCl; c) Cyprinus carpio at 1.1-1.2 µg/L TPTCl at pH 6.0 ■, 6.8 ▲, and 7.8 ● and d) at 0.855 ● and 0.0906 ■ µg/L TPTOH and 0.939 ▲ and 0.0985 ▼ µg/L TPTF; e) Gnathopogon caerulescens at 0.1 µg/L; f) Lepomis macochirus at 0.49 µg/L; g) Oncorhynchus mykiss at 2.8 µg/L; h) Pagrus major at 1.65 µg/L and i) at 0.0831 µg/L; j) Poecilia reticulata at 3.6 µg/L, k) at 1.9 µg/L and l) at 0.90 µg/L; m) Rudarius ercodes at 0.148 µg/L; n) Full life-cycle study with Pimephales promelas at 0.0654 ● and 0.231 ■ µg/L males, and ○ and □ females after spawning.

A few remarks can be made with regard to the studies that are considered reliable. First, it should be noted that the accumulation of TPT is a very slow process. Half-lifes from the kinetic studies vary from slightly less than 3 days to almost 50 days. Growth may influence the final outcome of the kinetic BCF. Usually, kinetic BCFs are corrected for growth. However, no data for growth were available. The BCF value for larvae of rainbow trout, which is the lowest selected value, might be affected by growth, because larvae still might grow relatively fast.
The data that result from studies, in which the bioaccumulation potential was determined in combination with a reproduction study, showed very high BCF values (up to 5700 L/kg for Japanese medaka, *Oryzias latipes,* and up to 20,000 L/kg for fathead minnow, *Pimephales promelas*).
In cases where variation in reported BCF values is small (e.g. *Oncorhynchus mykiss*, *Oryzias latipes*, *Pagrus major*) data often originate from a single experiment or from similar experiments by the same authors in which variation in characteristics of test water and organisms was limited. The studies by Tsuda et al. (1986, 1992, 1990b, 1990a, 1991, 1987a) generally show smaller BCF values than reported by other authors. Data from Tsuda et al (1990b) for common carp (*Cyprinus carpio*) lead to kinetic BCFs of 446-673 L/kg, while from the data reported by NITE kinetic BCFs ranging from 4570 to far above 7000 L/kg are derived. Similarly, the data from Tsuda et al. (1990a) for guppies (*Poecilia reticulata*) lead to a kinetic BCF of 1340, while from the data reported by Tas et al. (1990, 1996) kinetic BCFs of 4920 and 7940 are derived. Differences in biological characteristics of the test species (e.g. fat content, size and age) are also expected to contribute to variation, as well as the form in which the chemical is added. However, this is not an explanation for the large differences observed for carp, as the characteristics of the used fish are almost the same (about 9 cm and 20 g).
TPT is an organometalloid and the speciation of the compound may vary among different water types. It is noted that BCF values determined with TPT hydroxide (TPTOH) are significantly higher than those determined with TPT chloride, although the lowest BCF of all is determined with TPT hydroxide (wrongly denoted as TPTH in the study). This might be a result of speciation. However, the data to analyse this in more detail are lacking. Details on water characteristics are missing in most cases, and the available data do not allow for a further investigation into the relationship between BCF and water type. The only data that were generated with two different species of TPT within the same test system are the BCF for carp by NITE.
In these studies, it seems that BCFs for TPT hydroxide are much higher than those obtained with TPT fluoride. However, this is mainly due to the fact that the concentration in fish of the last sampling point with TPT hydroxide (10 weeks) goes up again, while the exposure time in tests with TPT fluoride is only 8 weeks. If only 8 weeks of exposure are considered the BCF values are very similar for both TPT species.
The data of Zhang et al. (2008) indicate that for a given species and water type, there is no influence of exposure concentration on the BCF.

2.6.3 Bioaccumulation and biomagnification

2.6.3.1 Bioaccumulation studies

Water, sediment and blue mussels (*Mytilus galloprovinciales*) were sampled from Maizuru Bay, Japan from July 1 to 3 in 2007 (Eguchi et al., 2010). Concentrations of TPT in mussels ranged from 0.2 to 13 μg/kg_{wwt} at the 9 locations. Total organotin compounds ranged from 8 to 35.5 μg/kg_{wwt}. Concentrations of TPT in water were below the detection limit of 1 ng/L at all

7 sampling sites. This means that the bioaccumulation factor (BAF) for mussels is up to 13,000 L/kg and higher. Sediment concentrations in the bay ranged from 0.2 to 17 μg/kg_{wwt}. This means that the bio-sediment accumulation factor (BSAF) on basis of wet weight mussel concentrations and dry weight sediment concentrations lies in the range of 0.2-0.3.
An earlier study (February 3, 2003) from the same area (Ohji et al., 2007) reported average concentrations in blue mussels ranging from 0.09 to 0.52 μg/kg_{wwt} in 8 locations. Concentrations in water ranged from the detection limit of 0.18 to 2.02 ng/L. Concentrations in sediment ranged from 0.13 to 3.27 μg/kg_{dwt}. Paired concentrations in blue mussels and water yielded BAFs from 50 to 2000 L/kg_{wwt}, paired concentrations in blue mussels and sediment yielded BSAFs from 0.1 to 1.2 kg_{dwt}/kg_{wwt}.

The concentrations of TPT were measured in water, sediment, plankton, mussels (*Mytilus edulis*), scallops (*Pecten caurinus*) and fish (*Physiculus maximowiczi*) from Otsuchi Bay, Japan in July 1996 (Harino et al., 1998). Because in only one of the water samples TPT was found above the detection limit of 3 ng/L, few conclusions can be drawn with regard to the BAF. Based on minimum, median, and maximum concentrations reported in a figure, the BAFs for mussels, scallops and fish can be estimated between 800 and 17,000 L/kg.

Low BAF values could be derived from data for water and fish from Theodore Roosevelt National Park in North Dakota (Jones-Lepp et al., 2004). The BAF values are 147 L/kg for shorthead redhorse (*Moxostoma macrolepidotum*), which is a fish from a lower trophic level and 94 L/kg for sauger (*Sander canadensis*), which is a piscivorous fish. However, water samples were grab samples and nothing is stated about particulate matter or filtration. The water concentration of 2.65 μg/L seems extraordinarily high for a field observation. Therefore, the validity of these BAF values could be argued.

Yamada and Takayanagi (Yamada and Takayanagi, 1992) report data from the Environment Agency Japan, where TPT was found in coastal waters in concentrations ranging from 5 to 88 ng/L, in sediment from 1 to 1100 μg/kg and in fish from 20 to 2600 μg/kg. Based on the geometric means of these ranges this would imply a BAF of 11,000 L/kg and a BSAF of 6.9.

Common whelks (*Buccinum undatum*) from the Eastern Scheldt contained TPT in concentrations equivalent to 7.6 to 13 μg Sn/kg_{wwt} (Mensink et al., 1997). The concentration of total organotin compounds summed up to 65 μg Sn/kg_{wwt}. The concentration of TPT in the carnivorous whelks was 8.1 times higher than the concentration of TPT in mussels (*Mytilus edulis*). The concentration of TBT in mussels was 6.8 times higher than that in whelks. This indicated the potential for biomagnification of TPT in contrast to TBT that is not biomagnified. Concentrations in sediment could hardly be determined and ranged from <0.2 to 0.6 ng Sn/kg_{dwt}. However, the detection limit for TPT in sediment, defined as three times the signal to noise ratio, is reported to be 2 ng Sn/g_{dwt}, so the reported concentration range is probably erroneous and the real concentrations are probably a thousand times higher. In that case, the BSAF based on wet weight whelk concentrations and dry weight sediment concentrations is around 8. For mussels this value would be around 1.

The concentration of organotin was determined in several fish species from Finnish lake water and the Finnish Baltic Sea coast (Rantakokko et al., 2010). The concentrations of TPT in perch ranges from 0.5 to 151 μg cation/kg_{wwt} for all samples (38), with fish from lake areas being less contaminated than sea areas.

The median value was 15.5 µg cation/kg_{wwt}. Concentrations of TPT contributed for 27 to 100% to the total amount of organotin compounds. In sediment the concentration of phenyltin compounds was only about 10% of the concentration of butyltin compounds. From this it was concluded that TPT had a higher accumulation potential than TBT.
Salmon and herring appeared to contain less organotin compounds than bream, perch, and pikeperch, probably because they forage in more open and less contaminated water of the Baltic Sea. Another indication of the elevated trophic magnification of TPT compared to TBT was the fact that TPT was the major compound in the predatory fish species salmon and perch, while TBT was the major compound in herring and pikeperch, but especially in burbot and whitefish.

2.6.3.2 Food web studies

Indeed, the magnification potential of TPT is confirmed by four food web studies that are available. These are summarized below. From these studies the biomagnification factor is derived, preferably determined as a trophic magnification factor (TMF).

In a food web study from the Western Scheldt in the Netherlands (Veltman et al., 2006), TPT concentrations were measured in a number of species. These species were the mollusc species cockle (*Cerastoderma edule*), the annelid species lugworm (*Arenicola marina*), the crustacean species brown shrimp (*Crangon crangon*), and the fish species plaice (*Pleuronectes platessa*), the gobiid fish *Chasmichthys gulosus*, sand eel (*Ammodytidae* sp.), herring (*Clupea harengus*), European flounder (*Platichthys flesus*), grey gurnard (*Eutrigla gurnardus*), common sole (*Solea solea*), whiting (*Merlangius merlangus*), and pout/bib (*Trisopterus luscus*), and eggs of common tern (*Sterna hirundo*).
Species were collected in spring 2003. The exact location of sampling is not mentioned in the study. The eggs of the common tern appeared to contain relatively low amounts of organotin compounds. Residues in eggs may not be representative of concentrations in adult birds, in which organotin compounds strongly accumulate in liver and in feathers. Further, birds are capable of metabolizing organotin compounds and they may eliminate organotin compounds by seasonal moulting.
For the aquatic food chain, TPT concentrations based on wet weight are varying from 2.1 to 21 µg Sn/kg_{wwt}. The reported concentration in suspended solids is 8.3 µg Sn/kg_{dwt} (only one value reported), which concentration can be assumed to be a factor of 10 lower on wet weight basis.
The food chain was not characterized by stable isotopes. The trophic level (TL) was estimated as suspended matter (TL=1), herbi-detrivores (TL=2: lugworm and cockle), primary carnivores (TL=3: shrimp, plaice, sand eel, herring, goby, and gurnard), primary-secondary carnivores (TL=3.5: flounder, sole, cod, whiting, and pout). With this kind of trophic level classification, all correlations, regardless of whether these concentrations were expressed as dry weight, wet weight or lipid weight, were significant and positive and the trophic magnification factor calculated from these data ranges from 1.74 (lipid weight) to 2.29 (wet weight, see Figure 2).

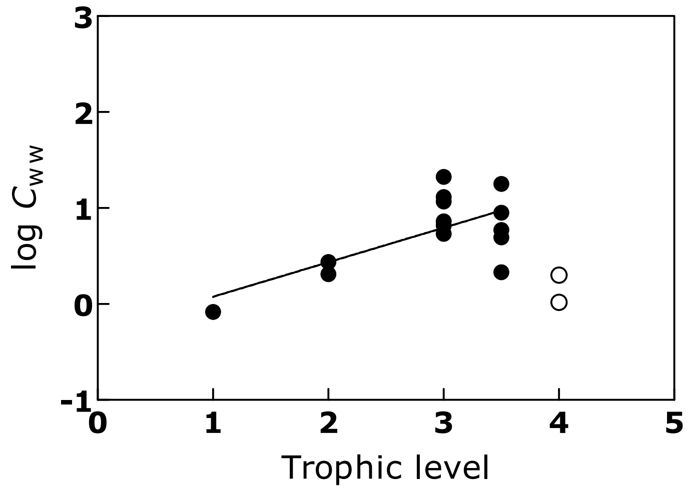


Figure 2: Trophic magnification of TPT in the Western Scheldt. Solid dots represent the aquatic food chain. Open dots are tern eggs. (data from Veltman et al. (2006))

The trophic levels can also be adapted from another study in the same area (Di Paolo et al., 2010), where at least the stable isotopes were measured for cockle, lugworm, herring, and whiting. The trophic levels for similar species were assigned the same values as these four species. If these trophic levels are used instead of the values of 2, 3, and 3.5, the trophic magnification factors are similar and range from 1.74 (dry weight) to 2.49 (wet weight). It should be noted that for the same samples all calculations for trophic magnification factors of TBT ended up around one. This again underlines the biomagnification potential of TPT in comparison with TBT. The BSAF of TPT on basis of wet weight biota concentrations and dry weight sediment concentrations is relatively constant and ranges from 0.25 to 2.5 through the whole food chain. Ri=4 for missing details on sampling location and trophic level.

In a trophic magnification study in Bohai Bay in North China, water, sediment and biota samples were taken in May, June and September 2002 (Hu et al., 2006). Fish and invertebrates were sampled from three locations in Bohai Bay, roughly separated by a distance of 50 km in total. The six phytoplankton and zooplankton samples were taken somewhat further out of the coast than the fish and invertebrates. Nevertheless, one of the samples lies well within the line of the three sampling points for fish and invertebrates. Further, the concentration range of the phytoplankton and zooplankton is relatively small (standard deviation of approximately 20%). Phytoplankton and seston mainly consisted of algae of the taxonomic groups Bacillariophyta and Pyrrophyta, zooplankton mainly consisted of small copepods (*Acartia bifilosa*, *Paracalanus parvus*, *Labidocera euchaeta*, and *Oithona similes*), which are primary herbivores. Five invertebrate species were sampled: crab (*Portunus trituberculatus*), burrowing shrimp (*Upogebia* sp.), short-necked clam (*Ruditapes philippinarum*), veined rapa whelk (*Rapana venosa*), and bay scallop (*Argopecten irradians*), and six fish species: weever (*Lateolabras japonicus*), catfish (*Chaeturichthys stigmatias*), bartail flathead (*Platycephalus indicus*), white flower croaker (*Nibea albiflora*), wolffish (*Obontamblyopus rubicundus*) and mullet (*Liza so-iuy*). In contrast to TBT, TPT showed significant biomagnification throughout the food chain (P<0.001). The resulting trophic magnification factor (TMF) was 3.70, based on wet weight concentrations, a value that is even larger than that of dichlorodiphenyldichloroethylene (DDE) (3.26) and hexachlorobenzene (2.96) in the same food chain. Water samples were also taken from 14 locations, but all samples appeared to be below the detection limit of 6.8 ng/L. This implies that for the six fish species the bioaccumulation factor (BAF), is at least in excess of 1000 L/kg and for one species at least higher than 5000 L/kg. The high accumulation in biota is also evident if sediment samples are considered. Out of the 14 sampling points, TPT was only detected in four samples at concentrations near the detection limit of 0.1 μg/kg_{dwt}. The wet weight concentrations in fish are up to 350 times higher than this concentration. The study is assigned Ri 2, because of some uncertainty remaining for the spread of the sampling locations and the sampling period of five months.

In another trophic magnification study, biota were collected from three sites of the Seto Inland Sea in Japan (Murai et al., 2008).
At Ainan-cho, Eheme Prefecture facing the Uwa Sea, the samples were collected in April 2002 and consisted of Particulate Organic Matter (POM; mostly phytoplankton), the algal species *Sargassum piluliferum*, the crustacean species *Anisomysis ryukyuensis*, *Caprella californica*, *Caprella monoceros*, *Caprella penantis*, *Caprella scaura*, *Galathea* sp., and *Hippolytidae* sp., the echinoderms *Anthocidaris* sp. and *Echinostrephus aciculatus*, the cnidarian *Lytocarpia niger*, the molluscs *Aplysia kurodai*, *Chlamys nobilis*, *Crassostrea nippona*, *Haliotis* sp., *Mytilus galloprovincialis*, *Pinctada fucata martensii*, *Pteria penguin*, and *Tectus pyramis* and the fish *Apogon doederleini*, *Apogon semilineatus*, *Calotomus japonicus*, *Canthigaster rivulata*, *Cercamia eremia*, *Diodon holocanthus*, *Halichoeres* sp., *Platyrhina sinensis*, *Pseudolabrus eoethinus*, *Scorpaenodes littoralis*, *Takifugu niphobles*, *Thalassoma lunare*.
At Takehara, Hiroshima Prefecture facing the middle of the Seto Inland Sea, the species were collected in September 2002 and consisted of POM (<0.1 mm), the algal species *Hizikia fusiformis* and *Sargassum thunbergii*, the crustaceans *Hemigrapsus sanguineus* and *Siliella okadai*, the molluscs *Acanthopleura japonica*, *Crassostrea nippona*, *Thais clavigera*, and the fish *Conger myriaster*, *Gobiidae* sp., *Halichoeres poecilopterus*, *Halichoeres* sp., *Hexagrammos otakii*, *Hypodytes rubripinnis*, *Scorpaenopsis cirrhosa*, *Sebastes inermis*, *Stephanolepis cirrhifer*, *Takifugu poecilonotus*, and *Thamnaconus modestus*.
At Akashi Strait, Hyogo Prefecture facing the east part of the Seto Inland Sea, the species were collected in May 2003 and consisted of POM (<0.1 mm), POM (>0.1 mm), the algal species *Ecklonia cava*, *Sargassum horneri*, and *Undraria pinnatifida*, the crustaceans *Balanus rostratus*, and *Caprella danilevskii*, the molluscs *Acanthopleura japonica*, *Aplysia kurodai*, *Batillus* sp., *Cellana nigrolineata*, and *Thais clavigera*, the echinoderms *Asterina pectinifera* and *Luidia maculate*, and the fish species *Halichoeres* sp., *Hexagrammos agrammus*, *Hexagrammos otakii*, *Repomucenus richardsoonii*, and *Takifugu niphobles*.
At all three locations a significant positive correlation was found between TPT concentration (wet weight basis) and trophic level as denoted by stable nitrogen isotopes. In contrast, such a relationship was not observed for any of the butyltin compounds. With a change in $\delta^{15}N$ (stable nitrogen isotope ratio) of 3.4‰ per trophic level, the trophic magnification factor is 2.24 for the Ainan-cho ecosystem (P=0.01), 5.30 for the Takehara ecosystem (P<0.0001) and 3.90 for the Akashi Strait ecosystem (P=0.001). It has to be noted that only in approximately 70% of the samples TPT concentrations were above the limit of detection. For the remainder of the samples, which were mostly related to the lower trophic levels, the concentration was set to half of the detection limit, a choice which has obviously influenced the final outcome. For this reason, the study is assigned Ri 4.

Another food web study was performed in lake system Westeinder (Grote Poel), a shallow freshwater lake in the Netherlands (Stäb et al., 1996). Samples of water, sediment, suspended matter, invertebrates, and fish were taken in the period of 16-30 August 1993 at nine locations in the lake over a distance of about 6 km. Birds entangled in fishing nets were collected in the period from December 1992 till August 1993. The samples contained sediment, suspended matter, water, chironomids, gammarids, mysids, zebra mussel (*Dreissena polymorpha*), eel (*Anguilla anguilla*), roach (*Rutilus rutilus*), silver bream (*Abramis bjoerkna*), ruffe (*Gymnocephalus cernuus*), smelt (*Osmerus eperlanus*), tench (*Tinca tinca*), bream (*Abramis brama*), perch (*Perca fluviatilis*), pike (*Esox lucius*), and pikeperch (*Stizostedion lucioperca*). The collected birds were grebe (*Podiceps cristatus*), tufted duck (*Aythya fuligula*), and cormorant (*Phalacrocorax carbo*).
Unfortunately, trophic levels were not reported in this study. However, from a schematic representation of the food web trophic levels can be assigned to each of the boxes. In that case, suspended matter and sediment can be assigned to trophic level 1, chironomids, gammarids, and zebra mussel to trophic level 2, mysids to trophic level 2.5, roach, silver bream, ruffe, tench, smelt and bream to 3, eel to 3,5, and perch, pike, and pikeperch to 4. Cormorant and grebe can be assigned to trophic level 4.5, and tufted duck to 3. Even with this assignment of trophic levels, strong magnification of TPT could be detected if the bird data are excluded from the analysis. For the sampling locations 1 to 5, at least one representative of all levels of the food chain was available. Resulting trophic magnification factors for TPT were 2.41, 2.98, 7.65, 6.58, and 3.20. If all data of the lake are combined a strong correlation is found. The resulting TMF would be 3.72 (see Figure 3).
Other organotin compounds showed relatively low biomagnification. For TBT the TMF over the whole lake was 1.39, while the TMF was smaller than one for MBT, DBT, and MPT. DPT concentrations had a lower but positive correlation with trophic level as well, with a TMF of 2.09.
Water samples were taken, but the concentration of TPT was in all cases at or below the detection limit of 5 ng/L. This means that the wet weight BAF for omnivorous fish from trophic level 3 is ≥7500, for benthivorous eel ≥17,000, and for piscivorous fish from trophic level 4 ≥14,000. Concentrations in sediment were very heterogeneous and ranged from <2 to 24 $\mu g/kg_{dwt}$. Two suspended matter samples showed much higher concentrations of 51 and 130 $\mu g/kg_{dwt}$, despite the fact that the organic carbon content was lower in these samples than in sediment. Due to the variability in sediment concentrations, BSAF values related to sediment concentrations are not very meaningful. However, BSAF values on basis of wet weight biota concentrations and dry weight suspended matter concentrations for the two locations where suspended matter was sampled are remarkably constant and range from 0.09 for zebra mussel to 1.1 for pike.
The ratios of the TPT concentrations in grebe compared to fish and tufted duck compared to zebra mussels were lower than one. The only cormorant that was analysed showed high concentrations of organotin compounds. However, this cormorant could have foraged somewhere else. The cormorant had also very high concentrations of the degradation products of TPT.
The study is assigned Ri 4 because of missing details on trophic level, and Ri 2 for derivation of BMF_2 (fish/mussel to bird/mammal).

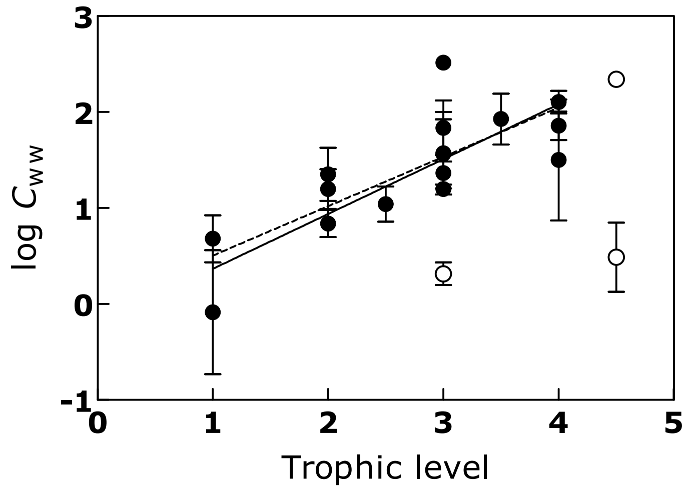


Figure 3: Trophic magnification of TPT in Lake Westeinder. Solid dots represent the aquatic food chain. Open dots are birds. The solid line is the regression line over all individual data of the aquatic food chain. The dotted line represents the regression over the means per species. (data from Stäb et al. (1996))

In summary, there are four food web studies from six ecosystems, which all showed significant biomagnification of TPT. Three of the studies were estuarine or marine ecosystems, while one ecosystem was a freshwater lake. All studies had some shortcomings. The most reliable study in Bohai Bay had a trophic magnification factor of 3.7, but the other studies showed similar values for magnification.

Table 11: Overview of trophic magnification factors of TPT.

Ecosystem	**Type**	**TMF**	**Ri**	**Reference**
Lake Westeinder	Freshwater lake	3.72	4	Stäb et al. (1996)
Western Scheldt	Estuary	2.29	4	Veltman (2006)
Ainan-cho	Sea	2.24	4	Murai et al. (2008)
Takehara	Sea	5.30	4	Murai et al. (2008)
Akashi Strait	Sea	3.90	4	Murai et al. (2008)
Bohai Bay	Sea	3.70	2	Hu et al. (2006)

2.6.4 *Combining fresh and saltwater data*

The present BCF data do not indicate that bioconcentration differs between freshwater or marine species. Tsuda et al. (1990a), observed a two-fold decrease in BCF for *Poecilia reticulata* (guppy) when exposed in saltwater as compared to freshwater. However, this might be due to changes in metabolism and osmoregulation of the guppies resulting from the transfer to saltwater, and the result is not taken into account. Only two out of ten species, for which reliable BCF values are available, are marine species (red sea bream (*Pagrus major*) and white-spotted pygmy filefish (*Rudarius ercodes*)). The BCF values derived from this study by Yamada and Takayanagi (1992) and Yamada et al. (1994) are 3000 to 5200 L/kg, which is in the middle of the range of BCF values.

In white-spotted charr (*Salvelinus leucomaenis*) from the Otsuchi region and the Miyako region in Japan, concentrations of TPT of 2.2 ± 1.5 and 3.4 ± 1.9 μg Sn/kg_{wwt} were measured. Total organotin compounds were in the

order of 20 µg Sn/kg_{wwt} (Ohji et al., 2011). Charr from the sea-run type accumulated TBT to a higher extent than freshwater-resident char. Actually, this effect was not observed for TPT. From this study it can be deduced that it would be justified to treat bioaccumulation of freshwater and saltwater together.
In another study, liver from flounder living outside the sluices of Lake IJsselmeer to the Waddenzee in the Netherlands (Vethaak et al., 2011) appeared to contain more TPT than inside the sluices. For sediment, the situation was reversed, resulting in BSAF values that are a factor of 3 to 4 higher for fluctuating freshwater and saltwater environments than for purely freshwater environments. However, sediment and flounder samples were not taken simultaneously, but in different years and seasons. Given the variability in concentrations over time, no firm conclusions can be drawn from these observations.
Because there are no strong indications that bioaccumulation differs between freshwater and saltwater, data for bioaccumulation are combined and the same values are used for freshwater and saltwater.

2.6.5 *Overall selection of bioaccumulation data*

Geometric mean BCFs for whole fish range from 566 L/kg for larvae of rainbow trout (*Oncorhynchus mykiss*) to almost 17,200 L/kg for fathead minnows (*Pimephales promelas*. The distribution of the BCFs for ten species is shown in Figure 4. The overall mean BCF for fish, calculated as the average of the log-normal distribution of the geometric mean per species, is 3500 L/kg. This value is taken forward for further calculations.

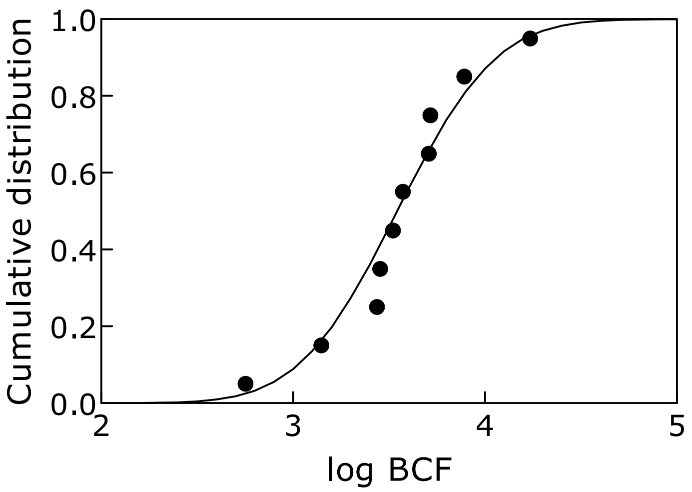


Figure 4: Species distribution of BCF values.

The value of 3.7 obtained from the Bohai-study with Ri 2 (see Table 11) is selected as BMF_1, and is considered representative for both freshwater and marine water. Because of the absence of magnification of TPT in birds, the value of BMF_2 is 1 kg/kg.
Combining the selected BCF value of 3500 L/kg and the BMF_1 of 3.7 kg/kg, the BAF value should be equal to 13,000 L/kg. Very few data on bioaccumulation factors are available, especially because the data are hampered by the fact that concentrations of TPT in organisms were below the detection limit (see section 2.6.3.1). However, these data do not contradict the estimated BAF value of 13,000 L/kg. Moreover, the ranges reported from Japanese coastal waters lead to an estimate of 11,000 L/kg for the BAF, which is a value similar to the

derived BAF value of 13,000 L/kg. Therefore, the final selected values are a BCF of 3500 L/kg and a BMF_1 value of 3.7 kg/kg. The BMF_2 value is 1 kg/kg.

2.7 Human toxicology

TPT acetate and TPT hydroxide are designated R24/25, R26, R37/38, R40, R41, R48/23, R63, R50/53, Carcinogenity Cat. 3 and Reproduction Cat. 3 (ESIS, 2010). In the new EU-GHS system, these compounds are classified as H351, H361d***, H330, H331, H301, H372**, H335, H315, H318, H400, H410, carc. cat. 2 and repr. cat. 2 (ECHA, 2012).
A group TDI for organotin compounds is available, which is based on immunotoxic effects in rats observed in chronic feeding studies (EFSA, 2004). The standard is valid for the sum of tributyltin (TBT), dibutyltin (DBT), TPT and di-*n*-octyltin (DOT). The TDI is presented as a group standard since similar mode of action and immunotoxic potency for the four compounds is assumed. The immunotoxic effects are assumed to be additive. This TDI was derived by EFSA and recently adopted as human toxicological MPR (Maximum Permissible Risk level) in RIVM Report nr. 711701092 (Tiesjema and Baars, 2010). The study from which the NOAEL was used to derive this TDI, was performed with bis(tributyltin) oxide (TBTO), hence the group TDI is expressed as 0.25 μg TBTO/kg_{bw}/day based on molecular mass of TBTO.

2.7.1 Recalculation of TDI for other compounds

The molecule bis(tributyltin) oxide contains two active (tributyltin) moieties. One TBTO molecule is thus assumed equitoxic to two TBT molecules. Similarly, based on the equitoxic potency assumed for this group standard, one molecule TBTO is equitoxic with two DBT, two TPT or two DOT molecules.
As an example, EFSA also expressed the group TDI as Sn and as TBT-Chloride. This was done as follows.

TDI expressed as Sn by EFSA
One molecule of TBTO contains two molecules of Sn, the TDI can be expressed as:
0.25 × 2* mol. weight [Sn]/mol. weight [TBTO] = 0.25 * 2 * 118.71/ 596.11 = 0.1 μg Sn/kg_{bw}/day.

TDI expressed as TBT-Chloride by EFSA
Since one molecule of TBTO (bis(tributyltin) oxide) contains two tributyltin molecules, the TDI can be expressed in TBT Chloride as:
0.25 × 2* mol. weight [TBT-Cl]/mol. weight [TBTO] = 0.25 * 2 * 325.51/ 596.11 = 0.27 μg TBT-Cl/kg_{bw}/day.

Standard expressed as TPT^+ for this report
In the same way, the standard of 0.25 μg TBTO/kg_{bw}/day can be recalculated into TPT^+ as:
0.25 × 2* mol. weight [TPT^+]/mol. weight [TBTO] = 0.25 * 2 * 350.02/ 596.11 = 0.29 μg TPT^+/kg_{bw}/day.

2.8 Trigger values

This section reports on the trigger values for ERL_{water} derivation (as demanded in the WFD).

Table 12: TPT: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp\text{-}water}$	3.0 [a]	[-]	$K_{oc} \times f_{OC,susp}$ [b]	K_{oc}: 2.4
BCF	3500	[L/kg]		2.6
BMF	3.7	[kg/kg]		2.6
Log K_{ow}	3.53 [c]	[-]		2.4
R-phrases	40 + 63	[-]		2.7
A1 value	-	[µg/L]		
DW standard	-	[µg/L]		

[a] Calculated from the mean of experimental log K_{oc} 4.4 and 3.5 for TPT hydroxide.
[b] $f_{OC,susp}$ = 0.1 kg_{OC}/kg_{solid} (EC, 2003).
[c] Log K_{ow} for TPT hydroxide.

- TPT has a log $K_{p,\ susp\text{-}water}$ ≥3; derivation of an $MPC_{sediment,\ eco}$ is triggered.
- TPT has a log $K_{p,\ susp\text{-}water}$ ≥3; expression of the MPC_{water} as $MPC_{susp,\ water}$ is required.
- TPT has a BCF >100; assessment of secondary poisoning is triggered.
- TPT is classified H351 (R40) and H361 (R63). Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{water,\ hh\ food}$) has to be derived.
- For TPT, no compound-specific A1 value or Drinking Water value is available from Council Directives 75/440, EEC and 98/83/EC, respectively. Therefore, a provisional drinking water limit is derived.

3 Water: ecotoxicity data and derivation of ERLs

3.1 Laboratory data

The aggregated ecotoxicity data for freshwater and marine species are presented in Table 13 and Table 14. All values are expressed on the basis of the TPT-ion. Detailed aquatic toxicity data for TPT are tabulated in Appendix 2.

Table 13: TPT: selected freshwater toxicity data for ERL derivation for the TPT ion.

Chronic[a] **Taxonomic group/** *species*	**NOEC/EC10 (µg TPT/L)**	**Acute**[a] **Taxonomic group/** *species*	**L(E)C50 (µg TPT/L)**
Algae		**Algae**	
Scenedesmus obliquus	2.3	*Scendesmus obliquus*	27
Scenedesmus vacuolatus	44.5	*Scenedesmus vacuolatus*	102
Macrophyta		**Macrophyta**	
Lemna minor	0.9 [n]	*Lemna minor*	12 [n]
Lemna polyrhiza	2.2 [c]	*Lemna polyrhiza*	24 [c,n]
		Platyhelminthes	
		Dugesia sp.	17.9 [d]
		Polycellis niger/tenius	19.9 [d]
Mollusca		**Mollusca**	
Marisa cornuarietis	0.016 [b]	*Physa fontinalis*	10.2 [d]
		Planorbis contortis	6.0 [d]
		Annelida	
		Tubifex sp.	11.0 [d]
Crustacea		**Crustacea**	
		Ceriodaphnia dubia	10.8
Daphnia magna	1.1 [i]	*Daphnia magna*	15.8 [e]
		Daphnia pulex	13.8
		Gammarus pulex	10.8 [d]
Insecta		**Insecta**	
Chironomus riparius	0.52 [m]	*Anopheles stephensi*	42 [f]
		Cloeon dipterum	144.5 [d]
		Endochironomus albipennis	259.2 [d]
Pisces		**Pisces**	
		Cyprinus carpio	36.2
Oncorhynchus mykiss	0.18	*Oncorhynchus mykiss*	23.9 [g]
Oryzias latipes	0.00043 [j]	*Oryzias latipes*	50.5
Phoxinus phoxinus	0.2 [k]		
Pimephales promelas	0.154 [l]	*Pimephales promelas*	6.4 [h]
Amphibia			
Pelophylax lessonae/esculenta	0.11		

[a] For detailed information see Appendix 1.
[b] Most sensitive endpoint: spawning mass production
[c] Most sensitive endpoint: growth rate
[d] Most sensitive exposure period: 96h
[e] Most sensitive exposure period: 48h
[f] Most sensitive stadium: 2nd instar and most toxic species TPT-Ac
[g] Geometric mean of 14.3 and 40.1 µg/L
[h] Geometric mean of 9.2, 6.8, 5.1, 5.7 and 5.7 µg/L
[i] Most sensitive endpoint: mortality; geometric mean of 0.73, 0.86 and 2.2 µg/L
[j] Most sensitive endpoint: larval survival
[k] Most sensitive endpoint: mortality and morphological deformities
[l] Most sensitive exposure period: 183 d
[m] Most sensitive endpoint: development rate
[n] Endpoint based on combined low and high concentration range

Table 14: TPT: selected marine toxicity data for ERL derivation for the TPT ion.

Chronic[a] **Taxonomic group/***species*	**NOEC/EC10 (µg TPT/L)**	**Acute**[a] **Taxonomic group/***species*	**L(E)C50 (µg TPT/L)**
		Bacteria	
		Vibrio fischeri	40 [b]
Algae			
Pavlova lutheri	0.04		
Mollusca			
Nucella lapillus	0.15		
Crustacea			
Rhithropanopeus harrisii	9.5		
Echinodermata			
Anthocidaris crassispina	245 [e]		
Paracentrotus lividus	1.0		
Ophiodermata brevispina	0.011 [d]		
		Pisces	
		Chasmichthys dolichognathus	19 [c]

[a] For detailed information see Appendix 1
[b] Geometric mean of 18 and 87 µg/L
[c] Geometric mean of 17, 20 and 20 µg/L
[d] Geometric mean of 0.009 and 0.0126 µg/L
[e] Most sensitive endpoint: embryo development

The lowest chronic value is an EC10 of 0.43 ng/L for *Oryzias latipes*. It should be noted that this value is almost a factor of 1000 lower than other chronic endpoints for fish species. This seems unrealistic and therefore an expert within the RIVM on the field of fish testing has been consulted and the author of the publication has been contacted if he could confirm the units of the endpoint reported. The large difference can be explained from the different exposure scenarios between the tests. The main difference is that exposure in this study was performed through maternal transfer, while in the other studies the eggs or fry were exposed directly. It was confirmed by the expert that the difference in exposure is an acceptable explanation for the differences observed. The reported units were confirmed by the author after email communication. For ibuprofen it has also been shown that difference in exposure and difference in the period of observation can result in NOECs for reproduction differing from each other with two orders of magnitude (Flippin et al., 2007, Han et al., 2010).

3.2 Field and mesocosm data

A summary of field studies is presented in Appendix 3. Although some of these studies were considered reliable, they did not result in endpoints relevant for derivation of the $MPC_{fw,\ eco}$ or $MAC_{fw,\ eco}$.

3.3 Treatment of fresh- and saltwater data

According to the new WFD guidance (EC, 2011), data from fresh- and saltwater tests should be pooled unless there are indications that sensitivity of species differs between the two compartments. For metals, however, data should be kept separated. TPT is an organometalloid, and the speciation of the compound may vary among different water types. The present data, however, do not indicate that there is a consistent difference between freshwater and marine species with respect to their sensitivity towards TPT. Therefore, the combined dataset will be used for derivation of risk limits. This is consistent with the use of a combined dataset for derivation of water quality standards for di- and tributyltin compounds by the International Commission of the Protection of the Rhine (ICPR) and the European Commission, respectively (EC, 2005, ICPR, 2009).

3.4 Derivation of the MPC_{fw} and MPC_{sw}

3.4.1 $MPC_{fw, eco}$ and $MPC_{sw, eco}$

3.4.1.1 Assessment factor method

The acute dataset is complete (algae, *Daphnia* and fish present). Chronic values are present for 18 species from eight taxonomic groups and three trophic levels.

According to the guidance an assessment factor of 10 should be applied to the lowest endpoint, this results in an $MPC_{fw, eco}$ of 0.043 ng/L. As stated in the introduction, endpoints from studies in which the substance was not measured during the test were considered unreliable. This was the case for many of the studies assessed and also considered studies which had lower endpoints than the chronic endpoints presented in Table 13 and Table 14. However, only one of the unreliable endpoints was lower than the lowest reliable endpoint of 0.43 ng/L. This endpoint (0.05 ng/L for *Indoplanorbis exustus*) was also considered unreliable because a blank control was not included, and the 'true' endpoint might have been higher. Therefore, the $MPC_{fw, eco}$ of 0.043 ng/L is considered to be sufficiently protective.
On the basis of the combined dataset, the $MPC_{sw, eco}$ is also derived from the lowest reliable endpoint of 0.43 ng/L for *O. latipes*. Since NOECs for three additional marine taxonomic groups are available (molluscs, echinoderms and a marine crab), no additional assessment factor is necessary. The $MPC_{sw, eco}$ is 0.043 ng/L.

3.4.1.2 Species sensitivity distribution method

The $MPC_{fw, eco}$ can also be derived by applying a Species Sensitivity Distribution (SSD) to the chronic data. This is allowed when at least 10 values (preferably 15) are available for different species covering at least eight taxonomic groups. With the chronic dataset covering 18 species, the eight taxonomic groups covered and their representatives in the present dataset are as follows:

- Fish: represented by *Oryzias latipes* (family Adrianichthyidae).
- A second family in the phylum Chordata: represented by *Oncorhynchus mykiss* (family Salmonidae).
- Crustaceans: represented by *Daphnia magna.*
- Insects: represented by *Chironomus riparius.*
- A family in another phylum than Arthropoda or Chordata: represented by the mollusc *Marisa cornuarietis*.
- A family in any order of insect or any phylum not already represented: represented by the echinoderms *Paracentrotus lividus* and *Ophiodermata brevispina.*
- Algae: represented by *Scenedesmus obliquus, Scenedesmus vacuolatus* and *Pavlova lutheri.*
- Macrophyta: represented by *Lemna minor* and *Lemna polyrhiza.*

With this coverage, the requirements for the SSD method are met. The SSD method is applied using EtX 2.0 (see Figure 5). The fit is accepted at all levels by all three statistical methods available in the program. The obtained HC5 is 2.3 ng/L with a lower limit of 0.21 ng/L and an upper limit of 11 ng/L.
The HC5 exceeds the EC10 for *Oryzias latipes*, if other fish species had been tested in a similar way it is likely that more endpoints in the dataset would be lower than the current HC5. Considering this fact in combination with the fact

that the lower limit is more than a factor of 10 lower than the HC5, it is not considered justified to use the default assessment factor of 5. Instead, an assessment factor of 10 is applied, resulting in an $MPC_{fw, eco}$ of 0.23 ng/L. Since NOECs for three additional marine taxonomic groups are available in the SSD dataset, the $MPC_{sw, eco}$ is equal to the $MPC_{fw, eco}$.

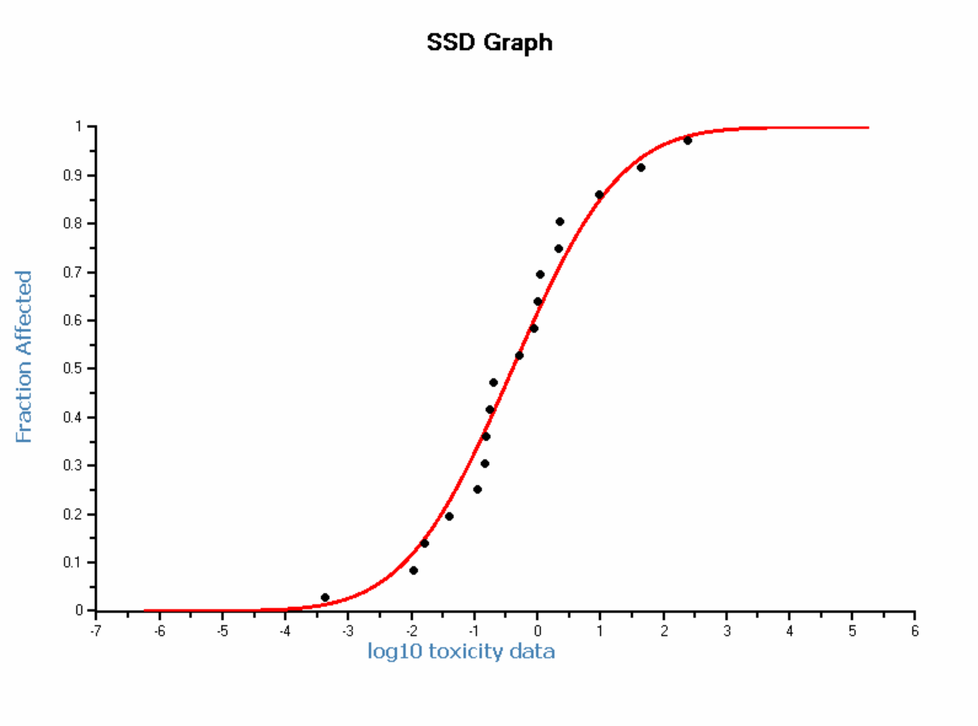


Figure 5: Species sensitivity distribution with chronic toxicity data for TPT.

3.4.1.3 Final choice of the $MPC_{fw, eco}$ and the $MPC_{sw, eco}$

The use of the SSD method is preferred over the assessment factor method, since it makes use of all available data. The value from this method (0.23 ng/L) is close to the lowest detection limit reported of 1.7 ng/L (RIWA, 2010). From this point of view, the value from the AF method (0.043) would also be less practical since it is much lower than the detection limit. Therefore, the $MPC_{fw, eco}$ is 0.23 ng/L and the $MPC_{sw, eco}$ is 0.23 ng /L, both expressed on the basis of the TPT-ion.

3.4.2 $MPC_{fw, secpois}$ and $MPC_{sw, secpois}$

Derivation of ERLs for secondary poisoning is required (see section 2.8). From an efficiency point of view, it is at first considered if the $MPC_{water, hh food}$ is protective for exposure through secondary poisoning. Therefore, a calculation has been performed starting with the chronic NOAEL of 0.025 mg/kg_{bw}/day for immunotoxicity of tributyltin oxide to rats which is the basis of the TL_{hh} as given in section 2.7. If this NOAEL is recalculated to TPT according the method given section 2.7, the NOAEL for TPT would be 0.029 mg/kg_{bw}/day. Immunotoxicity is not a relevant parameter for population dynamics and therefore this value can be taken as a worst case estimate for the toxicity of TPT to birds and mammals which are exposed through secondary poisoning. Using the default conversion factor of 20 to express the NOAEL as a concentration in food, the worst case NOAEC is 0.029 x 20 = 0.58 mg/kg_{food}. Applying an assessment factor of 30, the worst case $MPC_{oral, min}$ will then be 0.58 / 30 = 0.019 mg/kg_{food}. This value is lower than NOEC-values of 10 and >3 mg/kg_{food} for both bobwhite quail and mallard that are reported in the registration dossiers for TPT as plant protection product, which is an indication that the worst case $MPC_{oral, min}$ is indeed protective for birds. The calculated worst case $MPC_{oral, min}$ value is higher than the $MPC_{biota, hh, food}$ as calculated below in section 3.4.3. The $MPC_{fw, secpois}$ is derived with the same BCF and BMF_1 as used for the calculation of the $MPC_{water, hh food}$. Since no additional BMF is necessary for the saltwater compartment environment, $MPC_{sw, secpois}$ will also be covered by the $MPC_{water, hh food}$. It is concluded that derivation of an MPC for secondary poisoning of TPT is not necessary.

3.4.3 $MPC_{water, hh food}$

Derivation of $MPC_{water, hh food}$ for TPT is triggered (see section 2.8). Furthermore, the importance of the route of fish consumption for humans for organotin compounds was shown in a Finnish study (Airaksinen et al., 2010). It appeared that with an average consumption for the Finnish population of 45 g of fish per day, the consumption of fish filled 1.3% of the TDI. Of this amount the daily intake of only 10 g domestic wild fish contributed to 61% of the intake of organotin compounds, while the intake of domestic farmed fish contributed to only 4% and imported fish contributed to 35%. Domestic wild fish from Finland appeared to contain 1.9 to 31 μg/kg_{wwt} total organotin compounds. The most important sources were domestic perch and imported rainbow trout and salmon. These fish species are indeed predatory fish that are rather high in the aquatic food chain.

The $MPC_{water, hh food}$ is calculated using Equation 15 of the INS-Guidance. The TL_{hh} used as given in section 2.7, is derived from a TDI for organotin compounds in general assuming that exposure of organotin is fully attributed to TPT. With the TL_{hh} of 0.29 μg TPT/kg_{bw}/day, the $MPC_{hh food}$ becomes (0.1 × 0.29 × 70) / 0.115 = 17.7 μg/kg. Using the estimated BCF of 3500 L/kg and a BMF_1 of 3.7 kg/kg (section 2.6), the $MPC_{water, hh food}$ is calculated according to Equation 16 of the INS-Guidance as 17.7 / (3500 × 3.7) = 0.0014 μg/L = 1.4 ng TPT/L. The $MPC_{water, hh food}$ is valid for the fresh- and the saltwater compartment.

3.4.4 Selection of the MPC_{fw} and MPC_{sw}

The lowest of the individual MPCs based on direct exposure, secondary poisoning or human consumption of fishery products should be selected as the final MPC. These are the $MPC_{fw, eco}$ of 0.23 ng TPT/L and the $MPC_{sw, eco}$ of 0.23 ng TPT/L.

TPT has a log $K_{p, susp-water}$ ≥3; expression of the MPC_{water} as $MPC_{SPM, water}$ is required. The $MPC_{SMP, fw}$ and $MPC_{SMP, sw}$ are calculated according to:

$$MPC_{SPM, water} = MPC_{water, dissolved} \times K_{p, susp-water, Dutch standard}$$

For this calculation, $K_{p,susp-water,Dutch standard}$ is calculated from the log K_{oc} of 4.0 (mean of experimental log K_{oc} 4.4 and 3.5 for TPT hydroxide) as given in Table 12. With an $f_{OC,susp, Dutch standard}$ of 0.1176 the $K_{p, susp-water, Dutch standard}$ can be calculated to 1176 L/kg. With this value the $MPC_{SPM, fw}$ and $MPC_{SPM, sw}$ are 0.27 μg TPT/kg_{dwt}.

3.5 Derivation of the $MPC_{dw, hh}$

Since TPT has been used as a pesticide, the EU drinking water standard of 0.1 μg/L can be used as $MPC_{dw, hh. provisional}$. Since this value is less stringent than the MPC_{fw} derived, derivation of a separate $MPC_{dw, hh}$ is not necessary (EC, 2011).

3.6 Derivation of the NC_{fw} and NC_{sw}

The NC_{fw} and NC_{sw} are derived by dividing the MPC_{fw} and MPC_{sw} by a factor of 100. The NC_{fw} and NC_{sw} are 2.3 pg TPT/L.
The $NC_{SPM, fw}$ and $NC_{SPM, sw}$ are 2.7 ng TPT/kg_{dwt}.

3.7 Derivation of the $MAC_{fw, eco}$ and $MAC_{sw, eco}$

3.7.1 Assessment factor method

The acute dataset is complete and values are present for 22 species from 9 taxonomic groups and 3 trophic levels. The lowest acute value is an LC50 of 6.0 µg TPT/L for *Planorbis contortis*. According to the guidance an assessment factor of 10 can be applied when the potentially most sensitive taxonomic group is represented in the dataset. Although TPT has no specific mode of action, this is considered the case in view of the size of the dataset which covers a wide range of different taxa. This results in a $MAC_{fw, eco}$ of 0.6 µg TPT/L.
As stated in the introduction, endpoints from studies in which the substance was not measured during the test were considered unreliable. This was the case for many of the studies assessed and also considered studies which had lower endpoints than the acute endpoints presented in Table 13 and Table 14. Most of the rejected studies had additional deficiencies. None of the studies that were rejected solely because of missing analytical data did result in endpoints below the $MAC_{fw, eco}$ of 0.6 µg TPT/L. This $MAC_{fw, eco}$ is therefore considered to be sufficiently protective.
The $MAC_{sw, eco}$ should be derived with an additional assessment factor of 10 since acute endpoints for specific marine taxonomic groups are not available. However, the chronic data for specifically marine taxa show that these are not more sensitive to TPT than freshwater taxa. Therefore the additional assessment factor is not considered necessary and the $MAC_{sw, eco}$ is set to 0.6 µg TPT/L.

3.7.2 Species sensitivity distribution method

The $MAC_{fw, eco}$ can also be derived by applying an SSD to the acute data. For this the same criteria apply as for the SSD with chronic data (see section 3.3.1.2). With the acute dataset covering 22 species, the 8 taxonomic groups covered and their representatives in the present dataset are as follows:

- Fish: represented by *Oryzias latipes* (family Adrianichthyidae).
- A second family in the phylum Chordata: represented by *Oncorhynchus mykiss* (family Salmonidae).
- Crustaceans: represented by *Daphnia magna.*
- Insects: represented by *Endochironomus albipennis.*
- A family in another phylum than Arthropoda or Chordata: represented by the mollusc *Planorbis contortis*.
- A family in any order of insect or any phylum not already represented: represented by the bacteria *Vibrio fischeri.*
- Algae: represented by *Scenedesmus obliquus* and *Scenedesmus vacuolatus.*
- Macrophyta: represented by *Lemna minor* and *Lemna polyrhiza.*

With this coverage, the requirements for the application of the SSD method are met. The SSD method is applied using EtX 2.0 (see Figure 6). The fit is accepted at all levels by all three statistical methods available in the program. The obtained HC5 is 4.7 µg TPT/L with a lower limit of 2.4 µg/L and an upper limit of

7.4 µg/L. Application of the default assessment factor 10 results in a $MAC_{fw,\ eco}$ of 0.47 µg TPT/L.

An additional assessment factor for the $MAC_{sw,\ eco}$ is not considered necessary (see section 2.8). Therefore, the $MAC_{sw,\ eco}$ is equal to the $MPC_{fw,\ eco}$.

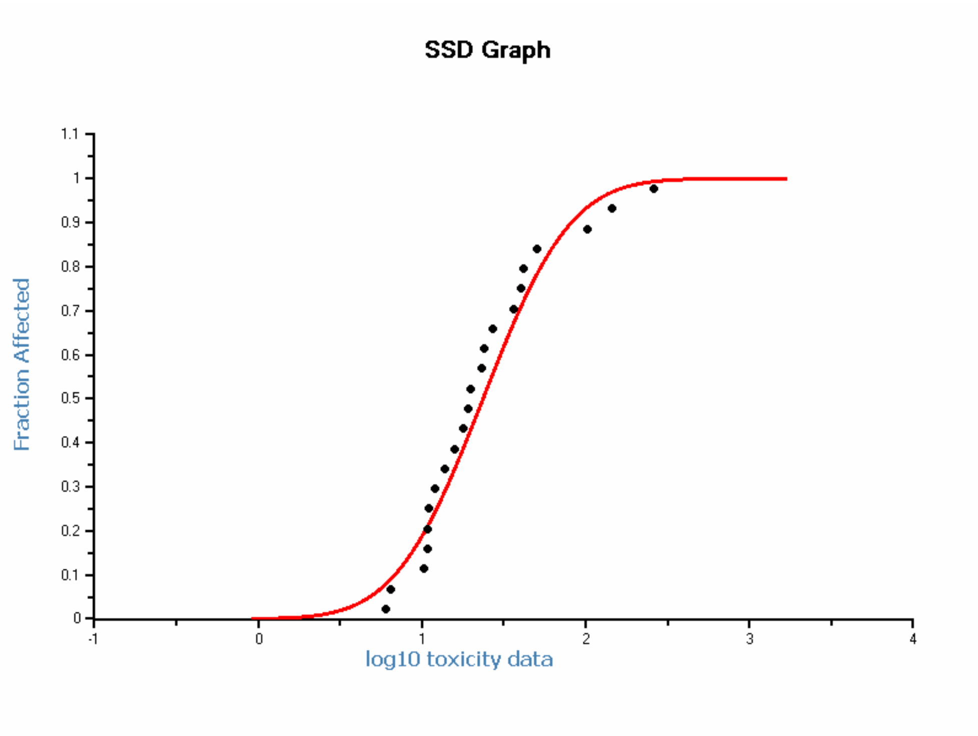


Figure 6: Species sensitivity distribution with acute toxicity data for TPT.

3.7.3 *Final choice of the $MAC_{fw,\ eco}$ and the $MAC_{sw,\ eco}$*

The use of the SSD method is preferred over the assessment factor method (EC, 2011). Therefore, the $MAC_{fw,\ eco}$ is 0.47 µg TPT/L and the $MAC_{sw,\ eco}$ is 0.47 µg TPT/L.

3.8 Derivation of the $SRC_{aquatic,\ eco}$

The $SRC_{aquatic,\ eco}$ is determined by the HC50 of 0.40 µg TPT/L from the SSD with chronic data. This HC50 has a lower limit of 0.11 µg/L and a higher limit of 1.4 µg/L. Since there are sufficient chronic data available, a comparison with acute data is not necessary. Therefore is the $SRC_{aquatic,\ eco}$ 0.40 µg TPT/L. The $SRC_{aquatic,\ eco}$ is valid for fresh- and saltwater compartments.

4 Sediment: Toxicity data derivation of ERLs

4.1 Sediment toxicity data

The endpoints for sediment are presented in Table 15. All values are expressed on the basis of the TPT-ion. Detailed sediment toxicity data for TPT are tabulated in Appendix 2.

Table 15: TPT: selected sediment toxicity data for ERL derivation for the TPT ion.

Chronic[a]	**NOEC/EC10**	**Acute**[a]	**L(E)C50**
Taxonomic group/*species*	**(µg TPT/kg$_{dwt}$)**	**Taxonomic group/***species*	**(µg TPT/kg$_{dwt}$)**
Mollusca		**Insecta**	
Potamopyrgus antipodarum	0.22	*Chironomus riparius*	2800 [b]
Ephoron virgo	23 [c]		

[a] for detailed information see Appendix 2
[b] geometric mean of 3.10 mg/kg$_{dwt}$ and 2.49 mg/kg$_{dwt}$
[c] Most sensitive endpoint: survival

4.2 Derivation of the MPC$_{sediment}$

A chronic endpoint is available for one sediment organism (mollusc) and two acute endpoints for two insects are available. Since only one chronic endpoint is available, an assessment factor of 100 is applied to this value. This results in an MPC$_{sediment, fw}$ of 0.22 / 100 = 2.2 ng TPT/kg$_{dwt}$. According to the INS guidance, when long-term toxicity data are available, a comparison with a value derived from the MPC$_{fw, eco}$ through equilibrium partition is not necessary.

Since it is concluded that marine species are not more sensitive to TPT than freshwater species, the MPC$_{sediment, sw}$ is equal to the MPC$_{sediment, fw.}$

4.3 Derivation of the NC$_{sediment}$

The NC$_{sediment, fw}$ is set a factor 100 below the MPC$_{sediment, fw}$ at 0.022 ng TPT/kg$_{dwt}$. The NC$_{sediment, sw}$ is also 0.022 ng TPT/kg$_{dwt}$.

4.4 Derivation of the SRC$_{sediment, eco}$

Based on the two NOECs available, the SRC$_{sediment, eco}$ is 2.2 µg TPT/kg$_{dwt}$. For comparison, the SRC$_{sediment, eco}$ is also derived by the equilibrium partition method (EqP) using the SRC$_{aquatic, eco}$ of 0.40 µg/L and the log K_{oc} of 4.0 (mean of experimental log K_{oc} 4.4 and 3.5 for TPT hydroxide). This results in an SRC$_{sediment, eco}$ of 236 µg TPT/kg$_{dwt}$. The SRC$_{sediment, eco}$ based on the acute value divided by 10 is 280 µg TPT/kg$_{dwt}$. The SRC$_{sediment, eco}$ is set to the lowest value: 2.2 µg/kg$_{dwt}$ for standard Dutch sediment with 10% organic matter (OM). The SRC$_{sediment, eco}$ is valid for the marine and the freshwater environment.

5 Comparison of derived ERLs with monitoring data

It should be considered that TPT will not occur on its own but as part of a mixture of organotin compounds. Therefore, the occurrence of mixture toxicity should be considered when performing a risk assessment. Organotin compounds are a group of substances of which the mechanisms of toxicity are comparable. Therefore, the risk assessment for every environmental compartment should be based on concentration addition for every organotin compound determined and not on TPT alone. However, since only ERLs for TPT are derived in this report, only these are compared with monitoring data.

The RIWA (Dutch Association of River Water companies) reports monitoring data for TPT. For the years 2006 to 2009 no concentrations of TPT exceeding the detection limit have been reported. However, since the detection limits (ranging from 1.7 to 5 ng/L) are higher than the MPC and NC for fresh surface water, it cannot be stated for sure that these limits are not exceeded in Dutch fresh surface waters.

Monitoring data for the marine environment are available in the database of Rijkswaterstaat (www.waterbase.nl). In this database, many measured concentrations of the TPT-cation in suspended matter in seawater exceed the reporting limit of 3 μg TPT/kg_{dwt}, and values are reported up to a concentration of 10 μg/kg_{dwt}. In marine sediment, almost all measured concentrations exceed the reporting limit with values up to 57 μg TPT/kg_{dwt}. Since the NC, MPC and SRC for suspended matter and sediment derived in this report are lower than the respective reporting limits, it can be concluded that the derived ERLs are likely to be exceeded in many cases in the Dutch marine water and sediment.

An analysis of 56 zebra mussel (*Dreissena polymorpha*) samples from different freshwater systems in the Netherlands yielded concentrations recalculated to fresh weight of 2.4 to 140 μg Sn/kg_{wwt} (Stäb et al., 1995). The median value is 11.4 μg Sn/kg_{wwt}. This median value is close to the maximum permissible concentrations in food of 6.0 and 6.5 μg Sn/kg_{food} (17.7 and 19 μg TPT/kg_{food}) as calculated for the assessment of human health and secondary poisoning respectively.

6 Conclusions

In this report, the risk limits Negligible Concentration (NC), Maximum Permissible Concentration (MPC), Maximum Acceptable Concentration for ecosystems (MAC_{eco}), and Serious Risk Concentration for ecosystems (SRC_{eco}) are derived for TPT in water, groundwater and sediment. Monitoring data indicates that the derived ERLs for marine water and sediment are likely to be exceeded. For freshwater surface water it is unsure if the derived MPC and NC are exceeded since these levels are lower than the reporting limits. It should be mentioned that TPT will not occur on its own but as part of other organotin compounds. For organotins, additive effects (mixture toxicity) should not be ruled out and the total group of organotins should be assessed by application of concentration addition. Furthermore, it should be mentioned that TPT has PBT properties. For this, it is advised that the compound is considered in other relevant frameworks.

The ERLs for the TPT-cation that were obtained are summarised in the table below.

Table 16: Derived MPC, NC, MAC_{eco}, and SRC_{eco} values for TPT.

ERL	**unit**	**value**			
		MPC	NC	MAC_{eco}	SRC_{eco}
fresh water [a]	ng/L	0.23	2.3×10^{-3}	4.7×10^{2}	4.0×10^{2}
susp. matter fresh water [b]	$\mu g/kg_{dwt}$	0.27	2.7×10^{-3}		
salt water	ng/L	0.23	2.3×10^{-3}	4.7×10^{2}	4.0×10^{2}
susp. matter salt water [b]	$\mu g/kg_{dwt}$	0.27	2.7×10^{-3}		
sediment fresh water [c]	ng/kg_{dwt}	2.2	0.022		2.2×10^{3}
sediment salt water [c]	ng/kg_{dwt}	2.2	0.022		2.2×10^{3}

[a] From the $MPC_{fw,\ eco}$, $MPC_{fw,\ secpois}$ and $MPC_{hh,\ food,\ water}$ the lowest one is selected as the 'overall' MPC_{water}.

[b] Expressed on the basis of Dutch standard suspended matter.

[c] Expressed on the basis of Dutch standard sediment.

References

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Appendix 1. Data on bioconcentration

Legend to data tables	Species properties
Test type	S = static; R = renewal; F = flow-through
Test water	am = artificial medium; dtw = dechlorinated tap water; dw = de-ionised/dechlorinated/distilled water; nw = natural water; rw = reconstituted (sea)water; rtw = reconstituted tap water; tw = tap water
BCF-method	Corg/Cw; Cf/Cw = BCF based on ratio between concentrations in organism/organ/fish and water; kinetics = BCF based on uptake and elimination rate constants
Ri	Reliability index, see section 2.2

Table A1.1: Bioconcentration factors for aquatic organisms.

Species	Species properties	Analysis	Test type	Test compound	Purity [%]	Test water	pH	Hardness $CaCO_3$ [mg/L]	Salinity [‰]	Temp. [°C]	Exp. time	Exp. conc. [µg/L]	BCF [L/kg_{wwt}]	BCF type	Method	Ri	Notes	Ref
Algae																		
Scenedesmus obliquus	log-phase	HPLC	S	TPT-Cl		am				25	96 h	1	1.14E+05		Corg/Cw	3	18,59	Huang et al.(1993)
Macrophyta																		
Lemna minor	from the field	LS-5 lumin. spectr.	R	TPT		am				25	8 d	2	5.45		Corg/Cw	2	19,20,21	Song and Huang (2001)
Lemna minor	from the field	LS-5 lumin. spectr.	R	TPT		am				25	8 d	5	2.76		Corg/Cw	2	19,20,21	Song and Huang (2001)
Mollusca																		
Crassostrea gigas	field collected			TPT							60 d	0.4	1398	whole animal dry weight	Corg/Cw	3	1,10,11	Meng et al. (2003)
Haliotis gigantea			F	TPT							63 d	0.1	14060	head	Corg/Cw	3	10,11	Horiguchi et al. (2002)
Haliotis gigantea			F	TPT							63 d	0.1	1260	muscle	Corg/Cw	3	10,11	Horiguchi et al. (2002)
Mytilus edulis	caught in field			TPT-Cl		nw					68 d	0.0008	36000	whole animal	kinetic	3	14	Suzuki et al. (1998)
Mytilus graynus	caught in field			TPT-Cl		nw					56 d		43000	whole animal	kinetic	3	14	Suzuki et al. (1998)
Thais clavigera	female, field collected			TPT							60 d	0.4	5510	whole animal dry weight	Corg/Cw	3	1,10,11	Meng et al. (2003)
Echinodermata																		
Antedon mediterranea	adult	GC-MS/MS	R	TPT-Cl	>98	am		37		16	14 d	0.033	23300	whole animal	Corg/Cw	3	1,4,15	Temolada et al. (2006)
Antedon mediterranea	adult	GC-MS/MS	R	TPT-Cl	>98	am		37		16	14 d	0.014	36700	whole animal	Corg/Cw	3	1,4,15	Temolada et al. (2006)
Antedon mediterranea	adult	GC-MS/MS	R	TPT-Cl	>98	am		37		16	28 d	0.0055	27500	whole animal	Corg/Cw	2	4,12,15	Temolada et al. (2006)
Crustacea																		
Daphnia magna	21 d old	GC	S	TPT-Cl	>97	am	8			20	72 h	8	198	whole animal	kinetics	2	12,24,27,29	Looser et al. (1998)
Daphnia magna	21 d old	GC	S	TPT-Cl	>97	am	8			20	72 h	8	190	whole animal	Corg/Cw	2	12,24,27,29	Looser et al. (1998)
Daphnia magna	21 d old	GC	S	TPT-Cl	>97	am	8			20	72 h	8	150	whole animal	Corg/Cw	3	12,24,27,30	Looser et al. (1998)
Daphnia magna	21 d old	GC	S	TPT-Cl	>97	am	8			20	72 h	8	100	whole animal	Corg/Cw	3	12,24,27,31	Looser et al. (1998)

Species	Species properties	Analysis	Test type	Test compound	Purity [%]	Test water	pH	Hardness $CaCO_3$ [mg/L]	Salinity [‰]	Temp. [°C]	Exp. time	Exp. conc. [μg/L]	BCF [L/kg_{wwt}]	BCF type	Method	Ri	Notes	Ref
Daphnia magna	21 d old	GC	S	TPT-Cl	>97	am	8			20	72 h	8	120	whole animal	Corg/Cw	3	12,24,27,32	Looser et al. (1998)
Daphnia magna	21 d old	GC	S	TPT-Cl	>97	am	8			20	72 h	8	60	whole animal	Corg/Cw	3	12,24,27,33	Looser et al. (1998)
Insecta																		
Chironomus riparius	2 w old larvae	GC	S	TPT-Cl	>97	am	8			20	72 h	4.8	796	whole animal	kinetics	2	1,25,28,29	Looser et al. (1998)
Chironomus riparius	2 w old larvae	GC	S	TPT-Cl	>97	am	8			20	72 h	4.8	680	whole animal	Corg/Cw	3	1,25,28,29	Looser et al. (1998)
Chironomus riparius	2 w old larvae	GC	S	TPT-Cl	>97	am	5			20	72 h	4.3	510	whole animal	Corg/Cw	3	1,25,28,29	Looser et al. (1998)
Pisces																		
Carassius auratus	2.8-3.5 cm, 0.9-1.7 g, lipid content 2.1-2.6%	GC-ECD	F	TPT-Cl	rg	dtw				18±1	14 d	3.2±0.3	257	whole fish	Cf/Cw	3	1	Tsuda et al. (1988)
Carassius auratus	2.8-3.5 cm, 0.9-1.7 g, lipid content 2.1-2.6%	GC-ECD	F	TPT-Cl	rg	dtw				18±1	14 d + 14 d	3.2±0.3	1085	whole fish	simultaneous model	2	45	Tsuda et al. (1988)
Carassius auratus	3.5-4.0 cm, 1.6-2.9 g	GC-FPD	F	TPT-Cl	98	dtw	7.1-7.2	39		23±1	28 d	0.14 ±0.01	1384	whole fish	Cf/Cw	3	1	Tsuda et al. (1991)
Carassius auratus	3.5-4.0 cm, 1.6-2.9 g	GC-FPD	F	TPT-Cl	98	dtw	7.1-7.2	39		23±1	28 d	0.14 ±0.01	1815	whole fish	kinetics	2	45	Tsuda et al. (1991)
Carassius carassius grandoculis	1-2 year, 43-70 g, 12-14 cm	GC-ECD	F	TPT-Cl	rg	dtw				22±1	7 d	7.5±0.5	50	muscle	Corg/Cw	3	1,58	Tsuda (1986)
Carassius carassius grandoculis	1-2 year, 43-70 g, 12-14 cm	GC-ECD	F	TPT-Cl	rg	dtw				22±1	7 d	7.5±0.5	50	vertebra	Corg/Cw	3	18	Tsuda (1986)
Carassius carassius grandoculis	1-2 year, 43-70 g, 12-14 cm	GC-ECD	F	TPT-Cl	rg	dtw				22±1	7 d	7.5±0.5	112	liver	Corg/Cw	3	18	Tsuda (1986)
Carassius carassius grandoculis	1-2 year, 43-70 g, 12-14 cm	GC-ECD	F	TPT-Cl	rg	dtw				22±1	7 d	7.5±0.5	31	kidney	Corg/Cw	3	18	Tsuda (1986)
Chasmichthys dolichognathus	5.21 cm, 1.67 g			TPT-Cl		nw	8.0-8.3		33.3-34.2	25.0±0.9	96 h	13.5±0.7	338	whole fish	Cf/Cw	3	6,9	Shimizu and Kimura (1991)
Chasmichthys dolichognathus	5.30 cm, 1.86 g			TPT-Cl		am	8.1-8.4		33.3-33.6	25.1±1.0	96 h	16.0±3.5	158	whole fish	Cf/Cw	3	6,7,9	Shimizu and Kimura (1991)
Chasmichthys dolichognathus	5.02 cm, 1.52 g			TPT-Cl		am	8.1-8.2		33.0-33.5	25.1±0.9	96 h	13.5±1.0	244	whole fish	Cf/Cw	3	6,7,9	Shimizu and Kimura (1991)
Chasmichthys dolichognathus	5.41 cm, 1.78 g			TPT-Cl		am	8.1-8.3		33.1-33.4	25.0±0.3	96 h	14.0±0.8	305	whole fish	Cf/Cw	3	6,8,9	Shimizu and Kimura (1991)
Cyprinus carpio		GC-ECD	F	TPT-Cl	rg	dtw					10 d	6	200	muscle	Corg/Cw	3	18,45	Tsuda (1986)
Cyprinus carpio	10.0-11.0 cm, 22.9-30.4 g	GC-ECD	F	TPT-Cl	rg	dtw				22±1	7 d	2.1	132	muscle	Corg/Cw	3	18	Tsuda et al. (1987b)
Cyprinus carpio	10.0-11.0 cm, 22.9-30.4 g	GC-ECD	F	TPT-Cl	rg	dtw				22±1	7 d	2.1	189	liver	Corg/Cw	3	18,45	Tsuda et al. (1987b)
Cyprinus carpio	10.0-11.0 cm, 22.9-30.4 g	GC-ECD	F	TPT-Cl	rg	dtw				22±1	7 d	2.1	491	gall bladder	Corg/Cw	3	18,45	Tsuda et al. (1987b)
Cyprinus carpio	10.0-11.0 cm, 22.9-30.4 g	GC-ECD	F	TPT-Cl	rg	dtw				22±1	7 d	2.1	565	kidney	Corg/Cw	3	18,45	Tsuda et al. (1987b)
Cyprinus carpio	10-12 cm, 25.6-36.1 g, lipid content 0.75-0.80%	GC-ECD	F	TPT-Cl	rg	dtw				23±1	10 d	5.6±0.6	269	muscle	Corg/Cw	3	18	Tsuda et al. (1987a)
Cyprinus carpio	10-12 cm, 25.6-36.1 g, lipid content 0.75-0.80%	GC-ECD	F	TPT-Cl	rg	dtw				23±1	10 d	5.6±0.6	912	liver	Corg/Cw	3	18	Tsuda et al. (1987a)
Cyprinus carpio	10-12 cm, 25.6-36.1 g, lipid content 0.75-0.80%	GC-ECD	F	TPT-Cl	rg	dtw				23±1	10 d	5.6±0.6	257	gall bladder	Corg/Cw	3	18	Tsuda et al. (1987a)
Cyprinus carpio	10-12 cm, 25.6-36.1 g, lipid content 0.75-0.80%	GC-ECD	F	TPT-Cl	rg	dtw				23±1	10 d	5.6±0.6	2089	kidney	Corg/Cw	3	18	Tsuda et al. (1987a)

Species	Species properties	Analysis	Test type	Test compound	Purity [%]	Test water	pH	Hardness $CaCO_3$ [mg/L]	Salinity [‰]	Temp. [°C]	Exp. time	Exp. conc. [µg/L]	BCF [L/kg_{wwt}]	BCF type	Method	Ri	Notes	Ref
Cyprinus carpio	8.5-9.5 cm, 16.5-22.1 g	GC-ECD	F	TPT-Cl	98	dtw	6.0 (5.9-6.1)	35.4-39.0		24±1	14 d	1.1±0.1 (1.0-1.3)	391	whole fish	Cf/Cw	3	12,55,56	Tsuda et al. (1990b)
Cyprinus carpio	8.5-9.5 cm, 16.5-22.1 g	GC-ECD	F	TPT-Cl	98	dtw	6.8 (6.7-6.8)	35.4-39.0		24±1	14 d	1.2±0.2 (1.0-1.5)	494	whole fish	Cf/Cw	3	12,55,56	Tsuda et al. (1990b)
Cyprinus carpio	8.5-9.5 cm, 16.5-22.1 g	GC-ECD	F	TPT-Cl	98	dtw	7.8 (7.7-7.9)	35.4-39.0		24±1	14 d	1.2±0.1 (1.0-1.4)	605	whole fish	Cf/Cw	3	12,55,56	Tsuda et al. (1990b)
Cyprinus carpio	8.5-9.5 cm, 16.5-22.1 g	GC-ECD	F	TPT-Cl	98	dtw	6.0 (5.9-6.1)	35.4-39.0		24±1	14 d	1.1±0.1 (1.0-1.3)	445.7	whole fish	kinetics	2	45	Tsuda et al. (1990b)
Cyprinus carpio	8.5-9.5 cm, 16.5-22.1 g	GC-ECD	F	TPT-Cl	98	dtw	6.8 (6.7-6.8)	35.4-39.0		24±1	14 d	1.2±0.2 (1.0-1.5)	566.8	whole fish	kinetics	2	45	Tsuda et al. (1990b)
Cyprinus carpio	8.5-9.5 cm, 16.5-22.1 g	GC-ECD	F	TPT-Cl	98	dtw	7.8 (7.7-7.9)	35.4-39.0		24±1	14 d	1.2±0.1 (1.0-1.4)	672.5	whole fish	kinetics	2	45	Tsuda et al. (1990b)
Cyprinus carpio	20.0 g; 9.2 cm; 4.8% lipids	HPLC	F	TPT-OH	97.6		6.9-7.8			25±2	10 w	0.855 ±0.005	5565	whole fish	Cf/Cw	3	22,23	NITE (2011)
Cyprinus carpio	20.0 g; 9.2 cm; 4.8% lipids	HPLC	F	TPT-OH	97.6		6.9-7.8			25±2	10 w	0.0906 ±0.0039	7055	whole fish	Cf/Cw	3	22,23	NITE (2011)
Cyprinus carpio	20.0 g; 9.2 cm; 4.8% lipids	HPLC	F	TPT-OH	97.6		6.9-7.8			25±2	10 w	0.855 ±0.005	>5233	whole fish	kinetics	2	22,23	NITE (2011)
Cyprinus carpio	20.0 g; 9.2 cm; 4.8% lipids	HPLC	F	TPT-OH	97.6		6.9-7.8			25±2	10 w	0.0906 ±0.0039	>6756	whole fish	kinetics	2	22,23	NITE (2011)
Cyprinus carpio	20.9 g; 9.1 cm; 4.0% lipids	HPLC	F	TPT-F	98.5		6.9-7.8			25±2	8 w	0.939 ±0.008	3910	whole fish	Cf/Cw	3	22,23	NITE (2011)
Cyprinus carpio	20.9 g; 9.1 cm; 4.0% lipids	HPLC	F	TPT-F	98.5		6.9-7.8			25±2	8 w	0.0985 ±0.0009	4495	whole fish	Cf/Cw	3	22,23	NITE (2011)
Cyprinus carpio	20.9 g; 9.1 cm; 4.0% lipids	HPLC	F	TPT-F	98.5		6.9-7.8			25±2	8 w	0.939 ±0.008	4571	whole fish	kinetics	2	22,23	NITE (2011)
Cyprinus carpio	20.9 g; 9.1 cm; 4.0% lipids	HPLC	F	TPT-F	98.5		6.9-7.8			25±2	8 w	0.0985 ±0.0009	7493	whole fish	kinetics	2	22,23	NITE (2011)
Dicentrachus labrax	9-16 cm, 10-25 g	GC-MS/MS		TPT-?	>99	nw	7.2-8.0			23±2	4 w	2.5	638	muscle	Corg/Cw	3	1,10,11	El Hassani et al. (2005)
Dicentrachus labrax	9-16 cm, 10-25 g	GC-MS/MS		TPT-?	>99	nw	7.2-8.0			23±2	4 w	2.5	656	liver	Corg/Cw	3	10,11	El Hassani et al. (2005)
Gnathopogon caerulescens	4.7-5.5 cm, 1.6-3.0 g	GC-FPD	F	TPT-Cl	98	dtw	6.9-7.0	36 (up) 38 (de)		25±1	35 d	0.10 ±0.02 (0.07-0.11)	2300	whole fish	Cf/Cw	3	18,55,57	Tsuda et al. (1992)
Gnathopogon caerulescens	4.7-5.5 cm, 1.6-3.0 g	GC-FPD	F	TPT-Cl	98	dtw	6.9-7.0	36 (up) 38 (de)		25±1	35 d + 21 d	0.10 ±0.02 (0.07-0.11)	2734	simultanous model	Cf/Cw	2		Tsuda et al. (1992)
Lepomis macrochirus		LSC	F	TPT-OH									3300	edible tissue		4		Visser and Linders (1992)
Lepomis macrochirus		LSC	F	TPT-OH									8200	non-edible tissue		4		Visser and Linders (1992)
Lepomis macrochirus	1.4 g	LSC	F	TPT-OH	≥97					22±1	56 d	0.5	4700	whole fish	Cf/Cw	3	1,38,39,55	EC (1996a, 1996b)
Lepomis macrochirus	1.4 g	LSC	F	TPT-OH	≥97					22±1	56 d + 56 d	0.49 ±0.02	7809	whole fish	simultaneous model	2	38,39,55	EC (1996a, 1996b)

Species	Species properties	Analysis	Test type	Test compound	Purity [%]	Test water	pH	Hardness $CaCO_3$ [mg/L]	Salinity [‰]	Temp. [°C]	Exp. time	Exp. conc. [µg/L]	BCF [L/kg$_{wwt}$]	BCF type	Method	Ri	Notes	Ref
Lepomis macrochirus	1.74 g	LSC	F	TPT-OH	>98	nw	6.2-7.6	23-26		17±1	170 d	0.51 ±0.05	3500	whole fish	Cf/Cw	4	12,38,39,55	EC (1996a, 1996b)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	1	2154	liver	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	1	1389	kidney	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	1	676	spleen	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	1	897	gills	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	1	191	muscle	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	2	2412	liver	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	2	1728	kidney	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	2	654	spleen	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	2	1324	gills	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	2	147	muscle	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	4	2735	liver	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	4	1338	kidney	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	4	919	spleen	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	4	566	gills	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	28 d	4	220	muscle	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	18 d	6	2676	liver	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	18 d	6	1492	kidney	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	18 d	6	1022	spleen	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	18 d	6	559	gills	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	4-5 months	GC-MS (w), GC-FPD (f)	F	TPT-Ac	>98	nw	7.7-7.8	380		10±1	18 d	6	250	muscle	Corg/Cw	3	18, 44,45	Schwaiger et al. (1996)
Oncorhynchus mykiss	newly hatched	LSC	S	14C-TPT-OH			07-Aug			10	4 d	3	669	whole fish	kinetics	3	1,2,49,50	Tas et al. (1989)
Oncorhynchus mykiss	newly hatched	LSC	S	14C-TPT-OH			07-Aug			10	4 d	3	82	whole fish	Cf/Cw	3	1,49,50	Tas et al. (1989)

Species	Species properties	Analysis	Test type	Test compound	Purity [%]	Test water	pH	Hardness $CaCO_3$ [mg/L]	Salinity [‰]	Temp. [°C]	Exp. time	Exp. conc. [µg/L]	BCF [L/kg_{wwt}]	BCF type	Method	Ri	Notes	Ref
Oncorhynchus mykiss	larvae, newly hatched, 72-146 mg	LSC	S	14C-TPT-OH	99	tw	07-Aug			10.0±0.5	4 d + 12 d	2.8±0.3	710	whole fish	kinetics	2	1,63	Tas et al. (1990)
Oncorhynchus mykiss	larvae, newly hatched, 72-146 mg	LSC	S	14C-TPT-OH	99	tw	07-Aug			10.0±0.5	4 d	2.8±0.3	95	whole fish	Cf/Cw	3	1,63	Tas et al. (1990)
Oncorhynchus mykiss	larvae, newly hatched, 72-146 mg	LSC	S	14C-TPT-OH	99	tw	07-Aug			10.0±0.5	4 d + 12 d	2.8±0.3	566	whole fish	simultaneous model	2	1,63	Tas et al. (1990)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; females	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	0.0016	4075	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; females	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	0.008	3613	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; females	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	0.04	3525	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; females	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	0.2	3600	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; females	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	1	4920	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; males	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	0.0016	5244	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; males	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	0.008	4575	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; males	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	0.04	5375	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; males	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	0.2	4745	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	adults; 5 months old; 650 mg; 32 mm; males	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	5 w	1	5595	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	eggs, maternal transfer	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	4 w	0.0016	638	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	eggs, maternal transfer	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	4 w	0.008	580	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	eggs, maternal transfer	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	4 w	0.04	530	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	eggs, maternal transfer	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	4 w	0.2	585	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Oryzias latipes	eggs, maternal transfer	GC-MS	F	TPT-Cl			7.9±0.1	81.1±1.2		25±1	4 w	1	876	whole fish	Cf/Cw	2	17,61	Zhang et al. (2008)
Pagrus major	juvenile; 24.3±3.4 g, 10-11% lipids	GC-FPD	F	TPT-Cl	98	nw				24.5±0.5	8 w	0.0633 ±0.0096	3100	whole fish	Cf/Cw	3	1,4	Yamada and Takayanagi (1992)
Pagrus major	juvenile; 13.3±2.7 g, 10-11% lipids	GC-FPD	F	TPT-Cl	98	nw				24.5±0.5	8 w	1.65 ±0.19	3300	whole fish	Cf/Cw	2	4,12	Yamada and Takayanagi (1992)
Pagrus major	juvenile; 13.3±2.7 g, 10-11% lipids	GC-FPD	F	TPT-Cl	98	nw				24.5±0.5	8 w	1.65 ±0.19	3678	whole fish	kinetics	2	4	Yamada and Takayanagi (1992)
Pagrus major	8.0±1.4 g	GC	F	TPT-Cl	98	nw				20	8 w	0.0831	3141	whole fish	Cf/Cw	2	4,12	Yamada et al. (1994)
Pagrus major	8.0±1.4 g	GC	F	TPT-Cl	98	nw				20	8 w + 4 w	0.0831	2987	whole fish	simultaneous model	2	4,12	Yamada et al. (1994)
Phoxinus phoxinus	fertilized eggs	GC-FPD	R	TPT-Cl						16	8 d	5.7	530	whole fish	Cf/Cw	3	1,5,41,68	Fent et al. (1991)
Phoxinus phoxinus	hatched larvae	GC-FPD	R	TPT-Cl						16	6 d	3.2	930	whole fish	Cf/Cw	3	1,5,68	Fent et al. (1991)
Phoxinus phoxinus	yolk-sac fry	GC-FPD	R	TPT-Cl						16	96 h	3.2	457	whole fish	Cf/Cw	3	1,5,42,68	Fent et al. (1991)
Phoxinus phoxinus	fertilized eggs	GC-FPD	R	TPT-Cl						16	8 d	5.7	704	whole fish	Cf/Cw	3	1,5,41,43	Fent et al. (1991)
Phoxinus phoxinus	hatched larvae	GC-FPD	R	TPT-Cl						16	6 d	3.2	1986	whole fish	Cf/Cw	3	1,5,43	Fent et al. (1991)

Species	Species properties	Analysis	Test type	Test compound	Purity [%]	Test water	pH	Hardness $CaCO_3$ [mg/L]	Salinity [‰]	Temp. [°C]	Exp. time	Exp. conc. [µg/L]	BCF [L/kg_{wwt}]	BCF type	Method	Ri	Notes	Ref
Phoxinus phoxinus	yolk-sac fry	GC-FPD	R	TPT-Cl						16	96 h	3.2	703	whole fish	Cf/Cw	3	1,5,42,43	Fent et al. (1991)
Pimephales promelas	newly fertilized embryos		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	<1 d	0.0654	1420-2160		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	newly fertilized embryos		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	<1 d	0.231	1510-2180		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	72-96 h old embryos		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	3-4 d	0.0654	2460-3170		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	72-96 h old embryos		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	3-4 d	0.231	2210		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	10-14 d post-hatch larvae		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	10-14 d	0.0654	6330-6560		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	pre-spawn adults		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	84 d	0.0654	9190-12100		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	pre-spawn adults		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	84 d	0.231	6930-8790		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	post-spawn males		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	155 d	0.0654	16800-19700		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	post-spawn males		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	155 d	0.231	14300-18500		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	post-spawn females		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	155 d	0.0654	13400-13800		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	post-spawn females		F	TPT-OH		nw	7.74-8.25	134-160		24.2-25.9	155 d	0.231	12200-14600		Cf/Cw	2	39,40	US EPA-OPTS (1988)
Pimephales promelas	newly fertilized embryos		F	TPT-OH	97-99					14.4-15.1	<1 d	0.0654	1420-2160		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	newly fertilized embryos		F	TPT-OH	97-99					14.4-15.1	<1 d	0.231	1510-2180		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	72-96 h old embryos		F	TPT-OH	97-99					14.4-15.1	3-4 d	0.0654	2460-3170		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	72-96 h old embryos		F	TPT-OH	97-99					14.4-15.1	3-4 d	0.231	2210		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	10-14 d post-hatch larvae		F	TPT-OH	97-99					14.4-15.1	10-14 d	0.0654	6330-6560		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	pre-spawn adults		F	TPT-OH	97-99					14.4-15.1		0.0654	9190-12100		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	pre-spawn adults		F	TPT-OH	97-99					14.4-15.1		0.231	6930-8790		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	post-spawn males		F	TPT-OH	97-99					14.4-15.1		0.0654	16800-19700		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	post-spawn males		F	TPT-OH	97-99					14.4-15.1		0.231	14300-18500		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	post-spawn females		F	TPT-OH	97-99					14.4-15.1		0.0654	13400-13800		Cf/Cw	4	39,40	EC (1996a, 1996b)
Pimephales promelas	post-spawn females		F	TPT-OH	97-99					14.4-15.1		0.231	12200-14600		Cf/Cw	4	39,40	EC (1996a, 1996b)

Species	Species properties	Analysis	Test type	Test compound	Purity [%]	Test water	pH	Hardness $CaCO_3$ [mg/L]	Salinity [‰]	Temp. [°C]	Exp. time	Exp. conc. [µg/L]	BCF [L/kg$_{wwt}$]	BCF type	Method	Ri	Notes	Ref
Poecilia reticulata		LCS	R	14C-TPT-OH			07-Aug			20	8 d	6	2450	whole fish	kinetics	3	1,2,3,49,51	Tas et al. (1989)
Poecilia reticulata		LSC	R	14C-TPT-OH			07-Aug			20	8 d	6	632	whole fish	Cf/Cw	3	1,49	Tas et al. (1989)
Poecilia reticulata	56-138 mg	LSC	R	14C-TPT-OH	99	tw	07-Aug			2.0±0.5	8 d + 6 d	6.1±0.4	14000	whole fish	kinetics	3	1,2,52,64,65	Tas et al. (1990)
Poecilia reticulata	56-138 mg	LSC	R	14C-TPT-OH	99	tw	07-Aug			2.0±0.5	8 d + 6 d	6.1±0.4	2100	whole fish	kinetics	3	1,2,3,64,65	Tas et al. (1990)
Poecilia reticulata	56-138 mg	LSC	R	14C-TPT-OH	99	tw	07-Aug			2.0±0.5	8 d	6.1±0.4	610	whole fish	Cf/Cw	3	1,64,65	Tas et al. (1990)
Poecilia reticulata	78-232 mg	LSC	R	14C-TPT-OH	99	tw	07-Aug			2.0±0.5	30 d + 53 d	4.1±0.1	2900	whole fish	kinetics	3	1,2,53,66	Tas et al. (1990)
Poecilia reticulata	78-232 mg	LSC	R	14C-TPT-OH	99	tw	07-Aug			2.0±0.5	30 d	4.1±0.1	1600	whole fish	Cf/Cw	3	1,53,66	Tas et al. (1990)
Poecilia reticulata	78-232 mg	LSC	R	14C-TPT-OH	99	tw	07-Aug			2.0±0.5	30 d + 53 d	3.6±0.6	4921	whole fish	simultaneous model	2	1,47,66	Tas et al. (1990)
Poecilia reticulata	115-315 mg; 2.6% lipids	GC-FPD	F	TPT-Cl							42 h	80	313	whole fish	Cf/Cw	3	9,16	Tas et al. (1991)
Poecilia reticulata													3571	whole fish	kinetics	3	2,54	Tas et al. (1991)
Poecilia reticulata	427±97 mg, 3.7±0.3 cm, 3.1±1.1% fat	GC-FPD	S	TPT-Cl			8.3±0.2			19.5±1.3	11 d + 154 d	1.9±0.1	10000	whole fish	kinetics	2	2,13,47	Tas et al. (1996)
Poecilia reticulata	427±97 mg, 3.7±0.3 cm, 3.1±1.1% fat	GC-FPD	S	TPT-Cl			8.3±0.2			19.5±1.3	11 d + 154 d	1.9±0.1	7941	whole fish	simultaneous model	2	13,47	Tas et al. (1996)
Poecilia reticulata	427±97 mg, 3.7±0.3 cm, 3.1±1.1% fat	GC-FPD	S	TPT-Cl			8.3±0.2			19.5±1.3	11 d	1.9±0.1	4500	whole fish	Cf/Cw	3	13,48	Tas et al. (1996)
Poecilia reticulata	female, 2.4-2.7 cm, 0.41-0.55 g, 2.7% lipid content	GC-FPD	F	TPT-Cl	98	dtw	7.1-7.3	37		25±1	14 d	0.90 ±0.07	1100	whole fish	Cf/Cw	3	18	Tsuda et al. (1990a)
Poecilia reticulata	female, 2.4-2.7 cm, 0.41-0.55 g, 2.7% lipid content	GC-FPD	F	TPT-Cl	98	am	8.0-8.2		19 g/L Cl	25±1	14 d	0.71 ±0.07	530	whole fish	Cf/Cw	3	4,12,60	Tsuda et al. (1990a)
Poecilia reticulata	female, 2.4-2.7 cm, 0.41-0.55 g, 2.7% lipid content	GC-FPD	F	TPT-Cl	98	dtw	7.1-7.3, 7.2-7.4	37		25±1	14 d + 14 d	0.90 ±0.07	1337	whole fish	simultaneous model	2		Tsuda et al. (1990a)
Poecilia reticulata	female, 2.4-2.7 cm, 0.41-0.55 g, 2.7% lipid content	GC-FPD	F	TPT-Cl	98	am	8.0-8.2, 8.1-8.3		19 g/L Cl	25±1	14 d + 14 d	0.71 ±0.07	493.7	whole fish	simultaneous model	3	4,60	Tsuda et al. (1990a)
Rudarius ercodes	juvenile; 1.1±0.2 g, 7% lipids	GC-FPD	F	TPT-Cl	98	nw				19.8±0.1	8 w	0.148 ±0.017	4100	whole fish	Cf/Cw	3	1,4	Yamada and Takayanagi (1992)
Rudarius ercodes	juvenile; 1.1±0.2 g, 7% lipids	GC-FPD	F	TPT-Cl	98	nw				19.8±0.1	8 w	0.148 ±0.017	5198	whole fish	kinetics	2	4	Yamada and Takayanagi (1992)
Thymallus thymallus	freshly hatched larvae from fertilized eggs from the river Rhine; 18.9±0.9 mg, 21.2±0.4% dw, 3.1±0.5% lipids	GC-FPD	R	TPT-Cl	>97	nw	8.3±0.1	340		15±1	168 h	3.2±0.4	7550	whole animal	kinetics	3	1,26,28,29,69,67	Looser et al. (1998)
Thymallus thymallus	freshly hatched larvae from fertilized eggs from the river Rhine	GC-FPD	S	TPT-Cl	>97	nw	8.3±0.1	340		15±1	48 h	3.2±0.4	2240	whole animal	Cf/Cw	3	1,26,28,29, 67	Looser et al. (1998)
Thymallus thymallus	freshly hatched larvae from fertilized eggs from the river Rhine	GC-FPD	S	TPT-Cl	>97	nw	8.3±0.1	340		15±1	48 h	3.2±0.4	1900	whole animal	Cf/Cw	3	26,28,34	Looser et al. (1998)
Thymallus thymallus	freshly hatched larvae from fertilized eggs from the river Rhine	GC-FPD	S	TPT-Cl	>97	nw	8.3±0.1	340		15±1	48 h	3.2±0.4	1550	whole animal	Cf/Cw	3	26,28,35	Looser et al. (1998)

Species	Species properties	Analysis	Test type	Test compound	Purity [%]	Test water	pH	Hardness $CaCO_3$ [mg/L]	Salinity [‰]	Temp. [°C]	Exp. time	Exp. conc. [µg/L]	BCF [L/kg_{wwt}]	BCF type	Method	Ri	Notes	Ref
Thymallus thymallus	freshly hatched larvae from fertilized eggs from the river Rhine	GC-FPD	S	TPT-Cl	>97	nw	8.3±0.1	340		15±1	48 h	3.2±0.4	1520	whole animal	Cf/Cw	3	26,28,36	Looser et al. (1998)
Thymallus thymallus	freshly hatched larvae from fertilized eggs from the river Rhine	GC-FPD	S	TPT-Cl	>97	nw	8.3±0.1	340		15±1	48 h	3.2±0.4	2000	whole animal	Cf/Cw	3	26,28,37	Looser et al. (1998)

Notes

1 Plateau not reached.
2 Recalculated from k1 and k2 given in paper.
3 High standard deviation of k2, estimated maximum value used.
4 Performed in seawater.
5 Value recalculated for mean measured concentration.
6 Data from abstracts and tables, paper in Japanese.
7 AM with Na_2SiO_3.
8 AM without Na_2SiO_3.
9 Exposure probably too short to reach equilibrium.
10 Water concentration not analysed, nominal concentration used.
11 Identity of the test compound unknown (-OH, -CL or -Ac).
12 Plateau reached.
13 Water solution prepared with generator column.
14 In-situ assays; BCF estimated from uptake by *Mytilus graynus* collected at clean site and exposed at contaminated site, and elimination by *Mytilus edulis* collected at contaminated field site and kept at clean site.
15 Recalculated from reported BCF on the basis of biota volume, estimated biota density is 1.2 g/mL.
16 Lethal body burdens used.
17 Concentrations in water were kept to the designed exposure doses but analysis not reported; flow-through with a 4-fold volume of water flowing through every 24 hours; concentrations are parent TPT (small amounts of metabolites are also measured).
18 Not clear if plateau is reached.
19 Measured concentrations after 8 days close to nominal concentrations.
20 No detail on TPT species.
21 No details on use of solvents.
22 Solvent = DMSO.
23 Equilibrium not reached after 8 or 10 weeks.
24 0.3% lipids (wet weight basis).
25 0.6% lipids (wet weight basis).
26 Larval density 1.3-2.1 g/L; 3.1% lipids (wet weight basis).
27 Close to steady state.
28 No steady state.
29 No humic acid.
30 1.1 mg C/L humic acid.
31 4.4 mg C/L humic acid.
32 8.0 mg C/L humic acid.
33 14.2 mg C/L humic acid.
34 1. mg C/L humic acid.
35 1.7 mg C/L humic acid.
36 4.3 mg C/L humic acid.
37 8.8 mg C/L humic acid.
38 Radiolabelled compound used.
39 Solvent = acetone.
40 Performed as a full lifecycle test in line with FIFRA 72-5 guideline; reported tissue concentrations are most likely whole body, at least for the small life-stages.
41 Started with embryos, continued to larval stage.
42 No elimination in clean water.
43 Exposure concentration recalculated as geometric mean of measured concentrations at t=0 and 24 h.
44 Measured concentrations within 20% of nominal.
45 BCFs read from graph.
46 Estimated from sum of reported organ BCFs.

47 Decline of measured concentrations in water with time was accounted for in calculation of k1 and k2 (according to Gobas and Zhang (1992)).
48 Based on concentrations in fish and water after 11 d read from graph.
49 Based on total radioactive residue in fish and water.
50 Expected BCF given as appr. 800 L/kg.
51 Expected BCF given as at least approx. 3000 L/kg.
52 Estimate of k2 not considered reliable in view of high standard deviation.
53 Based on average measured initial concentration in fresh solutions, renewal at days 1, 3, 6, 9, 13, 16, 20, 23, and 27.
54 k1 of 50 mL/g.d is mentioned in paper, but this value not reported in cited reference (Tas et al., (1990) reports 70, 22 and 41 L/kg/d).
55 Measured aqueous concentrations constant over test period.
56 BCF read from graph, 14 d values used.
57 BCF is average of time points 28 and 35 d.
58 Author presumes that equilibrium is reached, based on similar experiment with carp which was extended to 10 days. Relatively low BCF suggests otherwise. A closer look at the experiment with carp shows that equilibrium is likely not to be reached as well.
59 Based on concentration in supernatant.
60 *P. reticulata* is capable of adapting to saltwater; it is not known, however, whether or not this has influenced metabolism and thereby bioconcentration.
61 Used water was activated carbon treated.
62 Tested together with TBT. Concentrations in water were very close to lethal. Two highest (5, 15 ug/L) concentrations showed severe mortality.
63 Medium mortality for larvae (about 25% over 16 days).
64 Renewal daily for the first three days, every other day thereafter.
65 High mortality (about 50% over 14 days).
66 Mortality in depuration phase (about 13% over 83 days).
67 BCF does not match with concentrations in fish and water, probably the used water concentration is erroneous (used 3.741 instead of 3.174, which is the geomean of 4.2 and 2.4) which would imply an even higher BCF.
68 Based on average initial concentrations after renewal.
69 High uncertainty in fitted data.

Appendix 2. Detailed ecotoxicity data

Legend to data tables	Species properties
A	Test water analysed Yes/No
Test type	S = static; R = renewal; F = flow-through
Test water	am = artificial medium; dtw = dechlorinated tap water; dw = de-ionised/dechlorinated/distilled water; nw = natural water; rw = reconstituted (sea)water; rtw = reconstituted tap water; tw = tap water
Ri	Reliability index, see section 2.2

Table A2.1: Acute toxicity for freshwater organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Bacteria																		
Activated sludge		N	S	TPT-Cl	96	am	7.2	18		20	IC50	respiration	43300			3	80	Stasinakis et al. (2001)
Activated sludge		N	S	TPT-Cl	96	am	7.2	18		10	IC50	respiration	3600			3	80	Stasinakis et al. (2001)
Cyanobacteria																		
Anabaena cylindrica		N		TPT-Cl		am		25		5 m	EC50	photosynthesis		2004		3	24,77	Avery et al. (1991)
Anabaena cylindrica		N		TPT-Cl		am		25		3 h	EC50	nitrogenase		1146		3	24,77	Avery et al. (1991)
Anabaena flos-aquae		N	S	TPT-Ac	95	am		24		96 h	EC50	biomass	16.4			3	2,5,13	Ma et al. (2004)
Anabaena flos-aquae	log-phase	N		TPT-Cl		am	8	20		24 h	EC50	primary prod.			20	3	2,14	Wong et al. (1982)
Microcystis aeruginosa		N	S	TPT-Ac	95	am		24		96 h	EC50	biomass	24			3	2,5,13	Ma et al. (2004)
Microcystis flos-aquae		N	S	TPT-Ac	95	am		24		96 h	EC50	biomass	8			3	2,5,13	Ma et al. (2004)
Plectonema boryanum		N		TPT-Cl		am		25		5 m	EC50	photosynthesis		4325		3	24,77	Avery et al. (1991)
Algae																		
Ankistrodesmus falcatus	log-phase	N		TPT-Cl		am	8	20		24 h	EC50	primary prod.			20	3	2,14,24	Wong et al. (1982)
Ankistrodesmus falcatus	log-phase	N		TPT-Cl		am	8	20		8 d	EC50	growth			2	3	2,24	Wong et al. (1982)
Ankistrodesmus falcatus				TPT-Cl						8 d	IC50		2			4		Visser and Linders (1992)
Chlorella pyrenoidosa		N	S	TPT-Ac	95	am		24		96 h	EC50	biomass	36			3	2,5,13	Ma et al. (2004)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		48 h	EC50	photosynth. act.	101.9			3	5,11	Roessink et al. (2006a)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		72 h	EC50	photosynth. act.	8.8			3	5,11	Roessink et al. (2006a)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		96 h	EC50	photosynth. act.	5.6			3	5,11	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		48 h	EC50	photosynth. act.	187.7			3	5,11	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		72 h	EC50	photosynth. act.	51.5			3	5,11	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		96 h	EC50	photosynth. act.	15.8			3	5,11	Roessink et al. (2006a)
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		48 h	EC50	photosynth. act.	58			3	5,11	Roessink et al. (2006a)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		72 h	EC50	photosynth. act.	8.8			3	5,11	Roessink et al. (2006a)
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		96 h	EC50	photosynth. act.	5.6			3	5,11	Roessink et al. (2006a)
Scenedesmus obliquus	log-phase	Y	S	TPT-Cl		am		25		96 h	EC50	growth	5.6			3	5,11,70	Huang et al. (1993)
Scenedesmus obliquus	log-phase	Y	S	TPT-Cl		am		25	50	48 h	EC50	growth rate	30	27		2	5,11,66,75	Huang et al. (1993)
Scenedesmus obliquus	log-phase	Y	S	TPT-Cl		am		25	50	72 h	EC50	growth rate	24			3	5,11,66,75	Huang et al. (1993)
Scenedesmus obliquus	log-phase	Y	S	TPT-Cl		am		25	50	96 h	EC50	growth rate	21			3	5,11,66,75	Huang et al. (1993)
Scenedesmus obliquus	log-phase	N	S	TPT-Cl	>99	am	7.6	25		96 h	EC50	growth			2.62	3	5,11,69	Huang et al. (1993)
Scenedesmus obliquus	log-phase	N	S	TPT-OH	>99	am	7.6	25		96 h	EC50	growth			2.44	3	5,11,69	Huang et al. (1993)
Scenedesmus obliquus	log-phase	N	S	TPT-Ac	>99	am	7.6	25		96 h	EC50	growth			2.71	3	5,11,69	Huang et al. (1993)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		48 h	EC50	photosynth. act.	352.9			3	5,11	Roessink et al. (2006a)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		72 h	EC50	photosynth. act.	29.1			3	5,11	Roessink et al. (2006a)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		96 h	EC50	photosynth. act.	36			3	5,11	Roessink et al. (2006a)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Cl		am	7.2	25		48 h	EC50	tot. chlorophyll	3.8			3	15,36	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Ac		am	7.2	25		48 h	EC50	tot. chlorophyll	0.36			3	15,36,37	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Cl		am	7.2	25		48 h	EC50	chlorophyll-a cont.	3.8			3	15,36	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Ac		am	7.2	25		48 h	EC50	chlorophyll-a cont.	0.29			3	15,36,37	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Cl		am	7.2	25		48 h	EC50	chlorophyll-b cont.	3.6			3	15,36	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Ac		am	7.2	25		48 h	EC50	chlorophyll-b cont.	0.49			3	15,36,37	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Cl		am	7.2	25		48 h	EC50	respiration	3.2			3	15,36	Fargašová and Drtil (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Ac		am	7.2	25		48 h	EC50	respiration	9.9			3	15,36	Fargašová and Drtil (1996)
Scenedesmus quadricauda		N	S	TPT-Cl	97	am	7.2	25		12 d	EC50	growth rate	351			3	5,11	Fargašová (2002)
Scenedesmus quadricauda		N	S	TPT-Cl	97	am	7.2	25		12 d	EC50	chlorophyll-a cont.	1149			3	5,11	Fargašová (2002)
Scenedesmus quadricauda		N	S	TPT-Cl	97	am	7.2	25		12 d	EC50	oxygen evolution	1322			3	5,11	Fargašová (2002)
Scenedesmus quadricauda		N	S	TPT-Ac	97	am	7.2	25		12 d	EC50	growth rate	585			3	5,11	Fargašová (2002)
Scenedesmus quadricauda		N	S	TPT-Ac	97	am	7.2	25		12 d	EC50	chlorophyll-a cont.	409			3	5,11	Fargašová (2002)
Scenedesmus quadricauda		N	S	TPT-Ac	97	am	7.2	25		12 d	EC50	oxygen evolution	1845			3	5,11	Fargašová (2002)
Scenedesmus quadricauda	exponential growth	N	S	TPT-Cl		am	7.2	25		12 d	EC50	growth rate	1.3			3	15,36	Fargašová (1997b)
Scenedesmus quadricauda	exponential growth	N	S	TPT-Ac		am	7.2	25		12 d	EC50	growth rate	1.4			3	15,36	Fargašová (1997b)
Scenedesmus quadricauda	exponential growth	N	S	TPT-Cl		am	7.2	25		12 d	EC50	growth	1			3	15,36	Fargašová and Kizlink (1996b)
Scenedesmus quadricauda	exponential growth	N	S	TPT-Ac		am	7.2	25		12 d	EC50	growth	1.4			3	15,36	Fargašová and Kizlink (1996b)
Scenedesmus quadricauda	log-phase	N		TPT-Cl		am	8	20		24 h	EC50	primary prod.			40	3	2,14	Wong et al. (1982)
Scenedesmus quadricauda	exponential growth	N	S	TPT-Cl		am		22		8 d	EC50	growth rate	23.7			3	4,78	Xu et al. (2011)
Scenedesmus quadricauda	exponential growth	N	S	TPT-Cl		am		22		12 d	EC50	growth rate	20.5			3	4,78,79	Xu et al. (2011)
Scenedesmus subspicatus		N	S	TPT-Ac						72 h	EC50	biomass	32			3	15,18	EC (1996a, 1996b)
Scenedesmus subspicatus		N	S	TPT-Ac	50					72 h	EC50	biomass	69			3	18	EC (1996a, 1996b)
Scenedesmus subspicatus		N	S	TPT-Ac	50					72 h	EC50	growth rate	190			3	18	EC (1996a, 1996b)
Scenedesmus vacuolatus	at onset of log phase	Y	S	TPT-Cl	98	am	6.9	28		24 h	EC50	cell number	112	102		2	7,17	Walter et al. (2002)
Protozoa																		
Paramecium caudatum	SJ-4 strain	N	S	TPT-Cl		am		23		48 h	IC50	growth	11.6			3	3,7,28	Miyoshi et al. (2003)
Paramecium caudatum	SJ-4 strain	N	S	TPT-Cl		am		23		120 h	IC50	growth	30.8			3	3,7,28	Miyoshi et al. (2003)
Paramecium trichium	OH-24b strain	N	S	TPT-Cl		am		23		48 h	IC50	growth	2.6			3	3,7,28	Miyoshi et al. (2003)
Paramecium trichium	OH-24b strain	N	S	TPT-Cl		am		23		120 h	IC50	growth	5			3	3,7,28	Miyoshi et al. (2003)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [μg/L]	Value TPT-ion [μg/L]	Value Sn [μg/L]	Ri	Notes	Ref
Macrophyta																		
Ceratophyllum demersum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		2 d	EC50	photosynth. act.	240.6			3	5,11,39,40,45,46	Roessink et al. (2006a)
Ceratophyllum demersum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		7 d	EC50	photosynth. act.	92.5			3	5,11,39,40,45,46	Roessink et al. (2006a)
Ceratophyllum demersum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC50	photosynth. act.	1357.3			3	5,11,39,40,45,46	Roessink et al. (2006a)
Ceratophyllum demersum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC50	relative growth	12.9			3	5,11,39,40,45,46	Roessink et al. (2006a)
Elodea canadensis	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		2 d	EC50	photosynth. act.	197.8			4	5,11,39,40,45	Roessink et al. (2006a)
Elodea canadensis	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		7 d	EC50	photosynth. act.	176.6			4	5,11,39,40,45	Roessink et al. (2006a)
Elodea canadensis	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		21 d	EC50	photosynth. act.	44.5			4	5,11,39,40,45	Roessink et al. (2006a)
Elodea canadensis	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		21 d	EC50	relative growth	23.4			4	5,11,39,40,45	Roessink et al. (2006a)
Elodea nuttallii	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		2 d	EC50	photosynth. act.	59.4			3	5,11,39,40,45,46	Roessink et al. (2006a)
Elodea nuttallii	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		7 d	EC50	photosynth. act.	101.9			3	5,11,39,40,45,46	Roessink et al. (2006a)
Elodea nuttallii	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC50	photosynth. act.	97.7			3	5,11,39,40,45,46	Roessink et al. (2006a)
Elodea nuttallii	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC50	relative growth	11.87			3	5,11,39,40,45,46	Roessink et al. (2006a)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	IC50	growth			15.8	4	15,21,65	Song and Huang (2001)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	EC50	growth rate		11	3.8	2	15,21,65,24,61,62	Song and Huang (2001)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	EC50	growth rate		17	5.9	2	15,21,65,24,61,63	Song and Huang (2001)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	EC50	growth rate		12	4.2	2	15,21,65,24,61,64	Song and Huang (2001)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	EC50	chlorophyll cont.			3.2	3	15,21,65,9,61,62,76	Song and Huang (2001)
Lemna minor	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		2 d	EC50	photosynth. act.	64000			3	5,11,39,40,45,46,71	Song and Huang (2001)
Lemna minor	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		7 d	EC50	photosynth. act.	138.9			3	5,11,39,40,45,46	Song and Huang (2001)
Lemna minor	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20		21 d	EC50	photosynth. act.	130.4			3	5,11,39,40,45,46	Song and Huang (2001)
Lemna minor	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20		21 d	EC50	relative growth	198.9			3	5,11,39,40,45,46	Song and Huang (2001)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	IC50	growth			19.2	4	15,21,32	Song and Huang (2005)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	IC50	chlorophyll cont.			5.76	4	15,21,32,60	Song and Huang (2005)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	EC50	growth rate		9.6	3.3	2	15,21,32,24,61,62	Song and Huang (2005)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	EC50	growth rate		30	10.6	2	15,21,32,24,61,63	Song and Huang (2005)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	EC50	growth rate		24	8.2	2	15,21,32,24,61,64	Song and Huang (2005)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	EC50	chlorophyll cont.		64	21.9	2	15,21,32,9,61,63	Song and Huang (2005)
Lemna trisulca	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20		2 d	EC50	photosynth. act.	122.5			4	5,11,39,40,45	Roessink et al. (2006a)
Lemna trisulca	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20		7 d	EC50	photosynth. act.	69.5			4	5,11,39,40,45	Roessink et al. (2006a)
Lemna trisulca	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20		21 d	EC50	photosynth. act.	36.1			4	5,11,39,40,45	Roessink et al. (2006a)
Lemna trisulca	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20		21 d	EC50	relative growth	64.5			4	5,11,39,40,45	Roessink et al. (2006a)
Myriophyllum spicatum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20		21 d	EC50	relative growth	73.4			3	5,11,39,40,45,46	Roessink et al. (2006a)
Potamogeton crispus	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-10	20		2 d	EC50	photosynth. act.	127.9			4	5,11,39,40,45	Roessink et al. (2006a)
Potamogeton crispus	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-10	20		7 d	EC50	photosynth. act.	29			4	5,11,39,40,45	Roessink et al. (2006a)
Potamogeton crispus	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-10	20		21 d	EC50	relative growth	38.8			4	5,11,39,40,45	Roessink et al. (2006a)
Spirodela polyrhiza	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	6-9	20		2 d	EC50	photosynth. act.	5600			4	5,11,39,40,45	Roessink et al. (2006a)
Spirodela polyrhiza	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	6-9	20		7 d	EC50	photosynth. act.	29			4	5,11,39,40,45	Roessink et al. (2006a)
Spirodela polyrhiza	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	6-9	20		21 d	EC50	photosynth. act.	33.1			4	5,11,39,40,45	Roessink et al. (2006a)
Spirodela polyrhiza	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	6-9	20		21 d	EC50	relative growth	4.6			4	5,11,39,40,45	Roessink et al. (2006a)
Platyhelminthes																		
Dugesia sp.		Y	S	TPT-Ac	ag	nw	8	20		48 h	EC10	behaviour	2.7			4	5,11,39,40	Roessink et al. (2006a)
Dugesia sp.		Y	S	TPT-Ac	ag	nw	8	20		96 h	EC10	behaviour	2.9			4	5,11,39,40	Roessink et al. (2006a)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Dugesia sp.		Y	S	TPT-Ac	ag	nw	8	20		48 h	EC50	behaviour	9.8			4	5,11,39,40	Roessink et al. (2006a)
Dugesia sp.		Y	S	TPT-Ac	ag	nw	8	20		96 h	EC50	behaviour	6.1			4	5,11,39,40	Roessink et al. (2006a)
Dugesia sp.		Y	S	TPT-Ac	ag	nw	8	20		48 h	LC10	mortal./immobil.	24.9	21.3		2	5,11,39,40	Roessink et al. (2006a)
Dugesia sp.		Y	S	TPT-Ac	ag	nw	8	20		96 h	LC10	mortal./immobil.	19	16.3		2	5,11,39,40	Roessink et al. (2006a)
Dugesia sp.		Y	S	TPT-Ac	ag	nw	8	20		48 h	LC50	mortal./immobil.	35.3	30.2		2	5,11,39,40	Roessink et al. (2006a)
Dugesia sp.		Y	S	TPT-Ac	ag	nw	8	20		96 h	LC50	mortal./immobil.	20.9	17.9		2	5,11,39,40	Roessink et al. (2006a)
Polycelis niger/tenuis		Y	S	TPT-Ac	ag	nw	8	20		48 h	EC10	behaviour	3.1			4	5,11,39,40	Roessink et al. (2006a)
Polycelis niger/tenuis		Y	S	TPT-Ac	ag	nw	8	20		96 h	EC10	behaviour	3.4			4	5,11,39,40	Roessink et al. (2006a)
Polycelis niger/tenuis		Y	S	TPT-Ac	ag	nw	8	20		48 h	EC50	behaviour	10.6			4	5,11,39,40	Roessink et al. (2006a)
Polycelis niger/tenuis		Y	S	TPT-Ac	ag	nw	8	20		96 h	EC50	behaviour	6.6			4	5,11,39,40	Roessink et al. (2006a)
Polycelis niger/tenuis		Y	S	TPT-Ac	ag	nw	8	20		48 h	LC10	mortal./immobil.	42.4	36.3		2	5,11,39,40	Roessink et al. (2006a)
Polycelis niger/tenuis		Y	S	TPT-Ac	ag	nw	8	20		96 h	LC10	mortal./immobil.	20.8	17.8		2	5,11,39,40	Roessink et al. (2006a)
Polycelis niger/tenuis		Y	S	TPT-Ac	ag	nw	8	20		48 h	LC50	mortal./immobil.	46.9	40.1		2	5,11,39,40	Roessink et al. (2006a)
Polycelis niger/tenuis		Y	S	TPT-Ac	ag	nw	8	20		96 h	LC50	mortal./immobil.	23.2	19.9		2	5,11,39,40	Roessink et al. (2006a)
Mollusca																		
Biomphalaria glabrata		N	S	TPT-Fl			5.5			24 h	LC50	mortality	10-550			3		Crommentuijn et al. (1997)
Bithynia tentaculata		Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	NOEC	mortal./immobil.	≥1000	≥858		2	5,11,39,40,41	Roessink et al. (2006a)
Bithynia tentaculata		N	S	TPT-Ac				19±1		48 h	LC50	mortality	500			3	11,54	EC (1996a, 1996b)
Cipangopaludina malleata				TPT-OH						48 h	EC50		720			4	27	Roessink et al. (2006a)
Indoplanorbis exustus	adult			TPT-Cl							LC50	mortality	350			4		Goel and Prasad (1978)
Indoplanorbis exustus				TPT-OH						48 h	EC50		840			4	27	Roessink et al. (2006a)
Lymnaea stagnalis	26.5 ± 6.4 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		48 h	EC10	behaviour	10			3	5,11,39,40,44	Roessink et al. (2006a)
Lymnaea stagnalis	26.5 ± 6.4 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	EC10	behaviour	10			3	5,11,39,40,44	Roessink et al. (2006a)
Lymnaea stagnalis	26.5 ± 6.4 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		48 h	EC50	behaviour	25			3	5,11,39,40,44	Roessink et al. (2006a)
Lymnaea stagnalis	26.5 ± 6.4 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	EC50	behaviour	12			3	5,11,39,40,44	Roessink et al. (2006a)
Lymnaea stagnalis	26.5 ± 6.4 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		48 h	LC10	mortal./immobil.	264			3	5,11,39,40,44	Roessink et al. (2006a)
Lymnaea stagnalis	26.5 ± 6.4 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	LC10	mortal./immobil.	86			3	5,11,39,40,44	Roessink et al. (2006a)
Lymnaea stagnalis	26.5 ± 6.4 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		48 h	LC50	mortal./immobil.	907			3	5,11,39,40,44	Roessink et al. (2006a)
Lymnaea stagnalis	26.5 ± 6.4 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	LC50	mortal./immobil.	92			3	5,11,39,40,44	Roessink et al. (2006a)
Lymnea stagnalis				TPT-OH				22		2 d	LC100		50			4		Visser and Linders (1992)
Lymnea stagnalis				TPT-OH				22		9 d	LC100		10			4		Visser and Linders (1992)
Physa fontinalis	6.5 ± 1.0 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		48 h	EC10	behaviour	6			4	5,11,39,40,42	Roessink et al. (2006a)
Physa fontinalis	6.5 ± 1.0 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	EC10	behaviour	4			4	5,11,39,40,42	Roessink et al. (2006a)
Physa fontinalis	6.5 ± 1.0 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		48 h	EC50	behaviour	9			4	5,11,39,40,42	Roessink et al. (2006a)
Physa fontinalis	6.5 ± 1.0 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	EC50	behaviour	7			4	5,11,39,40,42	Roessink et al. (2006a)
Physa fontinalis	6.5 ± 1.0 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		48 h	LC10	mortal./immobil.	17	14.5		2	5,11,39,40,42	Roessink et al. (2006a)
Physa fontinalis	6.5 ± 1.0 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	LC10	mortal./immobil.	11	9.4		2	5,11,39,40,42	Roessink et al. (2006a)
Physa fontinalis	6.5 ± 1.0 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		48 h	LC50	mortal./immobil.	96	82.1		2	5,11,39,40,42	Roessink et al. (2006a)
Physa fontinalis	6.5 ± 1.0 mm	Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	LC50	mortal./immobil.	12	10.2		2	5,11,39,40,42	Roessink et al. (2006a)
Physella acuta				TPT-OH		nw				48 h	EC50		300			4	27	Roessink et al. (2006a)
Planorbis contortis	4.3 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	LC10	mortal./immobil.	6	5.1		2	5,11,39,40,42	Roessink et al. (2006a)
Planorbis contortis	4.3 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	LC10	mortal./immobil.	4	3.4		2	5,11,39,40,42	Roessink et al. (2006a)
Planorbis contortis	4.3 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	LC50	mortal./immobil.	15	12.8		2	5,11,39,40,42	Roessink et al. (2006a)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Planorbis contortis	4.3 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	LC50	mortal./immobil.	7	6		2	5,11,39,40,42	Roessink et al. (2006a)
Planorbis contortis		N	S	TPT-Ac				19±1		48 h	LC50	mortality	1000			3	11,54	EC (1996a, 1996b)
Pomacea canaliculata	35-40 days old	N	S	TPT-Ac	97	nw	7.5	26		72 h	LC50	mortality	4800			3	15	Lo and Hsieh (2000)
Semisulcospira libertina				TPT-OH						48 h	EC50		550			4	27	Roessink et al. (2006a)
Sphaerium sp.	8.6 ± 1.4 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	NOEC	mortal./immobil.	≥1000			4	5,11,39,40,41	Roessink et al. (2006a)
Annelida																		
Erpobdella	juv.; 11.5 ± 1.7 mm	Y?	S	TPT-Ac	ag	nw	7-8	20±2		48 h	EC10	behaviour	15.3			4	5,11,39,40	Roessink et al. (2006a)
Erpobdella	juv.; 11.5 ± 1.7 mm	Y?	S	TPT-Ac	ag	nw	7-8	20±2		96 h	EC10	behaviour	9.6			4	5,11,39,40	Roessink et al. (2006a)
Erpobdella	juv.; 11.5 ± 1.7 mm	Y?	S	TPT-Ac	ag	nw	7-8	20±2		48 h	EC50	behaviour	25.9			4	5,11,39,40	Roessink et al. (2006a)
Erpobdella	juv.; 11.5 ± 1.7 mm	Y?	S	TPT-Ac	ag	nw	7-8	20±2		96 h	EC50	behaviour	17.1			4	5,11,39,40	Roessink et al. (2006a)
Erpobdella	juv.; 11.5 ± 1.7 mm	Y?	S	TPT-Ac	ag	nw	7-8	20±2		48 h	LC10	mortal./immobil.	50.5			4	5,11,39,40	Roessink et al. (2006a)
Erpobdella	juv.; 11.5 ± 1.7 mm	Y?	S	TPT-Ac	ag	nw	7-8	20±2		96 h	LC10	mortal./immobil.	23.8			4	5,11,39,40	Roessink et al. (2006a)
Erpobdella	juv.; 11.5 ± 1.7 mm	Y?	S	TPT-Ac	ag	nw	7-8	20±2		48 h	LC50	mortal./immobil.	56.6			4	5,11,39,40	Roessink et al. (2006a)
Erpobdella	juv.; 11.5 ± 1.7 mm	Y?	S	TPT-Ac	ag	nw	7-8	20±2		96 h	LC50	mortal./immobil.	27.1			4	5,11,39,40	Roessink et al. (2006a)
Lumbriculus variegatus	31.4 ± 5.9 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	EC10	behaviour	4.1			3	5,11,39,40,43	Roessink et al. (2006a)
Lumbriculus variegatus	31.4 ± 5.9 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	EC10	behaviour	3.5			3	5,11,39,40,43	Roessink et al. (2006a)
Lumbriculus variegatus	31.4 ± 5.9 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	EC50	behaviour	8.8			3	5,11,39,40,43	Roessink et al. (2006a)
Lumbriculus variegatus	31.4 ± 5.9 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	EC50	behaviour	6.3			3	5,11,39,40,43	Roessink et al. (2006a)
Lumbriculus variegatus	31.4 ± 5.9 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	LC10	mortal./immobil.	21.4			3	5,11,39,40,43	Roessink et al. (2006a)
Lumbriculus variegatus	31.4 ± 5.9 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	LC10	mortal./immobil.	13.3			3	5,11,39,40,43	Roessink et al. (2006a)
Lumbriculus variegatus	31.4 ± 5.9 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	LC50	mortal./immobil.	22.6			3	5,11,39,40,43	Roessink et al. (2006a)
Lumbriculus variegatus	31.4 ± 5.9 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	LC50	mortal./immobil.	14.8			3	5,11,39,40,43	Roessink et al. (2006a)
Tubifex tubifex	worms 20 mm	N	S	TPT-Cl		tw		20		96 h	LC50	mortality	2.4			4*	11	Fargašová and Kizlink (1996a)
Tubifex tubifex	worms 20 mm	N	S	TPT-Ac		tw		20		96 h	LC50	mortality	1.9			4*	11	Fargašová and Kizlink (1996a)
Tubifex tubifex	worms 20 mm	N	S	TPT-Cl		tw		20		96 h	LC50	mortality	2.4			3	5,11	Fargašová (1997a)
Tubifex tubifex	worms 20 mm	N	S	TPT-Ac		tw		20		96 h	LC50	mortality	1.9			3	5,11	Fargašová (1997a)
Tubifex tubifex		N	S	TPT-Ac				19±1		48 h	LC50	mortality	70			3	11,54	EC (1996a, 1996b)
Tubifex	7.3 ± 2.4 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	EC10	behaviour	2.4			4	5,11,39,40,42	Roessink et al. (2006a)
Tubifex	7.3 ± 2.4 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	EC10	behaviour	2.3			4	5,11,39,40,42	Roessink et al. (2006a)
Tubifex	7.3 ± 2.4 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	EC50	behaviour	14.2			4	5,11,39,40,42	Roessink et al. (2006a)
Tubifex	7.3 ± 2.4 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	EC50	behaviour	10.7			4	5,11,39,40,42	Roessink et al. (2006a)
Tubifex	7.3 ± 2.4 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	LC10	mortal./immobil.	13.1	11.2		2	5,11,39,40,42	Roessink et al. (2006a)
Tubifex	7.3 ± 2.4 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	LC10	mortal./immobil.	9.2	7.9		2	5,11,39,40,42	Roessink et al. (2006a)
Tubifex	7.3 ± 2.4 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	LC50	mortal./immobil.	27	23.1		2	5,11,39,40,42	Roessink et al. (2006a)
Tubifex	7.3 ± 2.4 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	LC50	mortal./immobil.	12.9	11		2	5,11,39,40,42	Roessink et al. (2006a)
Crustacea																		
Acanthocyclops venustus	2.2 ± 0.4 mm	Y?	S	TPT-Ac	ag	nw		20±2		48 h	EC10	behaviour	2.7			4	5,11,39,40	Roessink et al. (2006a)
Acanthocyclops venustus	2.2 ± 0.4 mm	Y?	S	TPT-Ac	ag	nw		20±2		96 h	EC10	behaviour	0.1			4	5,11,39,40	Roessink et al. (2006a)
Acanthocyclops venustus	2.2 ± 0.4 mm	Y?	S	TPT-Ac	ag	nw		20±2		48 h	EC50	behaviour	5.8			4	5,11,39,40	Roessink et al. (2006a)
Acanthocyclops venustus	2.2 ± 0.4 mm	Y?	S	TPT-Ac	ag	nw		20±2		96 h	EC50	behaviour	0.5			4	5,11,39,40	Roessink et al. (2006a)
Acanthocyclops venustus	2.2 ± 0.4 mm	Y?	S	TPT-Ac	ag	nw		20±2		48 h	LC10	mortal./immobil.	2.9			4	5,11,39,40	Roessink et al. (2006a)
Acanthocyclops venustus	2.2 ± 0.4 mm	Y?	S	TPT-Ac	ag	nw		20±2		96 h	LC10	mortal./immobil.	0.1			4	5,11,39,40	Roessink et al. (2006a)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Acanthocyclops venustus	2.2 ± 0.4 mm	Y?	S	TPT-Ac	ag	nw		20±2		48 h	LC50	mortal./immobil.	6.9			4	5,11,39,40	Roessink et al. (2006a)
Acanthocyclops venustus	2.2 ± 0.4 mm	Y?	S	TPT-Ac	ag	nw		20±2		96 h	LC50	mortal./immobil.	0.8			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus	5.1 ± 1.4 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		48 h	EC10	behaviour	78.3			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus	5.1 ± 1.4 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		96 h	EC10	behaviour	26.0			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus	5.1 ± 1.4 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		48 h	EC50	behaviour	212.8			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus	5.1 ± 1.4 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		96 h	EC50	behaviour	95.6			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus	5.1 ± 1.4 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		48 h	LC10	mortal./immobil.	72.8			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus	5.1 ± 1.4 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		96 h	LC10	mortal./immobil.	72.8			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus	5.1 ± 1.4 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		48 h	LC50	mortal./immobil.	271.3			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus	5.1 ± 1.4 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		96 h	LC50	mortal./immobil.	271.3			4	5,11,39,40	Roessink et al. (2006a)
Asellus aquaticus		N	S	TPT-Ac	pure	tw	7.4	20	307	48 h	LC50	mortality	2670			3	8,9,25	Cotta-Ramusino and Doci (1987)
Asellus aquaticus		N	S	TPT-Ac	pure	tw	7.4	20	307	72 h	LC50	mortality	1870			3	8,9,25	Cotta-Ramusino and Doci (1987)
Asellus aquaticus		N	S	TPT-Ac	pure	tw	7.4	20	307	96 h	LC50	mortality	1420			3	8,9,25	Cotta-Ramusino and Doci (1987)
Asellus aquaticus		N	S	TPT-Ac	form.	tw	7.4	20	307	24 h	LC50	mortality	3000-5000			3	8,25	Cotta-Ramusino and Doci (1987)
Asellus aquaticus		N	S	TPT-Ac	form.	tw	7.4	20	307	48 h	LC50	mortality	1100			3	8,25	Cotta-Ramusino and Doci (1987)
Asellus aquaticus		N	S	TPT-Ac						48 h	LC50	mortality	1100			4	8	EC (1996a, 1996b)
Asellus aquaticus				TPT-Cl		am		24		96 h	LC50	mortality	50			4		Visser and Linders (1992)
Ceriodaphnia dubia	<24 h	Y	S	TPT-OH	99.75	nw	7-8	23.2	46.5	48 h	NOEC	immobility	2.7	2.6		1	16,17	Kline et al. (1989)
Ceriodaphnia dubia	<24 h	Y	S	TPT-OH	99.75	nw	7-8	23.2	46.5	48 h	EC50	immobility	11.3	10.8		1	16,17	Kline et al. (1989)
Daphnia galeata	1.8 ± 0.3 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		48 h	EC10	behaviour	7.3			4	5,11,39,40	Roessink et al. (2006a)
Daphnia galeata	1.8 ± 0.3 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		96 h	EC10	behaviour	5.4			4	5,11,39,40	Roessink et al. (2006a)
Daphnia galeata	1.8 ± 0.3 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		48 h	EC50	behaviour	16.1			4	5,11,39,40	Roessink et al. (2006a)
Daphnia galeata	1.8 ± 0.3 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		96 h	EC50	behaviour	8.4			4	5,11,39,40	Roessink et al. (2006a)
Daphnia galeata	1.8 ± 0.3 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		48 h	LC10	mortal./immobil.	28.2			4	5,11,39,40	Roessink et al. (2006a)
Daphnia galeata	1.8 ± 0.3 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		96 h	LC10	mortal./immobil.	13.1			4	5,11,39,40	Roessink et al. (2006a)
Daphnia galeata	1.8 ± 0.3 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		48 h	LC50	mortal./immobil.	41.9			4	5,11,39,40	Roessink et al. (2006a)
Daphnia galeata	1.8 ± 0.3 mm	Y?	S	TPT-Ac	ag	nw	8	20±2		96 h	LC50	mortal./immobil.	16			4	5,11,39,40	Roessink et al. (2006a)
Daphnia magna	24 h	N	S	TPT-Cl	>98	am	7.6	20		48 h	EC50	immobility	10.2			3	2	Bao et al. (1997)
Daphnia magna	<24 h	Y	S	TPT-OH	99.75	nw	7-8	23.2	46.5	48 h	NOEC	immobility	3.1	3		1	16,17	Kline et al. (1989)
Daphnia magna	<24 h	Y	S	TPT-OH	99.75	nw	7-8	23.2	46.5	48 h	EC50	immobility	16.5	15.8		1	16,17	Kline et al. (1989)
Daphnia magna	24 h	N	S	TPT-Cl	ag	am	7.5		200	24 h	EC50	mortal./immobil.	19			3	2,18	Vighi and Calimari (1985)
Daphnia magna	<24 h	Y	S	TPT-Cl		am		20±2	250	24 h	EC50	immobility	35	32		2	23	Steinhäuser et al. (1985)
Daphnia magna	<24 h	N	S	TPT-OH			8-9	21±1		24 h	LC50	mortality	20			3	5,52,56	EC (1996a, 1996b)
Daphnia magna	<24 h	N	S	TPT-OH			8-9	21±1		48 h	LC50	mortality	10			3	5,52,56	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	S	TPT-Ac			8-9	22	11.46	24 h	LC50	mortality	560			4	5,39,48,50,68	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	S	TPT-Ac			8-9	22	11.46	48 h	LC50	mortality	200			4	5,39,48,50,68	EC (1996a, 1996b)
Daphnia magna			S	TPT-Cl		am		24		48 h	LC50	mortality	80			4		Visser and Linders (1992)
Daphnia magna				TPT-Cl						48 h	LC50	mortality	11			4		Visser and Linders (1992)
Daphnia magna		N	S	TPT-Ac				19±1		48 h	LC50	mortality	75			3	11,54	EC (1996a, 1996b)
Daphnia magna	<24 h		S	TPT-OH	50					48 h	NOEC	mortality	32			4	18	EC (1996a, 1996b)
Daphnia magna	<24 h		S	TPT-OH	50					48 h	LC50	mortality	62			4	18	EC (1996a, 1996b)
Daphnia magna				TPT-OH						48 h	EC50		16.7			4	47	Roessink et al. (2006a)
Daphnia pulex	<24 h	Y	S	TPT-OH		nw	7-8	23.2	46.5	48 h	NOEC	immobility	2.5	2.4		2	16,17	Kline et al. (1989)
Daphnia pulex	<24 h	Y	S	TPT-OH		nw	7-	23.2	46.5	48 h	EC50	immobility	14.5	13.8		2	16,17	Kline et al. (1989)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Gammarus fasciatus	mature	N	S	TPT-OH	tg		7.1	12	44	96 h	LC50	mortality	66			4*		Mayer and Ellersieck (1986)
Gammarus fasciatus	mature	N	S	TPT-OH	tg		7-8	15	40-50	96 h	LC50	mortality	66			3		Johnson and Finley (1980)
Gammarus pulex	13.0 ± 4.0 mm	Y	S	TPT-Ac	ag	nw	6-8	20±2		48 h	EC10	behaviour	5.6			4	5,11,39,40, 42	Roessink et al. (2006a)
Gammarus pulex	13.0 ± 4.0 mm	Y	S	TPT-Ac	ag	nw	6-8	20±2		96 h	EC10	behaviour	4.5			4	5,11,39,40, 42	Roessink et al. (2006a)
Gammarus pulex	13.0 ± 4.0 mm	Y	S	TPT-Ac	ag	nw	6-8	20±2		48 h	EC50	behaviour	18.5			4	5,11,39,40, 42	Roessink et al. (2006a)
Gammarus pulex	13.0 ± 4.0 mm	Y	S	TPT-Ac	ag	nw	6-8	20±2		96 h	EC50	behaviour	8.9			4	5,11,39,40, 42	Roessink et al. (2006a)
Gammarus pulex	13.0 ± 4.0 mm	Y	S	TPT-Ac	ag	nw	6-8	20±2		48 h	LC10	mortal./immobil.	18.5	15.8		2	5,11,39,40, 42	Roessink et al. (2006a)
Gammarus pulex	13.0 ± 4.0 mm	Y	S	TPT-Ac	ag	nw	6-8	20±2		96 h	LC10	mortal./immobil.	11.6	9.9		2	5,11,39,40, 42	Roessink et al. (2006a)
Gammarus pulex	13.0 ± 4.0 mm	Y	S	TPT-Ac	ag	nw	6-8	20±2		48 h	LC50	mortal./immobil.	104.4	89.3		2	5,11,39,40, 42	Roessink et al. (2006a)
Gammarus pulex	13.0 ± 4.0 mm	Y	S	TPT-Ac	ag	nw	6-8	20±2		96 h	LC50	mortal./immobil.	12.6	10.8		2	5,11,39,40, 42	Roessink et al. (2006a)
Orconectes sp.	2.5 g; 18 mm	N	S	TPT-OH	97		7.4	20-21	40	96h	LC50	mortality	$>10^4$			3	5,52,55	EC (1996a, 1996b)
Proasellus meridianus/coxalis	5.6 ± 1.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	EC10	behaviour	37			4	5,11,39,40	Roessink et al. (2006a)
Proasellus meridianus/coxalis	5.6 ± 1.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	EC10	behaviour	32.4			4	5,11,39,40	Roessink et al. (2006a)
Proasellus meridianus/coxalis	5.6 ± 1.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	EC50	behaviour	139			4	5,11,39,40	Roessink et al. (2006a)
Proasellus meridianus/coxalis	5.6 ± 1.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	EC50	behaviour	90.9			4	5,11,39,40	Roessink et al. (2006a)
Proasellus meridianus/coxalis	5.6 ± 1.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	LC10	mortal./immobil.	137.4			4	5,11,39,40	Roessink et al. (2006a)
Proasellus meridianus/coxalis	5.6 ± 1.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	LC10	mortal./immobil.	39.1			4	5,11,39,40	Roessink et al. (2006a)
Proasellus meridianus/coxalis	5.6 ± 1.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	LC50	mortal./immobil.	558.5			4	5,11,39,40	Roessink et al. (2006a)
Proasellus meridianus/coxalis	5.6 ± 1.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	LC50	mortal./immobil.	138.5			4	5,11,39,40	Roessink et al. (2006a)
Insecta																		
Aedes aegypti	2nd inst., suscept.str.	N	S	TPT-Cl		dw		26		24 h	LC50	mortality	17			3	1,2,4	Kumar Das et al. (1984)
Aedes aegypti	4th inst., suscept.str.	N	S	TPT-Cl		dw		26		24 h	LC50	mortality	420			3	1,2,4	Kumar Das et al. (1984)
Aedes aegypti	4th inst., suscept.str.	N	S	TPT-Cl		dw		26		24 h	LC50	mortality	410			3	1,3,4	Kumar Das et al. (1984)
Aedes aegypti	4th inst., DDT tol. str.	N	S	TPT-Cl		dw		26		24 h	LC50	mortality	460			3	1,2,4	Kumar Das et al. (1984)
Aedes aegypti	4th inst., orlando str.	Y?	S	TPT-OH		dw		25-29		24 h	LC50	mortality	1490			3	3,5,29	Nguyen et al. (2000b)
Aedes aegypti	4th inst., orlando str.	Y?	S	TPT-Cl		dw		25-29		24 h	LC50	mortality	2530			3	3,5,29	Nguyen et al. (2000b)
Aedes aegypti	4th inst., orlando str.	Y?	S	TPT-Ac		dw		25-29		24 h	LC50	mortality	2300			3	5,11,29	Nguyen et al. (2000b)
Aedes aegypti	4th inst., orlando str.	Y?	S	TPT-F		dw		25-29		24 h	LC50	mortality	1500			3	3,5,29	Nguyen et al. (2000b)
Aedes aegypti	4th inst., orlando str.	Y?	S	bis-TPT-O		dw		25-29		24 h	LC50	mortality	840			3	3,5,29	Nguyen et al. (2000b)
Anopheles stephensi	larvae	N	S	TPT-OH		dw		27-28		24 h	LC50	mortality	21400			3	5,20,31,71	Ogwuru et al. (2001)
Anopheles stephensi	larvae	N	S	TPT-F		dw		27-28		24 h	LC50	mortality	1860			3	5,20,31	Ogwuru et al. (2001)
Anopheles stephensi	larvae	N	S	TPT-Cl		dw		27-28		24 h	LC50	mortality	20100			3	5,20,31,71	Ogwuru et al. (2001)
Anopheles stephensi	larvae	N	S	TPT-Br		dw		27-28		24 h	LC50	mortality	9410			3	5,20,31,71	Ogwuru et al. (2001)
Anopheles stephensi	larvae	N	S	TPT-Ac		dw		27-28		24 h	LC50	mortality	17400			3	5,20,31,71	Ogwuru et al. (2001)
Anopheles stephensi	2nd instar	Y	S	TPT-Ac		dw		27-30		24 h	LC50	mortality	49	42		2	5,11,33	Eng et al. (1999)
Anopheles stephensi	2nd instar	Y	S	TPT-Cl		dw		27-30		24 h	LC50	mortality	181	164		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	2nd instar	Y	S	TPT-OH		dw		27-30		24 h	LC50	mortality	562	536		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	2nd instar	Y	S	TPT-F		dw		27-30		24 h	LC50	mortality	672	637		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	2nd instar	Y	S	bis-TPT-O		dw		27-30		24 h	LC50	mortality	179	175		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	3rd instar	Y	S	TPT-Ac		dw		27-30		24 h	LC50	mortality	119	102		2	5,11,33	Eng et al. (1999)
Anopheles stephensi	3rd instar	Y	S	TPT-Cl		dw		27-30		24 h	LC50	mortality	420	381		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	3rd instar	Y	S	TPT-OH		dw		27-30		24 h	LC50	mortality	1310	1250		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	3rd instar	Y	S	TPT-F		dw		27-30		24 h	LC50	mortality	1790	1698		2	3,5,33	Eng et al. (1999)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Anopheles stephensi	3rd instar	Y	S	bis-TPT-O		dw		27-30		24 h	LC50	mortality	1250	1222		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	4th instar	Y	S	TPT-Ac		dw		27-30		24 h	LC50	mortality	2540	2173		2	5,11,33	Eng et al. (1999)
Anopheles stephensi	4th instar	Y	S	TPT-Cl		dw		27-30		24 h	LC50	mortality	120	109		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	4th instar	Y	S	TPT-OH		dw		27-30		24 h	LC50	mortality	5980	5703		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	4th instar	Y	S	TPT-F		dw		27-30		24 h	LC50	mortality	6010	5700		2	3,5,33	Eng et al. (1999)
Anopheles stephensi	4th instar	Y	S	bis-TPT-O		dw		27-30		24 h	LC50	mortality	3420	3343		2	3,5,33	Eng et al. (1999)
Chaoborus obscuripes		Y	S	TPT-Ac	ag	nw	7-8	20±2		96 h	NOEC	mortal./immobil.	≥1000			4	5,11,39,40,41	Roessink et al. (2006a)
Chironomus plumosus	larvae 20 mm	N	S	TPT-Cl		dtw		25		96 h	LC50	mortality	0.087			3	15	Fargašová and Kizlink (1996a)
Chironomus plumosus	larvae 20 mm	N	S	TPT-Ac		dtw		25		96 h	LC50	mortality	0.33			3	15	Fargašová and Kizlink (1996a)
Chironomus plumosus	larvae 20 mm	N	S	TPT-Cl		dtw		25		96 h	LC50	mortality	0.087			4*	5,11	Fargašová (1997a)
Chironomus plumosus	larvae 20 mm	N	S	TPT-Ac		dtw		25		96 h	LC50	mortality	0.33			4*	5,11	Fargašová (1997a)
Chironomus riparius		N	S	TPT-Ac	pure	tw	7.4	20	307	48 h	LC50	mortality	<30			3	8,25	Cotta-Ramusino and Doci (1987)
Chironomus riparius		N	S	TPT-Ac	from.	tw	7.4	20	307	24 h	LC50	mortality	70			3	8,25	Cotta-Ramusino and Doci (1987)
Chironomus riparius		N	S	TPT-Ac	form.	tw	7.4	20	307	48 h	LC50	mortality	50			3	8,25	Cotta-Ramusino and Doci (1987)
Chironomus riparius				TPT-OH						48 h	EC50		50			4	47	Roessink et al. (2006a)
Cloeon dipterum	5.5 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	EC10	behaviour	34.7			4	5,11,39,40,42	Roessink et al. (2006a)
Cloeon dipterum	5.5 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	EC10	behaviour	12.3			4	5,11,39,40,42	Roessink et al. (2006a)
Cloeon dipterum	5.5 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	EC50	behaviour	120.9			4	5,11,39,40,42	Roessink et al. (2006a)
Cloeon dipterum	5.5 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	EC50	behaviour	63			4	5,11,39,40,42	Roessink et al. (2006a)
Cloeon dipterum	5.5 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	LC10	mortal./immobil.	251.8	215.5		2	5,11,39,40,42	Roessink et al. (2006a)
Cloeon dipterum	5.5 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	LC10	mortal./immobil.	39.8	34.1		2	5,11,39,40,42	Roessink et al. (2006a)
Cloeon dipterum	5.5 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		48 h	LC50	mortal./immobil.	442.5	378.6		2	5,11,39,40,42	Roessink et al. (2006a)
Cloeon dipterum	5.5 ± 0.7 mm	Y	S	TPT-Ac	ag	nw	8	20±2		96 h	LC50	mortal./immobil.	168.9	144.5		2	5,11,39,40, 42	Roessink et al. (2006a)
Endochironomus albipennis	9.2 ± 1.2 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	EC10	behaviour	343			4	5,11,39,40	Roessink et al. (2006a)
Endochironomus albipennis	9.2 ± 1.2 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	EC10	behaviour	181.9			4	5,11,39,40	Roessink et al. (2006a)
Endochironomus albipennis	9.2 ± 1.2 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	EC50	behaviour	399.2			4	5,11,39,40	Roessink (2008)
Endochironomus albipennis	9.2 ± 1.2 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	EC50	behaviour	203.8			4	5,11,39,40	Roessink (2008)
Endochironomus albipennis	9.2 ± 1.2 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	LC10	mortal./immobil.	306.8	262.5		2	5,11,39,40	Roessink et al. (2006a)
Endochironomus albipennis	9.2 ± 1.2 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	LC10	mortal./immobil.	179.2	153.3		2	5,11,39,40	Roessink et al. (2006a)
Endochironomus albipennis	9.2 ± 1.2 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	LC50	mortal./immobil.	691.6	591.8		2	5,11,39,40	Roessink (2008)
Endochironomus albipennis	9.2 ± 1.2 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	LC50	mortal./immobil.	302.9	259.2		2	5,11,39,40	Roessink (2008)
Glyptotendipes sp.	11.7 ± 1.9 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	EC10	behaviour	382.6			4	5,11,39,40,72	Roessink (2008)
Glyptotendipes sp.	11.7 ± 1.9 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	EC10	behaviour	103.6			4	5,11,39,40,72	Roessink (2008)
Glyptotendipes sp.	11.7 ± 1.9 mm	Y	S	TPT-Ac	ag	nw		20±2		48 h	EC50	behaviour	420.8			4	5,11,39,40,72	Roessink (2008)
Glyptotendipes sp.	11.7 ± 1.9 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	EC50	behaviour	204.7			4	5,11,39,40,72	Roessink (2008)
Glyptotendipes sp.	11.7 ± 1.9 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	LC10	mortal./immobil.	287.7			4	5,11,39,40,72	Roessink (2008)
Glyptotendipes sp.	11.7 ± 1.9 mm	Y	S	TPT-Ac	ag	nw		20±2		96 h	LC50	mortal./immobil.	488.6			4	5,11,39,40,72	Roessink (2008)
Sigara sp.		Y	S	TPT-Ac	ag	nw	8	20±2		96 h	NOEC	mortal./immobil.	≥1000			4	5,11,39,40,41,72	Roessink et al. (2006a)
Pisces																		
Anguilla anguilla				TPT-Ac						24 h	LC100	mortality	400			4		UNEP (1989)
Carassius auratus		N	S	TPT-Ac	pure	tw	7.4	20	307	96 h	LC50	mortality	280			3	8,9,25	Cotta-Ramusino and Doci (1987)
Carassius auratus		N	S	TPT-Ac	pure	tw	7.4	20	307	96 h	LC50	mortality	676			3	8,25	Cotta-Ramusino and Doci (1987)
Carassius auratus		N	S	TPT-Ac	pure	tw	7.4	20	307	96 h	LC50	mortality	620			3	8,25	Cotta-Ramusino and Doci (1987)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Carassius auratus	1.0 g	N	S	TPT-OH	tg		7.1	18	44	96 h	LC50	mortality	62			4*		Mayer and Ellersieck (1986)
Carassius auratus	1.0 g	N	S	TPT-OH	tg		7	18	40-50	96 h	LC50	mortality	62			3		Johnson and Finley (1980)
Carassius auratus				TPT-Ac						24 h	LC100	mortality	75			4		UNEP (1989)
Carassius auratus				TPT-Cl						24 h	LC100	mortality	250			4		UNEP (1989)
Carassius auratus				TPT-OH						96 h	EC50		62			4	47	Roessink et al. (2006a)
Carassius auratus				TPT-Cl		am		24		96 h	LC50	mortality	40			4		Visser and Linders (1992)
Carassius auratus			R	TPT-Cl		am		24		28 d	LC50	mortality	6			4		Visser and Linders (1992)
Cyprinus carpio				TPT-Ac						48 h	LC50	mortality	320			4		UNEP (1989)
Cyprinus carpio	9 months; 2 g	N	S	TPT-Ac		tw	8-9	21-22	11-12	96 h	LC50	mortality	19			3	5,48,50	EC (1996a, 1996b)
Cyprinus carpio	7 mo; 2.1 g; 3.8 cm	Y	S	TPT-OH	50					96 h	LC50	mortality	38	36.2		2	18,39,58,59	EC (1996a, 1996b)
Gambusia affinis				TPT-Ac						24 h	LC100	mortality	400			4		UNEP (1989)
Ictalurus punctatus	2.6 g	N	S	TPT-OH	97	rw	7.4	20-21	40	96 h	LC50	mortality	24			3	5,49,52	EC (1996a, 1996b)
Lepomis macrochirus	0.5 g	N	S	TPT-OH	tg		7.1	24	44	96 h	LC50	mortality	23			4*		Mayer and Ellersieck (1986)
Lepomis macrochirus	0.5 g	N	S	TPT-OH	tg		7-8	13	40-50	96 h	LC50	mortality	23			3		Johnson and Finley (1980)
Oncorhynchus mykiss	0.8 g	N	S	TPT-OH	tg		7.1	13	44	96 h	LC50	mortality	<28			4*		Mayer and Ellersieck (1986)
Oncorhynchus mykiss	0.8 g	N	S	TPT-OH	tg		7-8	13	40-50	96 h	LC50	mortality	<28			3		Johnson and Finley (1980)
Oncorhynchus mykiss				TPT-OH						24 h	LC50	mortality	78			4		UNEP (1989)
Oncorhynchus mykiss	fry; 3 cm	N	F	TPT-OH	100		8.3	15	270	24 h	LC10	mortality	55	52		2	2,4	Tooby et al. (1975)
Oncorhynchus mykiss	fry; 3 cm	N	F	TPT-OH	100		8.3	15	270	24 h	LC50	mortality	78	74		2	2,4	Tooby et al. (1975)
Oncorhynchus mykiss	fry; 3 cm	N	F	TPT-OH	100		8.3	15	270	48 h	LC10	mortality	19	18		2	2,4	Tooby et al. (1975)
Oncorhynchus mykiss	fry; 3 cm	N	F	TPT-OH	100		8.3	15	270	48 h	LC50	mortality	30	29		2	2,4	Tooby et al. (1975)
Oncorhynchus mykiss	fry; 3 cm	N	F	TPT-OH	100		8.3	15	270	96 h	LC10	mortality	10	9.5		2	2,4	Tooby et al. (1975)
Oncorhynchus mykiss	fry; 3 cm	N	F	TPT-OH	100		8.3	15	270	96 h	LC50	mortality	15	14		2	2,4	Tooby et al. (1975)
Oncorhynchus mykiss				TPT-OH						48 h	EC50		32.6			4	47	Roessink et al. (2006a)
Oncorhynchus mykiss	fry; 3 cm		F	TPT-OH			8.3	20	270	24 h	LC50	mortality	78			4		Visser and Linders (1992)
Oncorhynchus mykiss	fry; 3 cm		F	TPT-OH			8.3	20	270	48 h	LC50	mortality	30			4		Visser and Linders (1992)
Oncorhynchus mykiss	fry; 3 cm		F	TPT-OH			8.3	20	270	96 h	LC50	mortality	15			4*		Visser and Linders (1992)
Oncorhynchus mykiss	3 months; 4.27 g	N	S	TPT-Ac	96	rw	8.31	11-12	47.3	96 h	LC50	mortality	37			3	5,48,49	EC (1996a, 1996b)
Oncorhynchus mykiss	5 monts; 1.48 g	N	S	TPT-OH		rw	8	11-13	47.86	96 h	LC50	mortality	22			3	5,48,51	EC (1996a, 1996b)
Oncorhynchus mykiss	4 mo, 1.5 g; 4.6 cm	Y	S	TPT-OH	50					96 h	LC50	mortality	42	40.1		2	18,39,57,58	EC (1996a, 1996b)
Oncorhynchus mykiss	4 months; 1.8 g	Y		TPT-Ac	95.3		7.8	14.6	358	21 d	NOEC		0.66	0.56		4	2,5,18,73	EC (1996a, 1996b)
Oncorhynchus mykiss	4 months; 1.8 g	Y		TPT-Ac	95.3		7.8	14.6	358	21 d	NOEC	length, weight	>3.3	>2.8		2	2,5,18,73	EC (1996a, 1996b)
Oncorhynchus mykiss	4 months; 1.8 g	Y		TPT-Ac	95.3		7.8	14.6	358	21 d	LC50	mortality	>3.3	>2.8		2	2,5,18,73	EC (1996a, 1996b)
Oncorhynchus mykiss	4 mo; 2.5 g; 5.4 cm	Y	F	TPT-OH	50					21 d	LC50	mortality	22.4	21.4		2	18,39,58,74	EC (1996a, 1996b)
Oncorhynchus mykiss	4 mo; 2.5 g; 5.4 cm	Y	F	TPT-OH	50					21 d	LC50	slowed reactions	10	9.5		4	18,39,58,74	EC (1996a, 1996b)
Oryzias latipes	Fish from market	N	R	TPT-Cl		dtw		20		96 h	LC50	mortality	64			3	18,19,30	Nagase et al. (1991)
Oryzias latipes	Fish from market	N	R	TPT-OH		dtw		20		96 h	LC50	mortality	66.1			3	18,19,30	Nagase et al. (1991)
Oryzias latipes	Fish from market	N	R	TPT-Ac		dtw		20		96 h	LC50	mortality	74			3	18,19,30	Nagase et al. (1991)
Oryzias latipes		Y		TPT-OH	97.6				25	48 h	LC50	mortality	52.9	50.5		2		NITE (2011)
Pimephales promelas	41 days old	Y	F	TPT-OH						96 h	LC50	mortality	9.6	9.2		2	17, 53	EC (1996a, 1996b)
Pimephales promelas	larvae <24 h	Y	S	TPT-OH			7-8	25	46.6	96 h	LC50	mortality	7.1			4*	53	EC (1996a, 1996b)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH			7-8	25	46.6	72 h	LC50	mortality	6			4*	53	EC (1996a, 1996b)
Pimephales promelas	larvae <24 h	Y	S	TPT-OH	96	nw	7-8	24-25	46.6	96 h	LC50	mortality	7.1	6.8		1	16,17,67	Jarvinen et al. (1988)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	24-25	46.6	96 h	LC50	mortality	5.4	5.1		1	16,17	Jarvinen et al. (1988)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	25	46.6	72 h	LC50	mortality	6	5.7		1	16,17	Jarvinen et al. (1988)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	25	46.6	72 h	LC50	mortality	6	5.7		1	16,17	Jarvinen et al. (1988)
Pimephales promelas	0.9 g	N	S	TPT-OH	tg		7.1	18	44	96 h	LC50	mortality	20			4*		Mayer and Ellersieck (1986)
Pimephales promelas				TPT-OH						96 h	LC50	mortality	20			4*		Mayer (1974)
Pimephales promelas	0.9 g	N	S	TPT-OH	tg		7-8	18	40-50	96 h	LC50	mortality	20			3		Johnson and Finley (1980)
Pimephales promelas				TPT-OH						96 h	EC50		20			4	47	Roessink et al. (2006a)
Poecilia reticulata				TPT-Cl		am		24		48 h	LC50	mortality	100			4		Visser and Linders (1992)
Poecilia reticulata				TPT-Cl		am		24		96 h	LC50	mortality	30			4		Visser and Linders (1992)
Poecilia reticulata			R	TPT-Cl		am		24		14 d	LC50	mortality	5			4		Visser and Linders (1992)
Poecilia reticulata	2-3 months	N	R	TPT-Cl		rw		22	25	14 d	LC50	mortality	9.25			3	26	Könemann (1981)
Poecilia reticulata	250 mg	N	S	TPT-Ac				19		48 h	LC50	mortality	34			3	11,54	EC (1996a, 1996b)
Rasbora heteromorpha	1-3 cm	N	F	TPT-OH	100		8.1	20	20	24 h	LC10	mortality	38			3	2,4	Tooby et al. (1975)
Rasbora heteromorpha	1-3 cm	N	F	TPT-OH	100		8.1	20	20	24 h	LC50	mortality	62			3	2,4	Tooby et al. (1975)
Rasbora heteromorpha	1-3 cm	N	F	TPT-OH	100		8.1	20	20	48 h	LC10	mortality	24			3	2,4	Tooby et al. (1975)
Rasbora heteromorpha	1-3 cm	N	F	TPT-OH	100		8.1	20	20	48 h	LC50	mortality	42			3	2,4	Tooby et al. (1975)
Rasbora heteromorpha	1.3-3 cm	N	F	formulation	20		7.2	20	20	48 h	LC50	mortality	220			3	22	Alabaster (1969)
Rasbora heteromorpha			F	TPT-OH			8.1	20	20	24 h	LC50	mortality	62			4*		Visser and Linders (1992)
Rasbora heteromorpha			F	TPT-OH			8.1	20	20	48 h	LC50	mortality	42			4*		Visser and Linders (1992)
Rasbora heteromorpha			F	TPT-OH	19		8.1	20	20	24 h	LC50	mortality	360			4		Visser and Linders (1992)
Rasbora heteromorpha			F	TPT-OH	19		8.1	20	20	48 h	LC50	mortality	230			4		Visser and Linders (1992)
Rasbora heteromorpha			F	TPT-OH	19		8.1	20	20	96 h	LC50	mortality	70			4		Visser and Linders (1992)
Rasbora heteromorpha				TPT-OH						48 h	EC50		96.1			4	47	Roessink et al. (2006a)
Rutilus rutilus				TPT-Cl		am		24		24 h	LC50	mortality	30			4		Visser and Linders (1992)
Rutilus rutilus				TPT-Cl		am		24		24 h	LC50	mortality	20			4		Visser and Linders (1992)
Rutilus rutilus				TPT-Cl		am		24		24 h	LC50	mortality	10			4		Visser and Linders (1992)
Amphibia																		
Rana esculenta	tadpoles; 20-21 d	N	S	TPT-Cl	>97	tw	8.2	20-22		48 h	NOEC	swimming behav.	10			3	2,5,34,35	Semlitsch et al. (1995)
Rana esculenta	tadpoles; 20-21 d	N	S	TPT-Cl	>97	tw	8.2	20-22		48 h	NOEC	feeding	5			3	2,5,34,35	Semlitsch et al. (1995)

Notes

1 Solvent concentration >0.01%.
2 Solvent: acetone.
3 Solvent: DMSO.
4 No solvent control performed.
5 Solvent control performed.
6 Water control <50% of the lowest exposure concentration.
7 Solvent concentration ≤0.01%.
8 No mention of controls performed.
9 Value recalculated from data in table.
10 Solvent unknown.
11 Solvent: ethanol.
12 Test concentrations >> water solubility.
13 Biomass was calculated using adsorption at 680 nm.
14 Primary production measured as $^{14}CO_2$ uptake.
15 No details on any use of solvents.
16 No solvent used, water concentrations prepared with a saturator system.
17 Results based on measured concentrations.
18 According to OECD guideline.

19 Solvent: DMSO + surfactant; solvent control perfomed.
20 Solvent: DMSO or acetone.
21 No detail on TPT species.
22 Formulation used, contains for 80% unfdefined auxiliary agents, no control for blank formulation performed.
23 According to DIN 38412 Teil 11.
24 Value recalculated from graph in paper.
25 Exposure in plastic tanks.
26 Solvent: acetone or propanol-2.
27 Original reference in Japanese.
28 Exposure in microplates with lettuce infusion.
29 Exposure in plastic Petri dishes; measurements not specified but 'analytical analysis showed that the total tin concentration remained constant during the test period'. Since this is not further specified, may have been without organisms present, and the exposure was in plastic, the validity of the studie is Ri 3.
30 Duration of experiment unclear: in the test 96 hours is mentioned but in the table 48 hours is reported. 10 fish were exposed in 2 L of water, weight of the fish is not reported. Fish are bought at local market and thus possible pre-exposure is not known.
31 Not a real aquatic LC50; contact toxicity study with soaked chromatography paper in paper cups.
32 Measured concentrations in bioconcentration tests after 8 days close to nominal concentrations; average concentration was 64.8% of nominal; renewal every two days.
33 The total tin concentration remained constant during the study, it is not reported if TPT concentrations were measured.
34 Positive effects of solvent may have masked toxicity effects at the lowest exposure levels.
35 Exposure in plastic dishpans; renewal after 3 days.
36 EC50 and EC10 calculated with Graphpad, using reported data.
37 Value unreliable, extrapolated too far out of the measured range.
38 Value from list of endpoints, no further information available.
39 Results based on nominal concentrations.
40 Detection limit 1 µg/L; GC-MSC; DOC of test medium was 8.8 mg/L.
41 Results from a range-finding test.
42 Measured concentrations were within 20% of nominal after 96 hours.
43 Measured concentration decreased to 24.1% of nominal after 96 hours, probably due to a too high loading of biomass.
44 Measured concentration decreased to 20.9% of nominal after 96 hours, probably due to a too high loading of biomass.
45 Medium enriched with nutrients.
46 Measured concentrations decreased to below detection limits (1 µg/L) after 14 days.
47 Original data cannot be retrieved.
48 Solvent: DMF.
49 According to EPA guideline from 1975.
50 According to BBA guidelines, but no replicates.
51 According to EPA guidelines, but no replicates.
52 Solvent: triethylene glycol.
53 According to the FIFRA protocol.
54 Exposure in Petri dishes.
55 Exposrue far above solubility (precipitate present).
56 According to EPA guideline.
57 Fish loading was 0.08 g/L.
58 Measured concentrations were above 80% of nominal.
59 Fish loading was 0.11 g/L.
60 Value is not in accordance with presented data.
61 Corrected for average recovery in bioconcentration test.
62 Low concentration range of 2 and 5 µg/L.
63 High concentration range of 5, 10, 25, and 50 µg/L.
64 Low and high concentration range combined.
65 Measured concentrations in bioconcentration tests after 8 days close to nominal concentrations; average measured concentration was 61% of nominal; renewal every two days.
66 Measured concentrations after 7 d were 33% (algae) and 77.5% (*S. obliquus*) of nominal, concentration in blanc samples containted 91.3% after 7 d; results based on nominal concentrations; control in exponential growth until 48 h.
67 Mean value of seven tests, ranging from 4.3 to 9.6 µg/L; static test based on initial measured concentrations.

68 Measured concentrations were within 79-80% of nominal; unclear if results are expressed on basis of nominal or measured concentrations; reported LOEC for death higher than LC50 therefore reported figures unreliable.
69 Probably wrong unit reported in table 1 of publication.
70 Details of analysis unclear, endpoint based on nominal concentrations.
71 Endpoint > watersolubility.
72 Results of analysis unknown.
73 Endpoints not specified; mean measured concentrations over the exposure time were calculated to be 66% of nominal, thus all concentrations were corrected by 66% of their nominal value.
74 Fish loading was 0.69 g/L.
75 Value recalculated for growth rate from data in table according to OECD guideline 201.
76 Confidence interval very large.
77 Exposure period too chort for a cyanobacterium.
78 Solvent: methanol.
79 Exposure period exceeds exponential growth phase.
80 The artificial medium consists of artificial synthetic waste water.

Table A2.2: Chronic toxicity for freshwater organisms.

Species	Species properties	A	Test type	Test comp.	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Cyanobacteria																		
Anabaena cylindrica		N		TPT-Cl		am		25		5 m	EC10	photosynthesis		566		3	17,57	Avery et al. (1991)
Anabaena cylindrica		N		TPT-Cl		am		25		3 h	EC10	nitrogenase		55		3	17,57	Avery et al. (1991)
Anabaena flos-aquae		N	S	TPT-Ac	95	am		24		96 h	NOEC	biomass	1			3	3,5,14	Ma et al. (2004)
Anabaena flos-aquae		N	S	TPT-Ac	95	am		24		96 h	EC10	biomass	1.5			3	3,5,14	Ma et al. (2004)
Microcystis aeruginosa		N	S	TPT-Ac	95	am		24		96 h	NOEC	biomass	2			3	3,5,14	Ma et al. (2004)
Microcystis aeruginosa		N	S	TPT-Ac	95	am		24		96 h	EC10	biomass	5.3			3	3,5,14	Ma et al. (2004)
Microcystis flos-aquae		N	S	TPT-Ac	95	am		24		96 h	NOEC	biomass	0.5			3	3,5,14	Ma et al. (2004)
Microcystis flos-aquae		N	S	TPT-Ac	95	am		24		96 h	EC10	biomass	0.8			3	3,5,14	Ma et al. (2004)
Plectonema boryanum		N		TPT-Cl		am		25		5 m	EC10	photosynthesis		160		3	17,57	Avery et al. (1991)
Algae																		
Ankistrodesmus falcatus	log-phase	N		TPT-Cl		am	8	20		24 h	EC10	primary prod.			2	3	3,15,17	Wong et al. (1982)
Ankistrodesmus falcatus	log-phase	N		TPT-Cl		am	8	20		8 d	EC10	growth			1	3	3,17	Wong et al. (1982)
Chlorella pyrenoidosa		N	S	TPT-Ac	95	am		24		96 h	NOEC	biomass	5			3	3,5,14	Ma et al. (2004)
Chlorella pyrenoidosa		N	S	TPT-Ac	95	am		24		96 h	EC10	biomass	13			3	3,5,14	Ma et al. (2004)
Chlorella vulgaris		N	S	TPT-Cl	>98			22		22 h	NOEC	photosynthetic activity	<386	<350		3	62	Murkowski and Skorska (2010)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		48 h	EC10	photosynth. act.	15.9			3	5,9	Roessink et al. (2006a)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		48 h	NOEC	photosynth. act.	10			3	5,9	Roessink et al. (2006a)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		72 h	EC10	photosynth. act.	2.6			3	5,9	Roessink et al. (2006a)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		72 h	NOEC	photosynth. act.	3			3	5,9	Roessink et al. (2006a)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		96 h	EC10	photosynth. act.	3.2			3	5,9	Roessink et al. (2006a)
Desmodesmus subspicatus		N	S	TPT-Ac	ag	am		20±1		96 h	NOEC	photosynth. act.	3			3	5,9	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		48 h	EC10	photosynth. act.	39.2			3	5,9	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		48 h	NOEC	photosynth. act.	10			3	5,9	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		72 h	EC10	photosynth. act.	14.3			3	5,9	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		72 h	NOEC	photosynth. act.	10			3	5,9	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		96 h	EC10	photosynth. act.	2.5			3	5,9	Roessink et al. (2006a)
Monoraphidium minutum		N	S	TPT-Ac	ag	am		20±1		96 h	NOEC	photosynth. act.	10			3	5,9	Roessink et al. (2006a)
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		48 h	EC10	photosynth. act.	5.5			3	5,9	Roessink et al. (2006a)
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		48 h	NOEC	photosynth. act.	3			3	5,9	Roessink et al. (2006a)
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		72 h	EC10	photosynth. act.	2.6			3	5,9	Roessink et al. (2006a)
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		72 h	NOEC	photosynth. act.	3			3	5,9	Roessink et al. (2006a)
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		96 h	EC10	photosynth. act.	3.2			3	5,9	Roessink et al. (2006a)
Pseudokirchneriella subcapitata		N	S	TPT-Ac	ag	am		20±1		96 h	NOEC	photosynth. act.	3			3	5,9	Roessink et al. (2006a)
Scenedesmus obliquus	log-phase	Y	S	TPT-Cl		am		25	50	96 h	EC10	growth	1.29			3	5,9,34,47	Huang et al. (1993)
Scenedesmus obliquus	log-phase	Y	S	TPT-Cl		am		25	50	48 h	EC10	growth rate	2.5	2.3		2	5,9,47,55	Huang et al. (1993)
Scenedesmus obliquus	log-phase	Y	S	TPT-Cl		am		25	50	72 h	EC10	growth rate	6.9			3	5,9,47,55	Huang et al. (1993)
Scenedesmus obliquus	log-phase	Y	S	TPT-Cl		am		25	50	96 h	EC10	growth rate	7.0			3	5,9,47,55	Huang et al. (1993)
Scenedesmus quadricauda	log-phase	N		TPT-Cl		am	8	20		24 h	EC10	primary prod.			20	3	3,15,17	Wong et al. (1982)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Cl		am	7.2	25		48 h	EC10	tot. chlorophyll	0.29			3	22,25	Fargašová (1996)

Species	Species properties	A	Test type	Test comp.	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Ac		am	7.2	25		48 h	EC10	tot. chlorophyll	0.005			3	22,25,26	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Cl		am	7.2	25		48 h	EC10	chlorophyll-a cont.	0.05			3	22,25,26	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Ac		am	7.2	25		48 h	EC10	chlorophyll-a cont.	0.001			3	22,25,26	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Cl		am	7.2	25		48 h	EC10	chlorophyll-b cont.	0.96			3	22,25	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Ac		am	7.2	25		48 h	EC10	chlorophyll-b cont.	0.01			3	22,25,26	Fargašová (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Cl		am	7.2	25		48 h	EC10	respiration	0.83			3	22,25	Fargašová and Drtil (1996)
Scenedesmus quadricauda	7-d old culture	N	S	TPT-Ac		am	7.2	25		48 h	EC10	respiration	0.57			3	22,25	Fargašová and Drtil (1996)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Cl		am	7.2	25		12 d	EC10	growth rate	0.01			3	22,25,26	Fargašová (1997b)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Cl		am	7.2	25		9 d	NOEC	chlorophyll-a cont.	10			3	22,25	Fargašová (1997b)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Cl		am	7.2	25		9 d	NOEC	respiration	1			3	22,25	Fargašová (1997b)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Ac		am	7.2	25		12 d	EC10	growth rate	0.03			3	22,25,26	Fargašová (1997b)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Ac		am	7.2	25		9 d	EC10	chlorophyll-a cont.	10			3	22,25	Fargašová (1997b)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Ac		am	7.2	25		9 d	EC10	respiration	1			3	22,25	Fargašová (1997b)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Cl		am	7.2	25		12 d	EC10	growth	0.01			3	22,25,26	Fargašová and Kizlink (1996b)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Ac		am	7.2	25		12 d	EC10	growth	0.03			3	22,25,26	Fargašová and Kizlink (1996b)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		48 h	EC10	photosynth. act.	54.6			3	5,9	Roessink et al. (2006a)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		48 h	NOEC	photosynth. act.	30			3	5,9	Roessink et al. (2006a)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		72 h	EC10	photosynth. act.	7.2			3	5,9	Roessink et al. (2006a)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		72 h	NOEC	photosynth. act.	3			3	5,9	Roessink et al. (2006a)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		96 h	EC10	photosynth. act.	17			3	5,9	Roessink et al. (2006a)
Scenedesmus quadricauda		N	S	TPT-Ac	ag	am		20±1		96 h	NOEC	photosynth. act.	3			3	5,9	Roessink et al. (2006a)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Cl		am		22		12 d	NOEC	growth rate	4			3	1,36,58	Xu et al. (2011)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Cl		am		22		12 d	NOEC	fluorescence	2			3	1,36,58	Xu et al. (2011)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Cl		am		22		8 d	EC10	growth rate	1.9			3	1,17,36	Xu et al. (2011)
Scenedesmus quadricauda	exp. growth	N	S	TPT-Cl		am		22		12 d	EC10	growth rate	2.4			3	1,17,36,58	Xu et al. (2011)
Scenedesmus subspicatus		N	S	TPT-Ac						72 h	NOEC	biom.,cell deform.	10			3	22,31	EC (1996a, 1996b)
Scenedesmus subspicatus		N	S	TPT-Ac	50					72 h	NOEC	growth rate, biom.	10			3	18	EC (1996a, 1996b)
Scenedesmus vacuolatus	onset log phase	Y	S	TPT-Cl	98	am	6.9	28		24 h	NOEC	algal reproduction	45.5	44.5		2	7,12	Walter et al. (2002)
Macrophyta																		
Ceratophyllum demersum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		2 d	EC10	photosynth. act.	62.2			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Ceratophyllum demersum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		7 d	EC10	photosynth. act.	1.6			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Ceratophyllum demersum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC10	photosynth. act.	48.1			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Ceratophyllum demersum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC10	relative growth	0.4			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Elodea canadensis	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		2 d	EC10	photosynth. act.	5.1			4	5,9,51,52,53,60	Roessink et al. (2006a)
Elodea canadensis	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		7 d	EC10	photosynth. act.	2.1			4	5,9,51,52,53,60	Roessink et al. (2006a)
Elodea canadensis	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		21 d	EC10	photosynth. act.	1.8			4	5,9,51,52,53,60	Roessink et al. (2006a)
Elodea canadensis	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		21 d	EC10	relative growth	1.5			4	5,9,51,52,53,60	Roessink et al. (2006a)
Elodea nuttallii	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		2 d	EC10	photosynth. act.	6.1			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Elodea nuttallii	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		7 d	EC10	photosynth. act.	34.8			3	5,9,51,52,53,54,60	Roessink et al. (2006a)

Species	Species properties	A	Test type	Test comp.	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Elodea nuttallii	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC10	photosynth. act.	79.9			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Elodea nuttallii	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC10	relative growth	1.8			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Lemna minor	from the field	Y	R	TPT		am		25	300	8 d	NOEC	chlorophyll cont.		5.8	2	2	20,21,22,	Song and Huang (2001)
Lemna minor	from the field	Y	R	TPT		am		25	300	8 d	NOEC	growth rate			<2	4	20,21,22,	Song and Huang (2001)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	EC10	growth rate		0.09	0.03	2	21,22,20,17,43,44	Song and Huang (2001)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	EC10	growth rate		2.6	0.9	2	21,22,20,17,43,45	Song and Huang (2001)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	EC10	growth rate		0.9	0.3	2	21,22,20,17,43,46	Song and Huang (2001)
Lemna minor	from the field	N	R	TPT-?		am		25	300	8 d	EC10	chlorophyll cont.			2.9	3	21,22,20,25,43,45,56	Song and Huang (2001)
Lemna minor	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		2 d	EC10	photosynth. act.	910			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Lemna minor	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		7 d	EC10	photosynth. act.	104.8			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Lemna minor	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC10	photosynth. act.	96.7			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Lemna minor	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC10	relative growth	180			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	EC10	growth rate		2.2	0.77	2	21,22,42,17,43,44	Song and Huang (2005)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	EC10	growth rate		6.4	2.2	2	21,22,42,17,43,45	Song and Huang (2001)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	EC10	growth rate		2.2	0.75	2	21,22,42,17,43,46	Song and Huang (2001)
Lemna polyrhiza	from the field	Y	R	TPT-?		am		25	300	8 d	EC10	chlorophyll cont.		4.6	1.6	2	21,22,42,25,43,45	Song and Huang (2001)
Lemna trisulca	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		2 d	EC10	photosynth. act.	21.9			4	5,9,51,52,53,60	Roessink et al. (2006a)
Lemna trisulca	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		7 d	EC10	photosynth. act.	9.9			4	5,9,51,52,53,60	Roessink et al. (2006a)
Lemna trisulca	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		21 d	EC10	photosynth. act.	11.2			4	5,9,51,52,53,60	Roessink et al. (2006a)
Lemna trisulca	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-9	20±2		21 d	EC10	relative growth	1.8			4	5,9,51,52,53,60	Roessink et al. (2006a)
Myriophyllum spicatum	appr. 2 g ww	Y	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC10	relative growth	32.3			3	5,9,51,52,53,54,60	Roessink et al. (2006a)
Potamogeton crispus	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-10	20±2		2 d	EC10	photosynth. act.	9			4	5,9,51,52,53,60	Roessink et al. (2006a)
Potamogeton crispus	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-10	20±2		7 d	EC10	photosynth. act.	5.6			4	5,9,51,52,53,60	Roessink et al. (2006a)
Potamogeton crispus	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	7-10	20±2		21 d	EC10	relative growth	23.8			4	5,9,51,52,53,60	Roessink et al. (2006a)
Spirodela polyrhiza	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	6-9	20±2		2 d	EC10	photosynth. act.	386.2			4	5,9,51,52,53,60	Roessink et al. (2006a)
Spirodela polyrhiza	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	6-9	20±2		7 d	EC10	photosynth. act.	5.6			4	5,9,51,52,53,60	Roessink et al. (2006a)
Spirodela polyrhiza	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	6-9	20±2		21 d	EC10	photosynth. act.	28.9			4	5,9,51,52,53,60	Roessink et al. (2006a)
Spirodela polyrhiza	appr. 2 g ww	Y?	S	TPT-Ac	ag	nw	6-9	20±2		21 d	EC10	relative growth	0.1			4	5,9,51,52,53,60	Roessink et al. (2006a)
Mollusca																		
Biomphalaria glabrata	eggs <15 h	N	S	TPT-OH	97			25		96 h	NOEC	hatching	0.1			3	1,9	Oliveira-Filho et al. (2010)
Indoplanorbis exustus	freshly laid viable eggs	N	S	TPT-Cl form.	60	tw		25-27		24 h	LC50	mortality	0.00062			3	10,11	Goel and Prasad (1978)
Indoplanorbis exustus	freshly laid viable eggs	N	S	TPT-Cl form.	60	tw		25-27		24 h	LC50	mortality	0.00094			3	10,11,25	Goel and Prasad (1978)
Indoplanorbis exustus	freshly laid viable eggs	N	S	TPT-Cl form.	60	tw		25-27		24 h	LC10	mortality	0.00039			3	10,11,25	Goel and Prasad (1978)
Indoplanorbis exustus	freshly laid viable eggs	N	S	TPT-Cl form.	60	tw		25-27		24 h	EC10	hatching time	0.00005			3	10,11,25,26	Goel and Prasad (1978)
Lymnea stagnalis		N	S	TPT-OH				22		5 w	NOEC	growth, egg prod., hatching success	<2			3	22	EC (1996a, 1996b)
Marisa cornuarietis	sex. mature ♀; >18 mo	N	R	TPT-Cl	rg	rw	7.5	24		50 d	NOEC	imposex			0.25	3	5,7,9,27	Janer et al. (2006)

Species	Species properties	A	Test type	Test comp.	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [μg/L]	Value TPT-ion [μg/L]	Value Sn [μg/L]	Ri	Notes	Ref
Marisa cornuarietis	sex. mature ♀; >18 mo	N	R	TPT-Cl	rg	rw	7.5	24		150 d	NOEC	imposex			0.125	3	5,7,9,27	Janer et al. (2006)
Marisa cornuarietis		Y	R	TPT		am				5 mo	NOEC	egg production		<0.003		3	5,9,48	Albanis et al. (2006)
Marisa cornuarietis		Y	R	TPT		am				5 mo	EC10	egg production		0.002		3	5,9,48	Albanis et al. (2006)
Marisa cornuarietis		Y	R	TPT		am				5 mo	NOEC	virilization		15.7		3	5,9,48	Albanis et al. (2006)
Marisa cornuarietis		Y	R	TPT		am				5 mo	EC10	virilization		0.02		3	5,9,48	Albanis et al. (2006)
Marisa cornuarietis				TPT							EC10	imposex			0.0159	4		Oehlmann et al. (2007)
Marisa cornuarietis				TPT							EC10	egg production			0.0006.25	4		Oehlmann et al. (2007)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	NOEC	imposex, fecundity		<0.126	<0.0434	2	4,5,9	Schulte-Oehlmann et al. (2000)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	EC10	imposex (VDSI)		0.0357	0.0123	2	4,5,9	Schulte-Oehlmann et al. (2000)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	EC50	imposex (VDSI)		0.583	0.201	2	4,5,9	Schulte-Oehlmann et al. (2000)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	EC10	imposex (fem.penis sheath length)		0.0432	0.0149	2	4,5,9	Schulte-Oehlmann et al. (2000)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	EC50	imposex (fem.penis sheath length)		0.632	0.218	2	4,5,9	Schulte-Oehlmann et al. (2000)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	EC10	spawning mass prod.		0.0162	0.00559	2	4,5,9,26	Schulte-Oehlmann et al. (2000)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	EC50	spawning mass prod.		0.133	0.0458	2	4,5,9	Schulte-Oehlmann et al. (2000)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	EC10	egg production		0.0167	0.00577	2	4,5,9,26	Schulte-Oehlmann et al. (2000)
Marisa cornuarietis	adult	Y	R	TPT-Cl		tw		22		4 mo	EC50	egg production		0.122	0.042	2	4,5,9	Schulte-Oehlmann et al. (2000)
Potamopyrgus antipodarum		N	S	TPT		am				56 d	NOEC	mortality		0.25		3	5,9,49	Albanis et al. (2006)
Potamopyrgus antipodarum		N	S	TPT		am				56 d	NOEC	embryo develop.		0.03		3	5,9,49	Albanis et al. (2006)
Potamopyrgus antipodarum		N	S	TPT		am				56 d	EC10	number of embryos		0.02		3	5,9,49	Albanis et al. (2006)
Potamopyrgus antipodarum		N	S	TPT		am				56 d	EC10	shelled embr./female		0.06		3	5,9,49	Albanis et al. (2006)
Potamopyrgus antipodarum		N	S	TPT		am				56 d	EC10	unshelled embryos/female		0.03		3	5,9,49	Albanis et al. (2006)
Crustacea																		
Asellus aquaticus			R	TPT-Cl		am		24		10 d	LC50	mortality	10			4		Visser and Linders (1992)
Cyclops vernalis	caught in field; 1st instar	N	S	TPT-OH	95	nw		23		21 d	NOEC	reproduction	≥3			3	3,28	EC (1996a, 1996b)
Daphnia magna	<48 h	N		TPT-OH				18±1		4 w	NOEC	mortality	0.1			3	1,36	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	F	TPT-OH			8	21	180	21 d	NOEC	erratic swimming	<0.20	<0.19		2	4,5,32,37	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	F	TPT-OH			8	21	180	21 d	LC100	survival	1.5	1.4		2	4,5,32,37	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	F	TPT-OH			8	21	180	21 d	NOEC	survival, reprod.	0.77	0.73		2	4,5,32,37	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	S	TPT-Ac			8	20±1	245	21 d	LC50	parental survival	3.98	3.41		2	5,38,39,41	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	S	TPT-Ac			8	20±1	245	21 d	NOEC	mortality	1	0.86		2	5,38,39,41	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	S	TPT-Ac			8	20±1	245	21 d	NOEC	reproduction	3.2	2.7		2	5,38,39,41	EC (1996a, 1996b)
Daphnia magna	<24 h	Y	S	TPT-OH	50					21 d	LC50	mortality	4.7	4.5		2	31,40	EC (1996a, 1996b)

Species	Species properties	A	Test type	Test comp.	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Daphnia magna	<24 h	Y	S	TPT-OH	50					21 d	NOEC	mortality, reprod.	2.3	2.2		2	31,40	EC (1996a, 1996b)
Daphnia magna				TPT-Ac						21 d	EC50		0.8			4	30	Roessink et al. (2006a)
Hyalella azteca	3-5 days		R	TPT						3 m	NOEC	mortality		0.3		3		Albanis et al. (2006)
Hyalella azteca	3-5 days		R	TPT						3 m	NOEC	time to sex. mat.		<0.24		3		Albanis et al. (2006)
Insecta																		
Chironomus riparius	1st instar	Y	S	TPT-OH						28 d	EC50	emergence	8.5			2	1.4	EC (2001)
Chironomus riparius	1st instar	Y	S	TPT-OH						28 d	NOEC	emergence	6			2	0.83	EC (2001)
Chironomus riparius	1st instar	Y	S	TPT-OH						28 d	NOEC	development	3.5			2	0.52	EC (2001)
Pisces																		
Danio Rerio	eggs	N	R	TPT-Ac	98	nw	8	28	379	96 h	NOEC	hatching time	<0.5			3	3,5	Strmac and Braunbeck (1999)
Danio Rerio	eggs	N	R	TPT-Ac	98	nw	8	28	379	96 h	NOEC	mortality	5			3	3,5	Strmac and Braunbeck (1999)
Danio Rerio	eggs	N	R	TPT-Ac	98	nw	8	28	379	96 h	LC50	mortality	40			3	3,5	Strmac and Braunbeck (1999)
Danio Rerio	eggs	N	R	TPT-Ac	98	nw	8	28	379	96 h	NOEC	development (malformations)	5			3	3,5	Strmac and Braunbeck (1999)
Oncorhynchus mykiss	fry	N	F	TPT-Cl	ag	tw	7	14±2	100	110 d	NOEC	mortality	0.046	0.042		2	3,5,50	De Vries et al. (1991)
Oncorhynchus mykiss	fry	N	F	TPT-Cl	ag	tw	7	14±2	100	110 d	EC50	mortality	0.82	0.74		2	3,5,17,50	De Vries et al. (1991)
Oncorhynchus mykiss	fry	N	F	TPT-Cl	ag	tw	7	14±2	100	110 d	EC10	mortality	0.2	0.18		2	3,5,17,50	De Vries et al. (1991)
Oncorhynchus mykiss	fry	N	F	TPT-Cl	ag	tw	7	14±2	100	110 d	NOEC	body weight	≥1.2	≥1.0		2	3,5,50	De Vries et al. (1991)
Oryzias latipes	5 months; 650 mg; 32 mm	N	F	TPT-Cl		nw	7.9	25±1	81	5 w	NOEC	reproduction	0.0016	0.0015		2	5,13,18,59	Zhang et al. (2008)
Oryzias latipes	5 months; 650 mg; 32 mm	N	F	TPT-Cl		nw	7.9	25	81	5 w	NOEC	fertilization success	>1	>0.9		2	5,13,18,59	Zhang et al. (2008)
Oryzias latipes	5 months; 650 mg; 32 mm	N	F	TPT-Cl		nw	7.9	25	81	5 w	NOEC	larval survival	<0.0016	<0.0015		2	5,13,18,59	Zhang et al. (2008)
Oryzias latipes	5 months; 650 mg; 32 mm	N	F	TPT-Cl		nw	7.9	25	81	5 w	EC50	larval survival	0.0078	0.0071		2	5,13,17,18,59	Zhang et al. (2008)
Oryzias latipes	5 months; 650 mg; 32 mm	N	F	TPT-Cl		nw	7.9	25	81	5 w	EC10	larval survival	0.00047	0.00043		2	5,13,17,18,59,61	Zhang et al. (2008)
Oryzias latipes	5 months; 650 mg; 32 mm	N	F	TPT-Cl		nw	7.9	25	81	5 w	NOEC	larval ocular develop.	0.008	0.007		2	5,13,18,59	Zhang et al. (2008)
Oryzias latipes	5 months; 650 mg; 32 mm	N	F	TPT-Cl		nw	7.9	25	81	5 w	NOEC	larval morphological deformations	0.04	0.04		2	5,13,18,59	Zhang et al. (2008)
Phoxinus phoxinus	24h fert. embr.	Y	R	TPT-Cl	>97	nw	8	16		9 d	NOEC	mortality, morph. deform.		0.2		2	3,4,5	Fent and Meier (1994)
Phoxinus phoxinus	24h fert. embr.	Y	R	TPT-Cl	>97	nw	8	16		9 d	NOEC	hatching success		5.1		2	3,4,5	Fent and Meier (1994)
Phoxinus phoxinus	24h fert. embr.	Y	R	TPT-Cl	>97	nw	8	21		5 d	NOEC	hatching success		≥14.2		2	3,4,5	Fent and Meier (1994)
Phoxinus phoxinus	24h fert. embr.	Y	R	TPT-Cl	>97	nw	8	21		5 d	NOEC	mortality, morph. deform.		<6.6		2	3,4,5	Fent and Meier (1994)
Phoxinus phoxinus	newly hatched larvae	Y	R	TPT-Cl	>97	nw	8	16		5 d	NOEC	mortality, morph. deformities		<1.8		2	3,4,5	Fent and Meier (1994)

Species	Species properties	A	Test type	Test comp.	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Pimephales promelas	<48 h embryos	Y	F?	TPT-OH	97.3		8	25	31	30 d post-hatch	NOEC	hatchability, growth	0.48	0.46		2	4,5,32	EC (1996a, 1996b)
Pimephales promelas	<48 h embryos	Y	F?	TPT-OH	97.3		8	25	31	30 d post-hatch	NOEC	survival	1.1	1		2	4,5,32	EC (1996a, 1996b)
Pimephales promelas	<24 h	Y	F?	TPT-OH	97.3		7-8	24-25	42	30 d	NOEC	mortality	0.15			4*	33	EC (1996a, 1996b)
Pimephales promelas	<24 h	Y	F?	TPT-OH	97.3		7-8	24-25	42	30 d	LC50	mortality	1.5			4*	33	EC (1996a, 1996b)
Pimephales promelas	<24 h	Y	F?	TPT-OH	97.3		7-8	24-25	42	30 d	EC50	growth	0.23			4	33	EC (1996a, 1996b)
Pimephales promelas	newly fert. eggs	Y	F	TPT-OH	97-99			14-15		183 d	NOEC	parental length and wet weight	0.161	0.154		2	3,4,5,35	EC (1996a, 1996b)
Pimephales promelas	newly fert. eggs	Y	F	TPT-OH	97-99			14-15		183 d	NOEC	reproduction	>0.914	>0.88		2	3,4,5,35	EC (1996a, 1996b)
Pimephales promelas	newly fert. eggs	Y	F	TPT-OH	97-99			14-15		183 d	NOEC	hatching success	>0.914	>0.88		2	3,4,5,35	EC (1996a, 1996b)
Pimephales promelas	newly fert. eggs	Y	F	TPT-OH	97-99			14-15		183 d	NOEC	F1 survival	0.469	0.449		2	3,4,5,35	EC (1996a, 1996b)
Pimephales promelas	newly fert. eggs	Y	F	TPT-OH	97-99			14-15		183 d	NOEC	F1 length and wet weight	>0.914	>0.88		2	3,4,5,35	EC (1996a, 1996b)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	24-25	47	30 d	NOEC	mortality	1.26	1.14		1	4,8	Jarvinen et al. (1988)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	24-25	47	30 d	LC50	mortality	1.5	1.4		1	4,8	Jarvinen et al. (1988)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	24-25	47	30 d	LC50	mortality	1.9	1.7		1	4,8,25	Jarvinen et al. (1988)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	24-25	47	30 d	LC10	mortality	1.8	1.6		1	4,8,25	Jarvinen et al. (1988)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	24-25	47	30 d	NOEC	weight	0.15	0.14		1	4,8	Jarvinen et al. (1988)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	24-25	47	30 d	EC50	weight	1.7	1.5		1	4,8,25	Jarvinen et al. (1988)
Pimephales promelas	larvae <24 h	Y	F	TPT-OH	96	nw	7-8	24-25	47	30 d	EC10	weight	0.2	0.19		1	4,8,25	Jarvinen et al. (1988)
Pimephales promelas			F	TPT						21 d	EC10	egg prod., fecundity		0.707		3		Albanis et al. (2006)
Pimephales promelas			F	TPT						21 d	EC50	egg prod., fecundity		0.918		3		Albanis et al. (2006)
Pimephales promelas				TPT-OH						96 h	EC50		1.2			4	30	Roessink et al. (2006a)
Rutilus rutilus	2 year old		R	TPT						14 d	LOEC	spermato- & oogenesis			0.594	4		Albanis et al. (2006)
Amphibia																		
Ambystoma barbouri	larvae	N	R	TPT-Cl	>95		7-8	21-24		96 d	NOEC	mortality	1			3	3,5,19,60	Rehage et al. (2002)
Ambystoma barbouri	larvae	N	R	TPT-Cl	>95		7-8	21-24		24 d	NOEC	feeding, growth	<1			3	3,5,19,60	Rehage et al. (2002)
Ambystoma barbouri	larvae	N	R	TPT-Cl	>95		7-8	21-24		37 d	NOEC	time to metamorph.	<1			3	3,5,19,60	Rehage et al. (2002)
Ambystoma barbouri	larvae	N	R	TPT-Cl	>95		7-8	21-24		33 d	NOEC	swimming behave.	1			3	3,5,19,60	Rehage et al. (2002)
Rana esculenta	tadpoles	Y	R	TPT-Cl		tw	6/8	23-25		73 d	NOEC	survival, time to metamorphosis		0.11		2	3,5,6,23,24	Fioramonti et al. (1997)
Rana lessonae	tadpoles	Y	R	TPT-Cl		tw	6/8	23-25		73 d	NOEC	survival, time to metamorphosis		0.11		2	3,5,6,23,24	Fioramonti et al. (1997)
Rana esculenta	tadpoles	Y	R	TPT-Cl		tw	6/8	23-25		30 d	NOEC	body mass		0.11		2	3,5,6,23,24	Fioramonti et al. (1997)
Rana lessonae	tadpoles	Y	R	TPT-Cl		tw	6/8	23-25		30 d	NOEC	body mass		0.11		2	3,5,6,23,24	Fioramonti et al. (1997)
Rana lessonae/esculenta	tadpoles	Y	R	TPT-Cl		tw	6/8	23-25		73 d	LC50	survival		1.5		2	3,5,6,17,23,24	Fioramonti et al. (1997)
Rana lessonae/esculenta	tadpoles	Y	R	TPT-Cl		tw	6/8	23-25		73 d	LC10	survival		0.34		2	3,5,6,17,23,24	Fioramonti et al. (1997)
Xenopus laevis	stage 42/43		R	TPT						larval stadia	LOEC	mortality + larval development			1.187	4		Albanis et al. (2006)
Xenopus laevis	3-4 year		R	TPT						14 d	LOEC	spermato- & oogenesis			0.119	4		Albanis et al. (2006)

Notes

1 No solvent control performed.
2 Solvent unknown.
3 Solvent: acetone.
4 Result based on mean measured concentration.
5 Solvent control performed.
6 Positive effects of solvent may have masked toxicity effects at the lowest exposure levels.
7 Solvent concentration ≤0.01%.
8 No solvent used, water concentrations prepared with a saturator system.
9 Solvent: ethanol.
10 Formulation used: TPT chloride wettable powder, solutions of the powder were further diluted.
11 No control for blank formulation.
12 Result based on measured concentrations.
13 Solvent 0.005% DMSO.
14 Biomass was calculated using adsorption at 680 nm.
15 primary production measured as CO_2 uptake.
16 NOEC=LOECD/3; 40% effect at 10 μg/L.
17 Value recalculated from graph in paper.
18 Concentrations in water were kept to the designed exposure doses; flow-through with a 4-fold volume of water flowing through every 24 hours; no parent mortality observed even at highest dose (1 μg/L); embryos and larvae were observed in clean filtered water after transfer of eggs in the last week of exposure.
19 Renewal every 96 hours.
20 Measured concentrations in bioconcentration tests after 8 days close to nominal concentrations; average concentration was 61% of nominal; renewal every two days.
21 No detail on TPT species.
22 No details on use of solvents.
23 Exposure in plastic dishpans; renewal after 3 days.
24 Measured concentrations did not differ significantly from nominal; results based on measured concentrations.
25 Value recalculated from table in paper.
26 Value unreliable, extrapolated too far out of the measured range.
27 Renewal every 24 hours.
28 Exposure in Petri dishes.
29 Exposed in artificial sediment containing 10% OM and 20% clay; active ingredient was spiked in water. Value is mean measured value recalculated over the period of exposure in the basis of data in the DAR; measured pH and temperature not reported but mentioned as within acceptable levels for survival of midge larvae.
30 Original data cannot be retrieved.
31 According to OECD guidelines.
32 Solvent: triethylene glycol.
33 No solvent used.
34 Endpoint recalculated from data in the ref.
35 According to FIFRA 72-5 guideline.
36 Solvent: methanol.
37 Mean measured concentrations were 60-67% of nominal.
38 Solvent: DMF.
39 Measured concentrations were >80% of nominal; results based on nominal concentrations.
40 Lowest mean measured concentration was 71% of nominal; all nominal concentrations were corrected by 71%.
41 Analysis performed throughout the test.
42 Measured concentrations in bioconcentration tests after 8 days close to nominal concentrations; average concentration was 64.8% of nominal; renewal every two days.
43 Corrected for average recovery in bioconcentration test (61%).
44 Low concentration range of 2 and 5 μg/L.
45 High concentration range of 5, 10, 25, and 50 μg/L.
46 Low and high concentration range combined.
47 Measured concentrations after 7 d were 33% (algae) and 77.5% (*S. obliquus*) of nominal, concentration in blanc samples contained 91.3% after 7 d; results based on nominal concentrations; control in exponential growth until 48 h.
48 30 snails in 40 liters of water, renewal every day.
49 20 or 40 (unclear) snails in one liter of water.

50 Final solvent concentration of 0.225 mg/L.
51 Results based on nominal concentrations.
52 detection limit 1 µg/L; GC-MSC; DOC of test medium was 8.8 mg/L.
53 Medium enriched with nutrients.
54 Measured concentrations decreased to below detection limits (1 µg/L) after 14 days.
55 Value recalculated for growth rate from data in table according to OECD guideline 201.
56 Confidence interval very large.
57 Exposure period too short for a cyanobacterium.
58 Exposure period exceeds exponential growth phase.
59 The used water was treated with activated carbon.
60 The used water was filtered.
61 See additional summary below.
62 Only two concentrations tested.

Short summary Zhang et al.(2008).

Adult Medaka (*Oryzias latipes*) were exposed for 5 weeks in a flow-through system to 1.6, 8, 40, 200, or 1000 ng/L TPT-Cl or a vehicle control (0.005% DMSO). The concentration in water was not measured, but ‘kept to the designated doses’. At the last week of exposure, eggs were collected a few hours after oviposition. Fertilized eggs were further cultured until 10 days post-hatch, in TFT-free water. NOECs of 1.6 ng/L and even lower were obtained for various endpoints, including larval survival, fecundity, hatching success and malformations/development.

The results of this study are about a factor of 100-1000 lower than results from other studies. The main difference is that exposure in this study was performed through maternal transfer, while in the other studies the eggs or fry were exposed directly. The article gives some mechanistical explanations in the introduction:

- TFT inhibits the conversion of testosterone to estrogen;
- TFT inhibits plasma vitellogenin, the precursor of yolk protein, and thus oocyte development;
- TFT inhibits all kinds of hormonal processes;
- TPT can be highly accumulated in eggs via maternal transfer.

In the other studies, also other fish species were used (there are no other studies using *Oryzias latipes*).

Table A2.3: Acute toxicity for marine organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Bacteria																		
Vibrio fischeri		N	S	TPT-Cl		am	6-8			15 m	EC50	luminescence	20	18		2	6,25	Argese et al. (1998)
Vibrio fischeri		N	S	TPT-Cl		am	6-8			15 m	EC50	luminescence	96	87		2	6,18	Macken et al. (2008)
Vibrio fischeri		N	S	TPT-Cl		am	6-8			30 m	EC50	luminescence	71	64		2	6,18	Macken et al. (2008)
Algae																		
Dunaliella tertiolecta		N	IF	TPT-Cl		am		17		60-75 m	EC50	photosynthesis	1079			3	6,14	Mooney and Patching (1995)
Dunaliella tertiolecta		N	IF	TPT-Cl		am		17		60-75 m	EC50	photosynthesis	837			3	6,14,22	Mooney and Patching (1995)
Dunaliella tertiolecta		N	IF	TPT-Cl		am		17		75 m	EC50	respiration	835			3	6,14,22	Mooney and Patching (1995)
Platymonas sp.	log-phase	N	S	TPT-Cl	>99	am	7.8	25		96 h	EC50	growth			0.63	3	6,14,28	Huang et al. (1996)
Platymonas sp.	log-phase	N	S	TPT-OH	>99	am	7.8	25		96 h	EC50	growth			0.7	3	6,14,28	Huang et al. (1996)
Platymonas sp.	log-phase	N	S	TPT-Ac	>99	am	7.8	25		96 h	EC50	growth			0.61	3	6,14,28	Huang et al. (1996)
Skeletonema costatum	log-phase; 2500 cells/ml	N	S	TPT-Ac		am	8.1	20	30	72 h	EC50	growth (cell nb.)	0.86			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	log-phase; 2500 cells/ml	N	S	TPT-Cl		am	8.1	20	30	72 h	EC50	growth (cell nb.)	0.92			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	log-phase; 2500 cells/ml	N	S	TPT-OH		am	8.1	20	30	72 h	EC50	growth (cell nb.)	0.59			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	log-phase; 2500 cells/ml	N	S	bis-TPT-O		am	8.1	20	30	72 h	EC50	growth (cell nb.)	0.81			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	post exponential growth	N	S	TPT-Ac		am	8.1	20	30	72 h	EC50	fluorescence	5.40			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	post exponential growth	N	S	TPT-Cl		am	8.1	20	30	72 h	EC50	fluorescence	3.60			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	post exponential growth	N	S	TPT-OH		am	8.1	20	30	72 h	EC50	fluorescence	1.70			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	post exponential growth	N	S	bis-TPT-O		am	8.1	20	30	72 h	EC50	fluorescence	2.40			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	post exponential growth	N	S	TPT-Ac		am	8.1	20	30	72 h	LC50	mortality	16.80			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	post exponential growth	N	S	TPT-Cl		am	8.1	20	30	72 h	LC50	mortality	13.80			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	post exponential growth	N	S	TPT-OH		am	8.1	20	30	72 h	LC50	mortality	13.90			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum	post exponential growth	N	S	bis-TPT-O		am	8.1	20	30	72 h	LC50	mortality	4.30			3	6,7,12	Walsh et al. (1985)
Skeletonema costatum		N	IF	TPT-Cl		am		17		60-75 m	EC50	photosynthesis	31			3	6,14	Mooney and Patching (1995)
Skeletonema costatum		N	IF	TPT-Cl		am		17		60-75 m	EC50	photosynthesis	30			3	6,14,22	Mooney and Patching (1995)
Skeletonema costatum		N	IF	TPT-Cl		am		17		60-75 m	EC50	respiration	147			3	6,14,22	Mooney and Patching (1995)
Skeletonema costatum				TPT-Ac						72 h	EC50		0.7			4	27	Roessink et al. (2006a)
Spirulina subsalsa		N	S			am		25±1		8 d	EC50	growth rate	15.63			3	11,13,19	Zhihui and Guolan (2000)
Spirulina subsalsa		N	S			am		25±1		8 d	EC50	Chlorophyll-a	9.38			3	11,13,19	Zhihui and Guolan (2000)
Spirulina subsalsa		N	S	TPT-Cl		am		25		8 d	IC50	growth rate	15.63			3	11,20	Huang et al. (2002)
Spirulina subsalsa		N	S	TPT-Cl		am		25		8 d	IC50	chlorophyll content	9.38			3	11,20	Huang et al. (2002)
Spirulina subsalsa		N	S	TPT-Cl		am		25		8 d	IC50	phycocyanin cont.	31.45			3	11,20	Huang et al. (2002)
Spirulina subsalsa		N	S	TPT-Cl		am		25		8 d	IC50	nitrate reduct. act.	6.05			3	11,20	Huang et al. (2002)
Tetraselmis suecica		N	S	TPT-Cl		nw		20	29-32	72 h	EC50	growth rate	5.0			3	6,17,18	Macken et al. (2008)
Thalassiosira guillardii				TPT-Ac						72 h	EC50		1.10			4	27	Roessink et al. (2006a)
Thalassiosira pseudonana	log-phase; 2500 cells/ml	N	S	TPT-Ac		am	8.1	20	30	72 h	EC50	growth (cell nb.)	1.09			3	6,7,12	Walsh et al. (1985)
Thalassiosira pseudonana	log-phase; 2500 cells/ml	N	S	TPT-Cl		am	8.1	20	30	72 h	EC50	growth (cell nb.)	1.34			3	6,7,12	Walsh et al. (1985)
Thalassiosira pseudonana	log-phase; 2500 cells/ml	N	S	TPT-OH		am	8.1	20	30	72 h	EC50	growth (cell nb.)	1.07			3	6,7,12	Walsh et al. (1985)
Thalassiosira pseudonana	log-phase; 2500 cells/ml	N	S	bis-TPT-O		am	8.1	20	30	72 h	EC50	growth (cell nb.)	1.25			3	6,7,12	Walsh et al. (1985)
Thalassiosira pseudonana				TPT-Ac						72 h	EC50		1.50			4	27	Roessink et al. (2006a)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Macrophyta																		
Porphyra yezoensis		N	S	TPT-Cl		nw		15		48 h	EC50	spore adhesion	30			3	11	Maruyama et al. (1991)
Porphyra yezoensis		N	S	TPT-Ac		nw		15		96 h	EC50	spore adhesion	60			3	11	Maruyama et al. (1991)
Porphyra yezoensis		N	S	TPT-Cl		nw		15		48 h	EC50	germination	3.6			3	11	Maruyama et al. (1991)
Porphyra yezoensis		N	S	TPT-Ac		nw		15		96 h	EC50	germination	6.3			3	11	Maruyama et al. (1991)
Mollusca																		
Haliotis discus discus	larvae	Y	S	TPT-Cl		am		20		48 h	LC50	mortality	1.4			3	33,34	Horiguchi et al. (1998)
Haliotis madaka	larvae	Y	S	TPT-Cl		am		20		48 h	LC50	mortality	1.5			3	33,34	Horiguchi et al. (1998)
Thais clavigera	larvae	Y	S	TPT-Cl		am		20		48 h	LC50	mortality	4.6			3	33,34	Horiguchi et al. (1998)
Crustacea																		
Artemia salina	24 h after hatching	Y?	S	TPT-OH		am		25-30	34.7	24 h	LC50	mortality	1461			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	24 h after hatching	Y?	S	TPT-Cl		am		25-30	34.7	24 h	LC50	mortality	898			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	24 h after hatching	Y?	S	TPT-Ac		am		25-30	34.7	24 h	LC50	mortality	818			3	6,14,23	Nguyen et al. (2000a)
Artemia salina	24 h after hatching	Y?	S	TPT-F		am		25-30	34.7	24 h	LC50	mortality	1520			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	48 h after hatching	Y?	S	TPT-OH		am		25-30	34.7	24 h	LC50	mortality	661			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	48 h after hatching	Y?	S	TPT-Cl		am		25-30	34.7	24 h	LC50	mortality	571			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	48 h after hatching	Y?	S	TPT-Ac		am		25-30	34.7	24 h	LC50	mortality	601			3	6,14,23	Nguyen et al. (2000a)
Artemia salina	48 h after hatching	Y?	S	TPT-F		am		25-30	34.7	24 h	LC50	mortality	546			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	72 h after hatching	Y?	S	TPT-OH		am		25-30	34.7	24 h	LC50	mortality	595			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	72 h after hatching	Y?	S	TPT-Cl		am		25-30	34.7	24 h	LC50	mortality	501			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	72 h after hatching	Y?	S	TPT-Ac		am		25-30	34.7	24 h	LC50	mortality	470			3	6,14,23	Nguyen et al. (2000a)
Artemia salina	72 h after hatching	Y?	S	TPT-F		am		25-30	34.7	24 h	LC50	mortality	561			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	96 h after hatching	Y?	S	TPT-OH		am		25-30	34.7	24 h	LC50	mortality	382			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	96 h after hatching	Y?	S	TPT-Cl		am		25-30	34.7	24 h	LC50	mortality	459			3	6,18,23	Nguyen et al. (2000a)
Artemia salina	96 h after hatching	Y?	S	TPT-Ac		am		25-30	34.7	24 h	LC50	mortality	270			3	6,14,23	Nguyen et al. (2000a)
Artemia salina	96 h after hatching	Y?	S	TPT-F		am		25-30	34.7	24 h	LC50	mortality	380			3	6,18,23	Nguyen et al. (2000a)
Carcinoscorpius rotundicauda	embryos	N	R	TPT-Cl		nw	8			24 h	LC100	survival	10000			3	14,15	Itow et al. (1998)
Crangon crangon			S	TPT-Ac		nw		15		48h	LC50		>33000			3	6	Portmann and Wilson (1971)
Limulus polyphemus	embryos	N	R	TPT-Cl		nw	8			24 h	LC100	survival	10000			3	14,15	Itow et al. (1998)
Nitocra spinipes	adult	N	S	TPT-Fl	31.94% Sn	nw	7.8	21	7	96 h	LC50	mortality	8			3	6,7	Lindén et al. (1979)
Palaemonetes pugio		Y	F	TPT-O?		nw		22-25		96 h	LC50	mortality	50			4	2,8,9	Clark et al.(1987)
Tisbe battagliai	6 ± 2 days old	N	S	TPT-Cl		nw		20	29-32	24 h	LC50	mortality	6.2			3	6,18,21	Macken et al. (2008)
Tisbe battagliai	6 ± 2 days old	N	S	TPT-Cl		nw		20	29-32	48 h	LC50	mortality	3.5			3	6,18,21	Macken et al. (2008)
Tisbe battagliai	6 ± 2 days old	N	S	TPT-Cl		nw		20	29-32	48 h	NOEC	mortality	2.9			3	6,18,21	Macken et al. (2008)
Echinodermata																		
Antedon mediterranea	amputated animals	N	R	TPT-Cl		asw		14		72 h	LC50	mortality	≈1.0			3	8,14,6,29,30,31	Barbaglio et al. (2006)
Pisces																		
Alburnus alburnus	8 cm	N	S	TPT-Fl	31.94% Sn	nw	7.8	10	7	96 h	LC50	mortality	400			3	6,7,8,31	Lindén et al. (1979)
Chasmichthys dolichognathus	5.2 cm, 1.7 g	Y		TPT-Cl		nw	8	25	33-34	96 h	LC50	mortality	19	17		2	1,2,3	Shimizu and Kimura (1991)
Chasmichthys dolichognathus	5.4 cm, 1.8 g	Y		TPT-Cl		asw	8	25	33	96 h	LC50	mortality	22	20		2	1,2,3,4	Shimizu and Kimura (1991)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Chasmichthys dolichognathus	5.0-5.3 cm, 1.5-1.9 g	Y		TPT-Cl		asw	8	25	33-34	96 h	LC50	mortality	22	20		2	1,2,3,5,32	Shimizu and Kimura (1991)
Lepomis macrochirus				TPT-Ac						96 h	EC50		23			4	27	Roessink et al. (2006a)
Oryzias latipes				TPT-Ac						48 h	EC50		20			4	27	Roessink et al. (2006a)
Pagrus major				TPT-Cl						48 h	LC50	mortality	13			4		Yamada and Takayanagi (1992)

Notes

1 Data from abstracts and tables, paper in Japanese.
2 Measured concentrations 70-80% of nominal.
3 Results based on measured concentrations.
4 AM without Na_2SiO_3.
5 AM with Na_2SiO_3.
6 Solvent control performed.
7 Solvent: acetone.
8 Results based on nominal concentration.
9 Unclear which compound has been tested, either TPT-hydroxide or Bis(TPT)-oxide.
10 Solvent concentration 0.01%.
11 No mentioning of solvent use.
12 Stock solutions were analysed; test solutions were below detection limits so could not be analysed.
13 Unclear which compound has been tested.
14 Solvent ethanol.
15 Exposure concentration > water solubility.
16 No solvent control performed.
17 According to ISO guideline.
18 Solvent: DMSO.
19 Growth rate and Chlorophyll-a content measured using absorption at 560 and 665 nm, respectively.
20 Not clear which range of concentrations was used and how IC50 is calculated.
21 According to ISO guideline with slight modifications.
22 EC50 calculated using data from graphs in paper and Graphpad.
23 Exposure in plastic Petri dishes; measurements not specified but 'analytical analysis showed that the total tin concentration remained constant during the test period'. Since this is not further specified, may have been without organisms present, and the exposure was in plastic, the validity of the study is Ri 3.
24 Nominal concentrations were verified by analysis with GC/FPD', but this is not further specified. Only a short abstract is available with not enough information to make a judgement.
25 Solvent ethanol or DMSO.
26 Compound was measured, but below detection limits.
27 Original data cannot be retrieved.
28 Wrong unit reported in table 1 of publication.
29 Solvent concentration 0.025 mL/L.
30 Time weighted average measured concentrations in similar exposure systems over 28 days were 5.5, 14 and 33 ng/L at 100, 225 and 500 ng/L (5-6% of nominal), reported in Tremolada et al. (2006).
31 Acetone concentration max. 0.5 mL/L.
32 Geometric mean of two trials, LC50 18 and 27 µg/L.
33 According to OECD guideline.
34 Measured concentrations for TPT-exposure not reported; result based on nominal concentrations.

Table A2.4: Chronic toxicity for marine organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Bacteria																		
Aeromonas hydrophyla		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			≥0.3	3	9,29	Mendo et al. (2003)
Aeromonas salmonicida		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			≥0.3	3	9,29	Mendo et al. (2003)
Bacillus megaterium		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			0.02	3	9,29	Mendo et al. (2003)
Corynebacterium auris		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			0.08	3	9,29	Mendo et al. (2003)
Enterobacter intermedius		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			≥0.3	3	9,29	Mendo et al. (2003)
Kurthia gibsonii		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			0.08	3	9,29	Mendo et al. (2003)
Microbacterium spp.		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			0.08	3	9,29	Mendo et al. (2003)
Micrococcus luteus		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			0.08	3	9,29	Mendo et al. (2003)
Oersinia xanthineolytica		N	S	TPT-Cl	>97	am		20	15	24 h	NOEC	growth			≥0.3	3	9,29	Mendo et al. (2003)
Vibrio fischeri		N	S	TPT-Cl		am	6-8			15 m	NOEC	luminescence	44			2	8,9	Macken et al. (2008)
Vibrio fischeri		N	S	TPT-Cl		am	6-8			30 m	NOEC	luminescence	44			2	8,9	Macken et al. (2008)
Algae																		
Dunaliella tertiolecta		N	IF	TPT-Cl	96	am		17		75 m	EC10	photosynthesis	778			3	8,11,28	Mooney and Patching (1995)
Dunaliella tertiolecta		N	IF	TPT-Cl	96	am		17		75 m	NOEC	photosynthesis	809			3	8,11	Mooney and Patching (1995)
Dunaliella tertiolecta		N	IF	TPT-Cl	96	am		17		75 m	EC10	respiration	783			3	8,11,28	Mooney and Patching (1995)
Dunaliella tertiolecta		N	IF	TPT-Cl	96	am		17		75 m	NOEC	respiration	809			3	8,11,28	Mooney and Patching (1995)
Enteromorpha intestinalis	spores	N	S	TPT-Cl		nw		15			NOEC	respiration	1.93			3	1,11	Callow et al. (1979)
Enteromorpha intestinalis	spores	N	S	TPT-Cl		nw		15			NOEC	photosynthesis	1.93			3	1,11	Callow et al. (1979)
Pavlova lutheri		Y	F	TPT-Cl		nw		17.5	29.2	8 d	NOEC	growth rate	0.04	0.04		2	6,7,27	Marsot et al. (1995)
Porphyra yezoensis		N	S	TPT-Cl		nw		15		48 h	NOEC	spore adhesion	3			3	2,3,33	Maruyama et al. (1991)
Porphyra yezoensis		N	S	TPT-Ac		nw		15		96 h	NOEC	spore adhesion	15			3	2,3,33	Maruyama et al. (1991)
Porphyra yezoensis		N	S	TPT-Cl		nw		15		48 h	LOEC	germination	1-1.6			3	11,33	Maruyama et al. (1991)
Porphyra yezoensis		N	S	TPT-Ac		nw		15		96 h	LOEC	germination	2			3	11,33	Maruyama et al. (1991)
Skeletonema costatum		N	F	TPT-Cl	96	am		17		75 m	EC10	photosynthesis	4.8			3	8,11,28	Mooney and Patching (1995)
Skeletonema costatum		N	F	TPT-Cl	96	am		17		75 m	EC10	respiration	6.8			3	8,11,28	Mooney and Patching (1995)
Spirulina subsalsa		N	S			am		25		8 d	NOEC	growth rate	5			3	23,24,25	Zhihui and Guolan (2000)
Spirulina subsalsa		N	S			am		25		8 d	NOEC	Chlorophyll-a	5			3	23,24,25	Zhihui and Guolan (2000)
Ulothrix flacca	spores	N	S	TPT-Cl		nsw		15			NOEC	respiration	193			3	1,11	Callow et al. (1979)
Ulothrix flacca	spores	N	S	TPT-Cl		nsw		15			NOEC	photosynthesis	19.3			3	1,11	Callow et al. (1979)
Mollusca																		
Arenicola cristata	embryo	N	S	TPT-Cl	>99.6	nw			28	7 d	NOEC	mortality	2.50			3		Crommentuijn et al. (1997)
Arenicola cristata	embryo	N	S	TPT-Cl	>99.6	nw			28	7 d	NOEC	morphology	0.50			3		Crommentuijn et al. (1997)
Crassostrea gigas	embryo	N	S	TPT-?		asw		25		24 h	LC10	mortality		0.52		2		Tsunemasa and Okamura (2011)
Haliotis gigantea			F	TPT						63 d	LOEC	spermatogenesis			0.10	4	4	Horiguchi et al. (2002)
Haliotis madaka	eggs	Y	S							48 h	EC50	development	0.19			4	4,8,30	Treuner et al. (2005)
Nassarius reticulatus				TPT							LOEC	imposex			0.10	4*		Oehlmann et al. (2007)
Nassarius reticulatus		N	R	TPT-Cl	97	asw		18		2 mo	LOEC	imposex			0.10	3	8,9	Barroso et al. (2002)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Nucella lapillus	adult	N	R	TPT-Cl		asw		14		3 mo	NOEC	male sex organ develop.		0.15	0.05	2	8,10,34	Schulte-Oehlmann et al. (2000)
Annelida																		
Arenicola cristata	embryos	N		TPT-Cl	>99.6	nsw		20	28	96 h	NOEC	survival	2.5			3	2,22,43	Walsh et al. (1986)
Arenicola cristata	embryos	N		TPT-Cl	>99.6	nsw		20	28	96 h	NOEC	development	1			3	2,22,43	Walsh et al. (1986)
Arenicola cristata	embryos	N		TPT-Cl	>99.6	nsw		20	28	168 h	NOEC	survival	2.5			3	2,22,43	Walsh et al. (1986)
Arenicola cristata	embryos	N		TPT-Cl	>99.6	nsw		20	28	168 h	NOEC	development	0.5			3	2,22,43	Walsh et al. (1986)
Arenicola cristata	embryos	N		bis-TPT-O	>99.6	nsw		20	28	96 h	NOEC	survival	2			3	2,22,43	Walsh et al. (1986)
Arenicola cristata	embryos	N		bis-TPT-O	>99.6	nsw		20	28	96 h	NOEC	development	0.5			3	2,22,43	Walsh et al. (1986)
Arenicola cristata	embryos	N		bis-TPT-O	>99.6	nsw		20	28	168 h	NOEC	survival	1.5			3	2,22,43	Walsh et al. (1986)
Arenicola cristata	embryos	N		bis-TPT-O	>99.6	nsw		20	28	168 h	NOEC	development	0.5			3	2,22,43	Walsh et al. (1986)
Crustacea																		
Acartia tonsa			R	TPT							LC10	mortality	0.27			4	39	Albanis et al. (2006)
Acartia tonsa			R	TPT							LOEC	malform. of genitals	0.0006			4	39	Albanis et al. (2006)
Acartia tonsa			R	TPT							LC10	larval development	0.00095			4	39	Albanis et al. (2006)
Rhithropanopeus harrisii	larvae	N	R	TPT-Cl		nw				10-12 d	LC50	zoeal development	35.6			3	32	Laughlin et al. (1984)
Rhithropanopeus harrisii	larvae			TPT						10-12 d	LC50		37			2*		UNEP (1989)
Rhithropanopeus harrisii	larvae	N	R	TPT-OH	>97	nw		25	15	12 d	LC50	mortality	35.6	34		2	13,14,32	Laughlin et al. (1985)
Rhithropanopeus harrisii	larvae	N	R	TPT-OH	>97	nw		25	15	12 d	NOEC	mortality	10	9.5		2	13,14,32	Laughlin et al. (1985)
Echinodermata																		
Antedon mediterranea			R	TPT							NOEC	reproductive stages	0.1			4	39,40	Albanis et al. (2006)
Antedon mediterranea			R	TPT							NOEC	egg size	0.225			4	39,40	Albanis et al. (2006)
Antedon mediterranea	adult	Y	R	TPT-Cl	>98	asw		16	37	2w	LOEC	egg size		0.033		3	8,11,19,38	Sugni et al. (2010)
Antedon mediterranea	amputated animals	N	R	TPT-Cl		asw		14		14 d	NOEC	regeneration	0.05			3	8,11,36,37	Barbaglio et al. (2006)
Antedon mediterranea			R	TPT						1 mo	NOEC	regeneration	0.05			4*	39,40	Albanis et al. (2006)
Anthocidaris crassispina	sperm	N	S	TPT-Cl	95	asw				15 mi	EC50	sperm tox	310	281		2	8,9,41,42	Shim et al. (2006)
Anthocidaris crassispina	mature eggs	N	S	TPT-Cl	95	asw				15 mi	EC50	fertilization	2400	2179		2	8,9,41,42	Shim et al. (2006)
Anthocidaris crassispina	fertile eggs	N	S	TPT-Cl	95	asw				15 mi	EC50	embryo development	270	245		2	8,9,41,42	Shim et al. (2006)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		asw	8	18	35	72 h	EC50	development	1.11			3	8,31	Arizzi Novelli et al. (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-Ac		asw	8	18	35	72 h	EC50	development	1.17			3	8,31	Arizzi Novelli et al. (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		asw	8	18	35	72 h	NOEC	development	0.4			3	8,31	Arizzi Novelli et al. (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-Ac		asw	8	18	35	72 h	NOEC	development	0.48			3	8,31	Arizzi Novelli et al. (2002)
Paracentrotus lividus	sperm	N	S	TPT-OH		asw	8	18	35	1 h	EC50	% fertilization	16.5	15.7		2	8,31,41,42	Arizzi Novelli et al. (2002)
Paracentrotus lividus	sperm	N	S	TPT-Ac		asw	8	18	35	1 h	EC50	% fertilization	18.5	16.8		2	8,31,41,42	Arizzi Novelli et al. (2002)
Paracentrotus lividus	sperm	N	S	TPT-OH		am		15	35	1 h	EC50	% fertilization	8.3	7.9		2	8,11,28,41,42	Moschino and Marin (2002)
Paracentrotus lividus	sperm	N	S	TPT-OH		am		15	35	1 h	EC10	% fertilization	1.08	1.03		2	8,11,28,41,42	Moschino and Marin (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		am		22	35	48 h	NOEC	development	2			3	8,11,42	Moschino and Marin (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		am		22	35	48 h	NOEC	development	1.5			3	8,11,42	Moschino and Marin (2002)

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Value TPT-ion [µg/L]	Value Sn [µg/L]	Ri	Notes	Ref
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		am		22	35	48 h	NOEC	development	1			3	8,11,42	Moschino and Marin (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		am		22	35	48 h	NOEC	development	1.5			3	8,11,42	Moschino and Marin (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		am		22	35	48 h	NOEC	larval growth	1			3	8,11,42	Moschino and Marin (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		am		22	35	48 h	NOEC	larval growth	0.5			3	8,11,42	Moschino and Marin (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		am		22	35	48 h	NOEC	larval growth	<0.1			3	8,11,42	Moschino and Marin (2002)
Paracentrotus lividus	fertilized eggs	N	S	TPT-OH		am		22	35	48 h	NOEC	larval growth	0.5			3	8,11,42	Moschino and Marin (2002)
Paracentrotus lividus	spent ♂ and ♀, just after spawning; 22-47 g	N	R	TPT-Cl	>98	asw		16	37	4 w	NOEC	testosterone and estradiol levels			0.1	3	8,11,12, 18	Lavado et al. (2006)
Paracentrotus lividus	adult	N	R	TPT-Cl	>98	asw		16	37	4 w	NOEC	reprod.: egg diameter	<0.1			3	8,11,20	Sugni et al. (2007)
Paracentrotus lividus	adult	N	R	TPT-Cl	>98	asw		16	37	4 w	NOEC	gonad growth	>0.5			3	8,11,19	Sugni et al. (2007)
Paracentrotus lividus			R	TPT						1 mo	LOEC	spermato- & oogenesis	0.1			3*	39,40	Albanis et al. (2006)
Platymonas sp.	log-phase	N	S	TPT-Cl	>99	am	7.8	25	18	96 h	EC50	growth			0.00063	3	11,15	Huang et al. (1996)
Platymonas sp.	log-phase	N	S	TPT-OH	>99	am	7.8	25	18	96 h	EC50	growth			0.0007	3	11,15	Huang et al. (1996)
Platymonas sp.	log-phase	N	S	TPT-Ac	>99	am	7.8	25	18	96 h	EC50	growth			0.00061	3	11,15	Huang et al. (1996)
Ophioderma brevispina		N	F	(bis)TPTO		sw		24-28	18-22	4 w	EC10	regeneration	0.0092	0.009		2	8,13,16,17, 21,43	Walsh et al. (1986)
Ophioderma brevispina		N	F	(bis)TPTO		sw		24-28	18-22	4 w	EC10	regeneration	0.0129	0.0126		2	8,13,16,17, 21,43	Walsh et al. (1986)
Pisces																		
Pagrus major										8 w	NOEC	feeding activity	1.16			4	5	Kuroshima et al. (1997)
Sparus aurata	fertilized eggs	N	S	TPT-Cl	>95	nw		19		24 h	LC50	mortality	34.17			3	8,13,42	Dimitrou et al. (2003)
Sparus aurata	fertilized eggs	N	S	TPT-Cl	>95	nw		19		24 h	NOEC	mortality	30			3	8,13,42	Dimitrou et al. (2003)

Notes

1 Numbers in text and figures don't match.
2 NOEC estimated from graph and information in text.
3 No mentioning of solvent use and no controls performed.
4 No detail on TPT species.
5 Paper in Japanese; feeding activity is not considered as endpoint for risk limit derivation.
6 Chemostat culture.
7 No information on solvent use in preparation of test solutions but solvent has had time to evaporate.
8 Solvent control performed.
9 Solvent: DMSO.
10 Solvent: glacial acetic acid.
11 Solvent: ethanol.
12 Assumed concentration is given as concentration TPT.
13 Solvent: acetone.
14 Solvent concentration 0.01%.
15 No solvent control performed.
16 The used water has been filtered.
17 Replicate test with concentrations 0.01, 0.1, 1 µg/L; because of wide spacing duplicate NOECs differ by factor of 10; recalculated EC10 is therefore considered more appropriate.
18 According to Tremolada et al. (2006), time weighted average actual concentration at NOEC was 0.0025 µg/L, expressed as ion.
19 According to Tremolada et al. (2006), time weighted average actual concentration at NOEC was 0.0055 µg/L, expressed as ion.
20 According to Tremolada et al. (2006), time weighted average actual concentration at NOEC was 0.0011 µg/L, expressed as ion.
21 Toxicant analysed in stock solution.

22 Stock solutions were analysed, but exposure concentrations could not be confirmed because they were below the detection limit.
23 No mentioning of solvent use.
24 Unclear which compound has been tested.
25 Growth rate and Chlorophyll-a content measured using absorption at 560 and 665 nm, respectively.
26 Effects on reproductive cells at lowest concentration; 94% abnormal cells at 100 ng/L compared to 14% in the control.
27 NOEC based on measured concentration in supernatant of overflow water; nominal concentration at inflow was 8.1 µg/L.
28 EC50/EC10 calculated using data from graphs in paper and Graphpad.
29 Exposure on agar plates.
30 Nominal concentrations were verified by analysis with GC/FPD', but this is not further specified. Only a short abstract is available with not enough information to make a judgement.
31 Solvent ethanol and DMSO.
32 All solution renewed daily.
33 Exposure with small drops on Petri dishes.
34 Renewal every 24 hours; Exposure concentrations were checked in a test with Marisa (see freshwater); range of recoveries obtained from 7 sampling points over 24 h was 19-98% at 75 ng/L, 20-140% at 150 ng/L, 32-150% at 250 ng/L and 70-130% at 500 ng/L; mean recovery over 24 h was 57.8-94.3% of nominal, recovery increased with increasing exposure concentration.
35 Total volume 55 L; 15L of which was renewed twice a week.
36 Solvent concentration 0.025 mL/L.
37 Result based on nominal; time weighted average measured concentrations in similar exposure systems over 28 days were 5.5, 14 and 33 ng/L at 100, 225 and 500 ng/L (5-6% of nominal), reported in Tremolada et al, (2005).
38 Significant effect reported for 39 ng/L (= predicted concentration at 500 ng/L nominal; 33 ng/L measured), but similar non-significant effect at 7.7 ng/L (= predicted at 100 ng/L nominal; 5.5 ng/L measured); concentration-response relationship absent, and not fully clear whether intermediate concentration 17 ng/L predicted (22 ng/L nominal; 14 ng/L measured) has been tested.
39 Expression of endpoint not clear.
40 Differences with original paper.
41 Not measured, but endpoint accepted in view of short exposure period.
42 Short-term test, but considered as chronic endpoint in view of parameter and life-stage.
43 The used water has been filtered.

Table A2.5: Toxicity for sediment organisms.

Species	Species properties	Sediment type	A	Test compound	Purity [%]	pH	o.m.	ClayT [%]	T [°C]	Exp. time	Criterion	Endpoint	Value test sediment $[mg/kg_{dwt}]$	Value test sediment Sn $[mg/kg_{dwt}]$	Value standard sediment $[mg/kg_{dwt}]$	Value standard sediment TPT-ion $[mg/kg_{dwt}]$	Ri	Notes	Ref
Mollusca																			
Hinia reticulata	adult	artificial	N	TPT-Cl					14	3 mo	NOEC	imposex (VDSI)		≥500			3	1,11	Schulte-Oehlmann et al. (2000)
Hinia reticulata	adult	artificial	N	TPT-Cl					14	3 mo	NOEC	atrophy in male and female gonads		<50			3	1,11	Schulte-Oehlmann et al. (2000)
Potamopyrgus antipodarum		artificial	Y	TPT-Cl	>98		3.9	0	15	8 w	EC10	unshelled embryos		3.00E-05		2.20E-04	2	7,10	Duft et al. (2003)
Potamopyrgus antipodarum		artificial	Y	TPT-Cl	>98		3.9	0	15	8 w	EC50	unshelled embryos		7.40E-04		5.50E-03	2	7,10	Duft et al. (2003)
Potamopyrgus antipodarum		artificial	Y	TPT-Cl	>98		3.9	0	15	8 w	EC50	unshelled embryos		7.20E-04		5.40E-03	4*	7,8,9,10	Duft et al. (2002)
Potamopyrgus antipodarum	adult female	artificial	Y	TPT-Cl			3.9	0	15	8 w	EC10	unshelled embryos		3.00E-05		2.20E-04	4*	7,9,10	Duft et al. (2007)
Potamopyrgus antipodarum	adult female	artificial	Y	TPT-Cl			3.9	0	15	8 w	EC50	unshelled embryos		7.40E-04		5.50E-03	4*	7,9,10	Duft et al. (2007)
Crustacea																			
Palaemonetes pugio		mixture	Y	TPT-O?			0.75		22-25	96 h	LC50	mortality	1		13.3		3	1,2,3,4,5	Clark et al. (1987)
Palaemonetes pugio		mixture	Y	TPT-O?			0.75		22-25	96 h	LC50	mortality	420		3150		3	1,2,3,4,6	Clark et al. (1987)
Insecta																			
Chironomus riparius	1st instar	sandy loam	Y	TPT-Ac			2	8.5	20	10 d	EC50	growth	0.7246		3.623	3.10	2	13,14	De Haas et al. (2005)
Chironomus riparius	1st instar	loam	Y	TPT-Ac			4.4	12	20	10 d	EC50	growth	1.279		2.907	2.49	2	13,15	De Haas et al. (2005)
Ephoron virgo	1st instar	sandy loam	Y	TPT-Ac			2	8.5	20	10 d	LC50	survival	0.04106		0.2053	0.18	2	13,14	De Haas et al. (2005)
Ephoron virgo	1st instar	sandy loam	Y	TPT-Ac			2	8.5	20	10 d	LC10	survival	0.0052		0.026	0.023	2	13,14,16	De Haas et al. (2005)
Ephoron virgo	1st instar	sandy loam	Y	TPT-Ac			2	12	20	10 d	EC50	growth	0.1462		0.731	0.63	2	13,14	De Haas et al. (2005)
Ephoron virgo	1st instar	sandy loam	Y	TPT-Ac			2	12	20	10 d	EC10	growth	0.0114		0.057	0.049	2	13,14,16	De Haas et al. (2005)
Ephoron virgo	1st instar	loam	Y	TPT-Ac			4.4	12	20	10 d	EC50	growth	0.7718		1.754	1.50	2	13,15	De Haas et al. (2005)
Ephoron virgo	1st instar	loam	Y	TPT-Ac			4.4	12	20	10 d	EC10	growth	0.0093		0.046	0.040	2	13,15,16	De Haas et al. (2005)

Notes

1 Solvent control performed.
2 Solvent: acetone.
3 Unclear which compound has been tested, either TPT-hydroxide or Bis(TPT)-oxide.
4 Animals not in sediment but in overlying water during exposure.
5 Static test.
6 Flow-through test.
7 Solvent: methanol, evaporated for 24 h before experiment start, solvent control performed.
8 Paper in German.
9 Same experiment as Duft et al. 2003.
10 Unclear if measured or nominal concentration.
11 Solvent: glacial acetic acid.
12 Compound was measured but below detection limits.
13 Tested sediment originated from mesocosm study and was sampled 15 weeks after addition of the TPT to the water of the system. Results based on measured concentrations in the sediment.
14 Original sediment originated from a relative uncontaminated location.
15 Original sediment originated from a historical polluted location.
16 Endpoint calculated from graph in paper.

Appendix 3. Summary of mesocosm studies

Field study 1.

Environmental impact of the fungicide Triphenyltin Hydroxide after application to rice fields. (Schaefer et al., 1981).

In a field study in rice fields in California, the effects of one field dose of 1.12 kg a.s./ha triphenyltin hydroxide (TPTH) were studied on phytoplankton, macrophytes, zooplankton, macroinvertebrates, fish and tadpoles. A 0.41 ha area of a rice paddy on the low end (water exit) of a 32.9 ha rice field was selected for treatment. Caged *Gambusia affinis* were placed in the treated paddy, one in an untreated paddy, twice a week after treatment. Residues were measured till 24 d after treatment and average (of 6 samples) concentrations were 146.33 µg/L one day after treatment, at day 24 no residues above the limit of detection (0.8 µg/L) were found. The application had major effects on almost all organism groups, of which most did not recover within the study period of 5 weeks. Restocking of the cages with healthy fish showed residual toxicity (>40%) for 15 days after treatment (average concentration 8.31 µg/L TPTH). No details about statistical elaboration of the results are given.

Use of the results for EQS derivation
Since only one dose is applied no endpoint for EQS derivation can be obtained from this study. Given the limited information in the paper, no statistical reliable results can be obtained from the study (Ri 3). The experiment with caged fish shows that concentrations of 8.31 µg/L still results in fish mortality. This result can be used to compare with other results of lab and field studies.

Impact of triphenyltin acetate in microcosms simulating floodplain lakes. I. Influence of sediment quality. (Roessink et al., 2006b).

Species/Population/Community	zooplankton, macro-invertebrates, phytoplankton, periphyton, macrophytes
Test Method	outdoor microcosms
System properties	140 x 120 cm, depth 80 cm
Formulation	Triphenyltin acetate
Analysed	Y
Exposure regime	1 application, 0, 1, 10, 30 and 100 µg/L.
Experimental time	40 weeks after treatment
Criterion	NOEC
Test endpoint	macrophyte community and populations
Value [µg/L]	NOEC = <1 peak, <0.1 (21 d TWA)
Ri	1

Test system
20 concrete outdoor microcosms, 140x120 cm, depth 80 cm, 10 cm sediment and 50 cm from two lakes alongside the River Waal, introduced 8 months before the experiment. 10 cosms were filled with sediment from a polluted lake, 10 from a clean lake. Water was obtained from a freshwater reservoir at the experimental facility. 20 shoots of *Elodea nuttallii* were planted in each microcosm, macroinvertebrates were partly introduced with the sediment, but

also added 7 and 4 months before the start of the experiment. Phytoplankton and zooplankton were entered with the sediments and with the water. The duration of the experiment was 40 weeks.
Two cosms were left untreated for both the types of cosms, and in each type triphenyltinacetate was applied once (2 replicate) on 18 June, 2001 at concentrations of 1, 10, 30, and 100 µg/L, by pouring 4 l into the water and stirring afterwards.
Since some immobile species disappeared from the cosms due to the treatment, a number of individuals were re-introduced in the cosms in order to assess potential recovery. (*Asellus aquaticus, Gammarus pulex, Erpobdella octoculata,* and a number of worm and snail species.)

Analytical sampling
Samples of the water of treated tanks were taken from the untreated, 10 and 30 µg/L treated cosms only at 3 and 10 h and 1, 3, 7, 14 and 28 d after TPT application. The analytical method did not distinguish between TPT acetate or hydroxide. Sediment samples were taken 2, 4, 15, 25 and 40 weeks after application. The concentration TPT in pore water and in sediment was determined.

Effect sampling
Macroinvertebrates were sampled using multi plates and pebble baskets. Individuals were identified (and counted) alive and replaced into the cosm. Phytoplankton, zooplankton and sediment dwelling Nematoda were sampled: total abundance, abundance of major taxonomic groups, abundance of individual taxa and taxa richness. For sampling scheme see table below.

Sampling scheme

Date (weeks after application)	Zooplankton	Phytoplankton, chlorophyll-*a*	Cover macrophytes and algae	Nematoda	Macro-invertebrates
-4	X				X
-3				X	
-2	X	X	X		X
-1	X	X			
0.1		X	X		
0.4	X				X
1	X	X	X		
2	X	X	X	X	X
3			X		
4	X	X	X		X
5			X		
6	X	X	X		
7			X		
8	X	X	X		X
10		X	X		
12	X		X	X	X
13			X		
15		X Chl-*a*			
23	X	X Chl-*a*			X
40					X

Decomposition of Populus leaves was assessed every 2 weeks.

Statistical analysis
Analyses of variance for individual taxa, NOEC with Williams test, PRC for zooplankton, phytoplankton, nematodes and macroinvertebrates.

Results

Chemical analysis
Measured concentrations in the solution applied were 95-102% of nominal. 3 h after application concentrations in the water column were higher than nominal, probably due to incomplete mixing.
DT50 in the water is 2-4 d (visual estimated from figure), in sediment TPT is very persistent (hardly degradation in 40 d).

Biological observations

Phytoplankton
A total of 45 taxa were found. Differences were found in community between cosms with clean and polluted sediment. For community and the individual taxa, no clear dose-effect relationship was found. For chlorophyll-*a*, a significant treatment related increase was found, in particular in the polluted cosms, in the two highest treatment levels. At the taxon level, this could only be confirmed for *Cosmarium* in the polluted cosms with a NOEC of 30 µg/L.

Periphyton and macrophyte cover
A NOEC for macrophyte cover of 30 µg/L was found in the clean cosms 2-13 weeks after application; in the polluted cosm, a NOEC of 10 µg/L was found in weeks 6, 7, 8 and 13.

Zooplankton
A total of 86 taxa were identified (57 in the clean cosms, 76 in the polluted cosms). Community analysis shows a clear dose response relationship. In the period 1-6 weeks post treatment the NOEC is 1 in the polluted cosms, and at week 8 and 12 in the clean cosms. The main zooplankton groups, Copepoda, Cladocera, and Rotifera, showed clear treatment related responses, with Copepoda the most sensitive, with a NOEC of 1 µg/L. The most sensitive taxon was *Keratella quadrata*, with a NOEC <1 on two consecutive sampling dates during the first weeks after TPT application in the clean cosm.

Nematodes
No significant treatment related effects were found for sediment-dwelling nematodes.

Macroinvertebrates
The macroinvertebrate community (83 taxa in total, 82 and 77 in clean and polluted cosms), showed clear significant treatment related effects, with a NOEC of 1 µg/L from week 2-23 and <1 at week 4 in the clean sediment, and a NOEC of 1 µg/L at weeks 2, 4 and 12 and <1 at weeks 8 and 23 in the polluted sediment.
For the individual taxa significant treatment related effects were found in both types of systems, with NOECs <1-10 for Annelida, Tricaldida and Mollusca in particular. The most sensitive taxa in the clean sediment systems were *Stylaria lacustris* and bivalve molluscs, with NOECs <1 µg/L, and *Stylaria lacustris, Polycelis nigra/tenuis, Planorbis contortus* and *Physa acuta* in the polluted soil sediments with NOECs <1 µg/L.

Evaluation of the scientific reliability of the field study

Criteria for a suitable (semi)field study

1. Does the test system represent a realistic freshwater community? Yes, zooplankton, macroinvertebrates, insects, benthic organisms, algae and macrophytes were present. Fish were lacking.
2. Is the description of the experimental setup adequate and unambiguous? Yes.
3. Is the exposure regime adequately described? Yes. Measured concentrations are presented in figures.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? The compound appeared to have broad biocidal action, represented by the broad range of taxa included in the study.
5. Is it possible to evaluate the observed effects statistically? No, raw data were not included in the journal paper.

This results in an overall assessment of the study reliability, -> Ri 1.

Although the substance disappears relatively fast from the water, effects were found for a long period (up to 23 weeks). The NOEC found in the study is <1 µg/L. Although effects were found in the lowest dose applied, this value can be used to compare with the MAC-EQS based on other available data. Because the substance disappears relatively fast from the water, the study is not suitable to derive an AA-EQS. As an indication and for comparison with other data, for determining an AA-EQS the 21 d TWA (extrapolated form of the measured concentrations in the 10 and 30 µg/L treatment) of <0.1 µg/L could be used as a worst case estimate.

Impact of triphenyltin acetate in microcosms simulating floodplain lakes. II. Comparison of species sensitivity distributions between laboratory and semi-field. (Roessink et al., 2006a)

In this paper a comparison is made between laboratory toxicity data, and the endpoints derived from it, with data from the semi-field study described above.

The available laboratory toxicity data used in the paper are copied below.

Laboratory toxicity data for invertebrates.

Species	***x***	**EC $_x$ (µg/l)**		**LC $_x$ (µg/l)**	
		48 h	**96 h**	**48 h**	**96 h**
Acanthocyclops venustus	10	2.7 (1.8–4.0)	0.1 (0.0–1.5)	2.9 (1.9–4.5)	0.1 (0.0–0.9)
	50	5.8 (4.7–7.1)	0.5 (0.1–2.2)	6.9 (5.5–8.8)	0.8 (0.3–2.0)
Lumbriculus variegatus	10	4.1 (2.6–6.7)	3.5 (2.1–5.8)	21.4 (*)	13.3 (12.2–14.5)
	50	8.8 (6.7–11.5)	6.3 (4.8–8.3)	22.6 (*)	14.8 (13.7–15.9)
Physa fontinalis	10	5.8 (3.7–8.2)	4.2 (2.8–6.1)	17.2 (4.3–69.1)	10.6 (9.7–11.5)
	50	9.3 (7.6–11.5)	7.1 (5.6–9.1)	96.3 (36.3–255.0)	11.8 (10.9–12.8)
Dugesia sp.	10	2.7 (1.5–5.0)	2.9 (1.7–5.0)	24.9 (18.7–33.1)	19.0 (18.0–20.0)
	50	9.8 (7.2–13.2)	6.1 (4.6–8.0)	35.3 (29.9–41.6)	20.9 (19.9–22.0)
Polycelis niger/tenuis	10	3.1 (1.7–5.6)	3.4 (1.9–5.9)	42.4 (39.2–45.8)	20.8 (*)
	50	10.6 (7.9–14.2)	6.6 (5.0–8.8)	46.9 (43.1–51.0)	23.2 (*)
Tubifex	10	2.4 (0.6–9.2)	2.3 (0.5–9.3)	13.1 (7.7–22.1)	9.2 (5.5–15.4)
	50	14.2 (8.0–25.3)	10.7 (5.5–21.1)	27.0 (20.5–35.5)	12.9 (10.0–16.7)

Species	x	EC $_x$ (µg/l)		LC $_x$ (µg/l)	
		48 h	96 h	48 h	96 h
Planorbis contortis	10	5.7 (3.0–10.9)	3.5 (2.2–5.5)	–[a]	–[a]
	50	14.7 (10.6–20.3)	6.6 (5.0–8.6)	–[a]	–[a]
Daphnia galeata	10	7.3 (4.9–10.8)	5.4 (3.4–8.5)	28.2 (14.1–56.5)	13.1 (*)
	50	16.1 (13.1–19.9)	8.4 (6.8–10.4)	41.9 (35.8–49.1)	16.0 (*)
Gammarus pulex	10	5.6 (2.4–13.6)	4.5 (2.1–9.8)	18.5 (4.6–74.1)	11.6 (5.7–23.7)
	50	18.5 (12.3–27.9)	8.9 (6.1–12.7)	104.4 (39.4–276.5)	12.6 (7.0–22.9)
Lymnaea stagnalis	10	10.0 (5.3–18.6)	9.7 (*)	263.5 (124.0–559.9)	85.8 (*)
	50	24.9 (18.3–34.0)	11.8 (*)	906.9 (387.0–2125.7)	92.1 (*)
Erpobdella juv.	10	15.3 (*)	9.6 (6.1–15.0)	50.5 (47.1–54.1)	23.8 (*)
	50	25.9 (*)	17.1 (13.2–22.1)	56.6 (53.2–60.3)	27.1 (*)
Cloeon dipterum	10	34.7 (19.2–63.0)	12.3 (4.9–31.2)	251.8 (173.6–365.2)	39.8 (*)
	50	120.9 (89.6–163.1)	63.0 (42.3–93.8)	442.5 (327.4–598.1)	168.9 (*)
Proasellus meridianus/coxalis	10	37.0 (19.3–71.1)	32.4 (17.1–61.2)	137.4 (74.7–253.1)	39.1 (21.4–71.6)
	50	139.0 (97.8–197.4)	90.9 (65.7–125.8)	558.5 (364.7–855.4)	138.5 (99.1–193.6)
Asellus aquaticus	10	78.3 (36.7–167.3)	26.0 (8.7–77.8)	72.8 (33.9–156.4)	72.8 (33.9–156.4)
	50	212.8 (146.3–309.5)	95.6 (56.6–161.3)	271.3 (184.1–399.7)	271.3 (184.1–399.7)
Endochironomus albipennis	10	343.0 (162.5–724.0)	181.9 (170.0–194.6)	306.8 (163.9–574.0)	179.2 (112.5–285.3)

Laboratory toxicity data for phytoplankton

Species		X	Time after application (h)		
			48	72	96
Selenastrum capricornutum	EC $_x$ (µg/l)	10	5.5 (4.8–6.3)	2.6 (1.9–3.6)	3.2 (2.7–3.7)
		50	58.0 (51.4–65.5)	8.8 (7.0–11.0)	5.6 (4.9–6.4)
	NOEC (µg/l)		3.0	3.0	3.0
Desmodesmus subspicatus	EC $_x$ (µg/l)	10	15.9 (8.9–28.5)	10.1 (8.4–12.3)	11.1 (9.9–12.5)
		50	101.9 (84.9–122.4)	23.0 (20.1–26.3)	18.1 (16.5–19.9)
	NOEC (µg/l)		10.0	10.0	10.0
Monoraphidium minutum	EC $_x$ (µg/l)	10	39.2 (17.5–87.5)	14.3 (11.7–17.4)	2.5 (1.1–6.1)
		50	187.7 (104.7–336.5)	51.5 (40.5–65.4)	15.8 (10.6–23.7)
	NOEC (µg/l)		10.0	10.0	10.0
Scenedesmus quadricauda	EC $_x$ (µg/l)	10	54.6 (35.1–84.8)	7.2 (2.9–17.9)	17.0 (12.9–22.6)
		50	352.9 (133.6–931.7)	29.1 (19.4–43.6)	36.0 (30.8–42.1)
	NOEC (µg/l)		30.0	3.0	3.0

Laboratory toxicity data for macrophyte species.

	x	EC $_x$ (µg/l)			Relative growth 21 days
		PSII 2 days	PSII 7 days	PSII 21 days	
Spirodela polyrhiza	10	386.2 (234.0–637.3)	5.6 (2.3–13.3)	28.9 (26.5–31.5)	0.1 (0.0–3.9)
	50	$5.6*10^3$ ($2.6*10^3$–$1.2*10^4$)	29.0 (18.3–45.8)	33.1 (30.3–36.3)	4.6 (0.7–29.5)
Potamogeton crispus [a]	10	9.0 (3.2–25.6)	5.6 (2.3–13.3)	–	23.8 (18.8–30.1)
	50	127.9 (78.5–208.2)	29.0 (18.3–45.8)	–	38.8 (31.0–48.4)
Lemna trisulca	10	21.9 (13.3–35.8)	9.9 (5.4–18.1)	11.2 (6.3–19.7)	1.8 (0.2–15.4)
	50	122.5 (93.9–159.9)	69.5 (51.1–94.6)	36.1 (27.5–47.5)	64.5 (25.6–162.6)
Ceratophyllum demersum	10	62.2 (38.8–99.7)	1.6 (0.0–82.4)	48.1 (0.9–2548.2)	0.4 (0.0–17.6)
	50	240.6 (184.9–313.1)	92.5 (18.1–473.4)	1357.3 (327.5–$5.6*10^3$)	12.9 (2.0–82.8)
Elodea nuttallii [a]	10	6.1 (1.1–34.0)	34.8 (11.0–109.9)	79.9 (x–x)	1.8 (1.1–3.0)
	50	59.4 (25.7–137.1)	101.9 (63.8–162.9)	97.7 (x–x)	11.8 (7.4–18.8)
Lemna minor	10	$9.1*10^2$ ($2.1*10^2$–$3.9*10^3$)	104.8 (93.0–118.2)	96.7 (x–x)	180.0 (x–x)
	50	$6.4*10^4$ ($1.0*10^2$–$4.0*10^7$)	138.9 (60.1–321.4)	130.4 (x–x)	198.9 (x–x)
Elodea canadensis	10	5.1 (1.9–13.8)	2.1 (0.2–23.9)	1.8 (0.0–214.9)	1.5 (0.1–29.7)
	50	197.8 (132.6–295.1)	176.6 (69.1–451.7)	44.5 (4.8–413.8)	23.4 (8.5–64.5)
Myriophyllum spicatum	10	NA	NA	NA	32.3 (18.7–55.6)
	50	NA	NA	NA	73.4 (44.9–200.0)

Roessink et al. calculate HC5 values based on the EC50, see below.

HC5 values (µg/L) derived by Roessink et al. (2006a), based on EC50 values

Taxa	24 h	48 h	72 h	96 h
macroinvertebrates	5	2.9	1.8	1.3
algae PSII				1.3
Macrophytes PSII				1.9
Macrophytes rel. growth				4.2

Based on the microcosm data, Roessink et al. (2006a) derived HC5 values too. The HC5 based on peak concentration varied between 0.2 µg/L and 0.6 µg/L, depending on the data (2, 4 and 8 weeks post application) or the type of sediment; the HC5 based on the 21-TWA varied between 0.1 µg/L and 0.2 µg/L.

The authors conclude that the organisms in the field study responded significantly more sensitive than invertebrate species in the laboratory.

Evaluation of the results
The evaluator recalculated the HC5 for both the EC50 and the EC10 values. For this aim all data were combined, using the 96 h data for the invertebrates and phytoplankton, and the 7 d data from the macrophytes.
The average EC50 is 42.02 µg/L, and the average EC10 is 19.23 µg/L. The HC5 value for the EC50 values is 2.04 µg/L, and the HC5 for EC10 values is 0.62 µg/L.

Based on the available data it can be concluded that the EC50 - EC10 ratio is 2-4. However, not all species required for an SSD are available. It is recommended to do the calculations combined with other available laboratory data.

Also with the recalculated data, the conclusion of the authors that the semi field study is more sensitive is still valid.

For the field study the result of the SSD is in line with the overall outcome of the field study as described before.

Interactions between nutrients and organic micro-pollutants in shallow freshwater model ecosystems.
(Roessink, 2008)

The paper describes that the time-to-effect for TPT in the mesocosms is rather long, so that the time point 4 weeks post exposure is a relevant moment for assessing the effects. Also indirect effects and bio-accumulation are discussed. The paper does not present new data on which an endpoint for EQS derivation can be derived.

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