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

Environmental risk limits for polycyclic aromatic hydrocarbons (PAHs)

For direct aquatic, benthic, and terrestrial toxicity

RIVM report 607711007/2012

E.M.J. Verbruggen

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

Environmental risk limits for polycyclic aromatic hydrocarbons (PAHs)

For direct aquatic, benthic, and terrestrial toxicity

RIVM Report 607711007/2012

Colophon

E.M.J. Verbruggen

Contact:
Eric Verbruggen
Expertise Centre for Substances (SEC)
eric.verbruggen@rivm.nl

This investigation has been performed by order and for the account of Ministry of Infrastructure and Environment (I&M), within the framework of Soil Quality, Prevention and Risk Assessment

Abstract

Environmental risk limits for polycyclic aromatic hydrocarbons (PAHs)
For direct aquatic, benthic, and terrestrial toxicity

RIVM derived maximum permissible concentrations (MPCs) and serious risk concentrations (SRC) for ecosystems for the 16 well-known polycyclic aromatic hydrocarbons (PAHs). This is done for all individual PAHs for water, sediment and soil. Data on the toxic effects were collected for each PAH in water, soil and sediment organisms. For this study, the methodology of the framework 'International and national environmental quality standards for substances in the Netherlands' (INS) is used. This method is nationally recognized and where possible, based on European directives.

Alternative research method for environmental risk limits PAHs
In this study the environmental risk limits were also derived in an alternative way. For this goal, the knowledge was used from previous research on the environmental risk limits of mineral oil that was suitable for PAHs as well. The environmental risk limits are derived based on the calculated concentration of substances in the organisms after they have taken up the substances from the water (for sediment and soil: water in sediment or soil moisture). This method is based on the assumption that certain effects of all 16 PAHs occur at the same concentrations in organisms that live in water, soil and sediment. Because PAHs cause effects in the same way, the concentrations can be added together. This provides insight into the effect of all PAHs simultaneously, as they occur in the environment (toxic unit aproach).

Difference in internal and external concentrations
The internal effect concentration of PAHs does not differ between organisms in soil, water and sediment. In contrast, large differences between the effect concentrations of the substances outside the organisms were observed. Especially the effect concentrations between soil or sediment on the one hand and water on the other hand were different, and also the effect concentrations of individual PAHs in water. The harmful effects of the substances are thus largely determined by the extent to which a substance is partitioned between water, soil and sediment, and is taken up from water (equilibrium partitioning). As an example, soil binds a substance strongly, so less will end up in soil moisture and eventually in soil organisms. Measurements of concentrations of substances in the environment would thus be better based on concentrations in water.

Keywords:
naphthalene, acenaphthene, acenaphthylene, fluorene, phenanthrene, anthracene, pyrene, fluoranthene, chrysene, benz[*a*]anthracene, benzo[*k*]fluoranthene, benzo[*b*]fluoranthene, benzo[*a*]pyrene, benzo[*ghi*]perylene, dibenz[*a*,*h*]anthracene, indeno[1,2,3-*cd*]pyrene

Rapport in het kort

Milieurisicogrenzen voor polycyclische aromatische koolwaterstoffen (PAK's)
Voor directe aquatische, benthische en terrestrische toxiciteit

Het RIVM heeft de maximaal toelaatbare risiconiveaus (MTR) en ernstige risisconiveaus (ER) voor ecosystemen afgeleid voor de 16 bekendste polycyclische aromatische koolwaterstoffen (PAK's). Dit is voor alle afzonderlijke PAK's gedaan voor water, sediment en bodem. Hiervoor zijn gegevens verzameld over de giftige effecten van elke PAK op water-, bodem- en sedimentorganismen. Voor het onderzoek is de methodologie van het kader '(Inter)nationale normen stoffen' (INS) gebruikt. Deze methode is nationaal erkend en waar mogelijk gebaseerd op Europese richtlijnen.

Alternatieve onderzoekswijze voor milieurisicogrenzen PAK's
In dit onderzoek zijn de milieurisicogrenzen ook op een alternatieve manier afgeleid. Hiervoor is de kennis gebruikt van eerder uitgevoerd onderzoek naar de milieurisicogrenzen van minerale olie die ook geschikt bleek voor PAK's. De milieurisicogrenzen zijn afgeleid op basis van de berekende concentratie van stoffen in organismen nadat zij de stoffen via het water hebben opgenomen (voor sediment en bodem: water in sediment of bodemvocht). Deze methode is gebaseerd op de aanname dat bepaalde effecten van alle 16 PAK's optreden bij dezelfde concentraties in organismen die leven in water, bodem en sediment. Omdat de PAK's op dezelfde manier effecten veroorzaken, mogen de concentraties bij elkaar opgeteld worden. Hierdoor wordt inzicht verkregen in het effect van alle PAK's tegelijkertijd, zoals ze ook in het milieu voorkomen (toxic unit aproach).

Verschil inwendige en externe concentraties
De inwendige effectconcentratie van PAK's blijkt bij organismen in bodem, water en sediment niet te verschillen. Daarentegen zijn grote verschillen tussen de effectconcentraties van de stoffen aangetroffen als deze buiten de organismen werden waargenomen. Vooral de effectconcentraties tussen bodem of sediment enerzijds en water anderszijds verschilden, evenals de effectconcentraties van de individuele PAK's in water. De schadelijke effecten van de stoffen worden dus in grote mate bepaald door de mate waarin een stof zich verdeeld tussen water, bodem en sediment en wordt opgenomen vanuit water (evenwichtspartitie). Zo bindt de bodem een stof sterk aan zich waardoor er minder in bodemvocht en uiteindelijk in bodemorganismen terechtkomt. Metingen van concentraties van stoffen in het milieu zouden daardoor beter gebaseerd kunnen worden op concentraties in water.

Trefwoorden:
naftaleen, acenafteen, acenaftyleen, fluoreen, fenantreen, antraceen, pyreen, fluoranteen, chryseen, benz[*a*]antraceen, benzo[*k*]fluoranteen, benzo[*b*]fluoranteen, benzo[*a*]pyreen, benzo[*ghi*]peryleen, dibenzo[*a*,*h*]antraceen, indeno[1,2,3-*cd*]pyreen

Contents

Summary

In this report maximum permissible concentrations for ecosystems ($MPCs_{eco}$), maximum acceptable concentrations for aquatic ecosystems ($MAC_{eco,water}$), and serious risk concentrations for ecosystems ($SRCs_{eco}$) are derived for polycyclic aromatic hydrocarbons (PAHs). These environmental risk limits (ERLs) are derived using data on ecotoxicology and environmental chemistry, and represent the potential risk of substances to the ecosystem. They are the scientific basis for environmental quality standards (EQSs) set by the Ministry of Infrastructure and the Environment.

Polycyclic aromatic hydrocarbons are substances that have both natural and anthropogenic origins. They can be formed as a result of combustion, and are constituents of many petroleum products as well. PAHs have different physicochemical and environmental properties (e.g. log K_{ow}, log K_{oc}, solubility and BCF). The PAHs that have been considered in this report are the 16 PAHs that were selected by the US Environmental Protection Agency (EPA). These 16 PAHs are also considered in the European Risk Assessment Report (RAR) on coal tar pitch, high temperature (European Commission, 2008). This work forms the basis of the derivation of the environmental risk limits as presented in this report. Additional data that were retrieved after the completion of the RAR, were added to this data set.
For each of the individual PAHs environemental risk limits for direct ecotoxicity were derived for water, soil, and sediment. The methodology used for this derivation was that of the project 'International and national environmental quality standards for substances in the Netherlands' (INS). Environmental quality standards should be protective for direct ecotoxicity, secondary poisoning of predators such as birds and mammals, and human toxicology through indirect exposure of humans. However, in this report only the route of direct ecotoxicity is addressed. Thus, the derived risk limits cannot be considered directly as proposals for environmental quality standards.

All cited ecotoxicity studies were collected and carefully evaluated for their usefulness and reliability. Because of the volatility of especially the lower PAHs and the adsorptive behaviour especially for the higher PAHs, only studies in which the exposure concentrations were verified were considered reliable. An overview of the derived risk limits for each individual PAH is given in Table 94. Contrary to earlier reports on derivation of risk limits for PAHs a substantial amount of terrestrial and benthic ecotoxicity data was retrieved. Therefore, the number of risk limits for individual PAHs that is derived by equilibrium partitioning is substantially lower. Although many more data were retrieved in comparison with earlier risk limit derivations, and consequently lower assessment factors were applied, the values are in general not higher than, but comparable with the existing risk limits.

Apart from the derivation of risk limits for each PAH individually, an approach is presented in which the risk limits are derived based on internal residues. This method has been developed and applied for the derivation of risk limits for total petroleum hydrocarbons (TPH) before. It is assumed that toxicity of all PAHs is similar and possibly caused by narcosis, for which the total concentration of compounds in the cell membrane is the key parameter. This means that toxicity of different PAHs differs only as a consequence of different accumulation potential. However, effects are equal on molar basis expressed as residues in the cell membranes. Further, because of similar action, the sum of the internal

concentrations of different compounds gives rise to the same effect as that of a similar concentration of an individual compound, which is referred to as concentration additivity.
To calculate the total internal residues, pore water concentrations were calculated first for soil and sediment, by considering partitioning between organic carbon and water. From water concentrations, the internal residues were calculated using a partition coefficient between the membrane and water. From all chronic toxicity data for individual PAHs expressed as internal residues, a set of no observed effect residues (NOERs) for 54 species was obtained, partly geometric means of data for individual PAHs. On basis of these data, a species sensitivity distribution (SSD) was constructed, including aquatic, terrestrial and benthic species. On basis of internal residues there appeared to be no significant differences between the compartments and between the individual PAHs, which confirms the assumption that indeed accumulation from (pore) water is the determining factor for toxicity. This SSD appeared to be very similar to the SSD for TPH, suggesting a similar mode of toxic action.
From the SSD the HC5 and HC50 were derived. These values, based on internal residues, were transferred to the environmental risk limits for water, soil and sediment for each PAH by means of the equilibrium partition coefficients between membranes and water and between soil or sediment and water. For the MPC values a default assessment factor of 5 has been applied to the HC5, to account for uncertainties in the method and for the potential of certain PAHs to exert a high acute toxicity through phototoxicity, which is not well covered by the chronic data set. The obtained quality standards are generally higher (less conservative) than the quality standard for each PAH individually. An overview of the standards derived by this method is presented in Table 99.

If monitoring data are compared with the environmental risk limits it must be kept in mind that the toxic unit approach should be applied, because of the assumed concentration additivity for PAHs. Because toxicity can be explained by equilibrium partitioning, it could be considered to use techniques that are capable to measure freely dissolved concentrations in field samples (such as SPME). This would take account of the possibly strongly reduced bioavailability of PAHs in the field.

1 Introduction

1.1 Project framework

In this report, environmental risk limits (ERLs) for surface water (freshwater and marine), sediment, and soil are derived for 16 polycyclic aromatic hydrocarbons (PAHs). The following ERLs are considered:

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

  The MPCs for water and soil should not result in risks due to secondary poisoning (considered as part of the ecosystem in the definition above) and/or risks for human health aspects. These aspects are therefore also addressed in the MPC derivation. Within the context of the Water Framework Directive a risk of 10^{-6} on a life-time basis is used. Therefore, this value has been adapted within the framework of the project 'International and national environmental quality standards for substances in the Netherlands' (INS) (Van Vlaardingen and Verbruggen, 2007). However, in this report only the direct ecotoxic effects are considered.
- Maximum acceptable concentration (MAC_{eco}) – concentration protecting aquatic ecosystems for effects due to short-term exposure or concentration peaks.
- Serious risk concentration (SRC_{eco}) – concentration at which possibly serious ecotoxicological effects are to be expected. The derivation of SRC values based on human-toxicological endpoints (SRC_{human}) is not part of this report.

These ERLs serve as advisory values that are used by the Steering Committee for Substances to set environmental quality standards (EQS) for various policy purposes. EQSs are all legally and non legally binding standards used in Dutch environmental policy.
The NC can be used to set the target value (TV). The MPC and the MAC_{eco} can be used as generic environmental quality standards. The SRC_{eco} can be used to derive intervention values (IV), after comparison with the human toxicological SRC value, and for groundwater also with the maximum concentration in drinking water. Above IV soil and groundwater is considered to be seriously contaminated.

1.2 Selection of substances

ERLs are derived for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, pyrene, fluoranthene, chrysene, benzo[*a*]anthracene, benzo[*k*]fluoranthene, benzo[*b*]fluoranthene, benzo[*a*]pyrene, benzo[*ghi*]perylene, dibenz[*a,h*]anthracene, and indeno[1,2,3-

cd]pyrene (Table 1), which are selected because of their importance for soil, sediment, and groundwater in the scope of the project 'Risk Assessment of contaminated Soil and Ground Water'.

Table 1: Selected compounds

Compound	***CAS number***
Naphthalene	91-20-3
Acenaphthylene	208-96-8
Acenaphthene	83-32-9
Fluorene	86-73-7
Phenanthrene	85-01-8
Anthracene	120-12-7
Pyrene	129-00-0
Fluoranthene	206-44-0
Chrysene	218-01-9
Benz[*a*]anthracene	56-55-3
Benzo[*k*]fluoranthene	207-08-9
Benzo[*b*]fluoranthene	205-99-2
Benzo[*a*]pyrene	50-32-8
Benzo[*ghi*]perylene	191-24-2
Dibenz[*a,h*]anthracene	53-70-3
Indeno[1,2,3-*cd*]pyrene	193-39-5

These substances have been chosen, because they represent the 16 PAHs selected by the US Environmental Protection Agency (US EPA). These 16 PAHs were considered in the EU RAR on coal tar pitch high-temperature (European Commission, 2008). The same 16 PAHs were considered for the human toxicological part of the serious risk concentration (SRC_{human}), with one additional compound, which was benzo[*j*]fluoranthene (Lijzen et al., 2001; Baars et al., 2001). This was done for the revision of the first tranche of intervention values in 2001. At that time the ecotoxicological data underlying risk limits for PAHs were not updated and the SRC_{eco} values were derived based on the old data for 10 PAHs (Verbruggen et al., 2001). These PAHs were selected by the Dutch Ministry for Housing, Spatial Planning and the Environment (VROM) and contained the above mentioned PAHs, except acenaphthylene, acenaphthene, fluorene, pyrene, benzo[*b*]fluoranthene, and dibenz[*a,h*]anthracene. The data for these 10 PAHs were collected prior to 1995, when the MPCs and NCs for these substances were derived (Kalf et al., 1995).

1.3 Reading guide to the report

In chapter 2, the methodology followed in the derivation of the environmental risk limits will be shortly derived. In chapter 3, the derivation of the ERLs in water (freshwater and marine water), sediment, and soil will be presented for each of the PAHs individually. In chapter 4, a summary of the derived ERLs will be given and a comparison is presented with existing risk limits and quality standards, including the human toxicological part of the SRCs. Further, an alternative method to the ERLs derived in chapter 3 is proposed. With this approach, ERLs are derived as one value for all PAHs, based on internal concentrations in the lipids (membranes) of organisms.

2 Methods

2.1 Guidance followed for this project

In this report ERLs are derived following the methodology of the project 'International and national environmental quality standards for substances in the Netherlands' (INS) (Van Vlaardingen and Verbruggen, 2007). The updated INS guidance is in accordance with the guidance by Lepper (2005) which forms part of the Priority Substances Daughter Directive (2006/0129 (COD)) amending the Water Framework Directive (2000/60/EC) (WFD guidance) and the Technical Guidance Document (TGD) for the risk assessment of new and existing substances and biocides (European Commission, 2003). The WFD guidance, which is based on the Technical Guidance Document, only applies to the derivation of MPC and MAC_{eco} for water and the MPC for sediment. ERL derivations for water and sediment are performed for both the freshwater and marine compartment. For the MPC for soil, the updated INS guidance follows the Technical Guidance Document.

Because of the extent of this work, this report takes only direct aquatic, benthic and terrestrial ecotoxicological effects of PAHs into account. The risk limits derived are the serious risk concentration for ecosystems (SRC_{eco}), which serves as basis for the intervention value, the maximum permissible concentration for ecosystems (MPC_{eco}) and the maximum acceptable concentration for ecosystems ($MAC_{eco,\ water}$), a concentration that protects aquatic ecosystems from adverse effects caused by short-term exposure or concentration peaks. The compartments considered in the derivation of the SRC_{eco} and MPC_{eco} are fresh and marine water, fresh and marine sediment, and soil. The $MAC_{eco,\ water}$ is only derived for the water compartment, because this is the most dynamic compartment and quickly fluctuating concentrations are not deemed relevant for soil and sediment. An overview of which ERLs are derived in this report is given in Table 2.

It is important to note that a complete SRC, MPC and NC derivation integrates both ecotoxicological data, consisting of both direct toxicity as well as secondary poisoning of predators, and a human toxicological threshold value. The height of the final environmental risk limit can be determined by either one of these protection objectives. Because the indirect routes were not taken into account, no further evaluation of bioconcentration and biomagnification data is made in this report. However, it can be stated that BCF values for these substances are generally higher than 100 (see section 2.2.2). On basis of these BCF values, PAHs trigger the route for the derivation of secondary poisoning and human toxicological based MPC values (see section 2.2.2). The human toxicological values for the SRC for soil and groundwater are derived by the exposure model CSOIL and for the SRC for aquatic sediment by the model SEDISOIL (Lijzen et al., 2001). In section 4.1, these values are compared with the ecotoxicological values derived in this report.

Table 2: Overview of which ERLs are derived in this report

Protection level	***Protection goal***	***Water***	***Sediment***	***Soil***
NC		X	X	X
MPC	Ecotoxicity	Y	Y	Y
	Secondary poisoning	X	I	X
	Human toxicological	X	I	X
MAC_{eco}		Y	I	
SRC	Ecotoxicity	Y	Y	Y
	Human toxicological	N	N	N

X: Not derived in this report.
Y: Derived in this report.
N: Not relevant for the specific compartment.

2.2 Trigger values

2.2.1 Sediment and suspended matter

This section reports on the trigger values for ERL water derivation (as demanded in the context of the WFD). In line with the upcoming new technical guidance document for deriving environmental quality standards, a sediment quality standard should be derived if the organic carbon-water partition coefficient (K_{oc}) is larger than 1000. With the equation as given by Karickhoff et al. (1979) for log K_{oc} this is true for all 16 PAHs (see section 2.3.2).

2.2.2 Secondary poisoning

Under the Water Framework Directive (WFD) the route of secondary poisoning is triggered if the bioconcentration factor (BCF) is larger than 100 (Lepper, 2005; Van Vlaardingen and Verbruggen, 2007). Recently, an overview of the bioaccumulation of PAHs was made (Bleeker and Verbruggen, 2009). Apparently for the PAHs high BCF values are observed in fish (Table 3).

Table 3: Overview of BCF values for fish. If possible, data were normalized to 5% lipid content

Compound	***BCF fish***
Naphthalene	462, 515, 66, 76, 310, 320
Acenaphthylene	510, 507, 678, 698
Acenaphthene	973, 988
Fluorene	1158, 1658, 818, 755
Phenanthrene	1805, 4751, 2544, 2423, 2546, 1149
Anthracene	2545, 1960, 1126, 3581, 2476, 4973
Pyrene	1474, 75, 50
Fluoranthene	2771
Chrysene	
Benz[*a*]anthracene	260
Benzo[*k*]fluoranthene	
Benzo[*b*]fluoranthene	
Benzo[*a*]pyrene	~30
Benzo[*ghi*]perylene	
Dibenz[*a,h*]anthracene	
Indeno[1,2,3-*cd*]pyrene	

For invertebrates, higher and even more variable BCF values were observed, mainly due to the absence of metabolism in these species. For all PAHs for which reliable BCF data (all except benzo[*b*]fluoranthene and indeno[1,2,3-*cd*]pyrene) are available, BCF values tend to be much higher than 100 (Bleeker and Verbruggen, 2009). Therefore, the route of secondary poisoning is triggered for PAHs. This report focuses on direct ecotoxicity only and therefore, this route is not further considered here.

2.2.3 Human toxicological threshold limits and carcinogenicity

The classification in EU framework is shown in Table 4. Those substances, for which no Risk Phrases (R-phrases) are listed, have not been classified in EU framework (EC Regulation No. 1272/2008). In this table, the values presented by the US Environmental Protection Agency, the Integrated Risk Information System (US EPA IRIS) (http://www.epa.gov/ncea/iris/index.html) and the Agency for Toxic Substances and Disease Registry (ATSDR) (http://www.atsdr.cdc.gov/mrls/index.asp) are included as well. Further, the human toxicological MPR values that were derived in the framework of intervention values and served as basis for the SRC_{human} are presented in Table 4 (Baars et al., 2001). It should be noted that the values for carcinogenicity are based on a cancer risk of 10^{-4} per lifetime. The limit value for generic quality standards under the WFD an within the framework of INS is a probability of 10^{-6} per lifetime (Lepper, 2005). Therefore, these MPR values (Van Vlaardingen and Verbruggen, 2007) should be divided by a factor of 100 for the derivation of the human toxicological MPC values within the context of the WFD and INS.

RIVM (Baars et al., 2001) concluded that naphthalene, fluorene, anthracene, and benzo[*ghi*]perylene are not carcinogenic. It was concluded that acenapthene, acenapthylene, phenanthrene and pyrene should be considered as suspected carcinogens. However, for phenanthrene an MPR value was derived based on a threshold approach (TDI), because the relative carcinogenic potential is extremely low. For the other substances (fluoranthene, chrysene, benz[*a*]anthracene, benzo[*k*]fluoranthene, benzo[*b*]fluoranthene, benzo[*a*]pyrene, dibenz[*a,h*]anthracene, and indeno[1,2,3-*cd*]pyrene), it was concluded that these substances were probably carcinogenic.

US EPA (IRIS) concluded that acenaphthylene, phenanthrene, anthracene, pyrene, fluoranthene, and benzo[*ghi*]perylene are not classifiable for human carcinogenicity. For fluoranthene and pyrene this is in contrast with the conclusion by RIVM that pyrene was possibly and fluoranthene probably carcinogenic to humans. US EPA (IRIS) concluded that chrysene, benz[*a*]anthracene, benzo[*k*]fluoranthene, benzo[*b*]fluoranthene, benzo[*a*]pyrene, dibenz[*a,h*]anthracene, and indeno[1,2,3-*cd*]pyrene are probably human carcinogens.

For all substances with a classification R40 (limited evidence of a carcinogenic effect), R45 (may cause cancer), R46 (may cause heritable genetic damage), R60 (may impair fertility), R61 (may cause harm to the unborn child), or R68 (possible risk of irreversible effects) the derivation of a human toxicological quality standard under the Water Framework Directive is triggered (Lepper, 2005). For the other substances that were not classified in EU framework, but are suspected or probable carcinogens, this holds true as well. Still for the other substances fluorene, phenanthrene and anthracene the TDI values are low, while the BCF values are rather high, which makes them eligible for the derivation of a human toxicological MPC (e.g. one of the R-phrases R22, R25, R28 (harmful, toxic, or very toxic if swallowed), or R48 (danger of serious damage to health by prolonged exposure) in combination with a BCF > 100 would trigger the human route as well).

However, this report is restricted to the derivation of the environmental risk limits for direct ecotoxicity. As such, the derivation of human toxicological maximum permissible concentration or serious risk concentrations is outside the scope of this report. The derivation of SRC_{human} for the 16 PAHs can be found in another report (Lijzen et al., 2001). In section 4.1, they are compared to the SRC_{eco} values derived in this report.

Table 4: Overview of human toxicological data: Classification in EU framework, Reference dose (RfD) from US EPA (IRIS), minimal risk level (MRL) from ATSDR, and maximum permissible risk (MPR) from RIVM

Compound	***Classification***	***US EPA (IRIS) RfD mg/kg$_{bw}$/d***	***ATSDR MRL (oral intermediate exposure mg/kg$_{bw}$/d***	***RIVM MPR (TDI or 10^{-4} lifetime cancer risk) mg/kg$_{bw}$/d***
Naphthalene	R40, R22, R50/53	0.02	0.6	0.04
Acenaphthylene				0.050 *
Acenaphthene		0.06	0.6	0.50 *
Fluorene		0.04	0.4	0.040
Phenanthrene				0.040
Anthracene		0.30	10	0.040
Pyrene		0.030		0.50 *
Fluoranthene		0.040	0.4	0.050 *
Chrysene	R45, R68, R50/53			0.050 *
Benz[*a*]anthracene	R45, R50/53			0.0050 *
Benzo[*k*]fluoranthene	R45, R50/53			0.0050 *
Benzo[*b*]fluoranthene	R45, R50/53			0.0050 *
Benzo[*a*]pyrene	R45, R46, R60, R61, R43, R50/53			0.00050 *
Benzo[*ghi*]perylene				0.030
Dibenz[*a,h*]anthracene	R45, R50/53			0.00050 *
Indeno[1,2,3-*cd*]pyrene				0.0050 *

* These values are based on a cancer risk of 10^{-4} per lifetime (Baars et al., 2001).

2.3 Data collection and evaluation

2.3.1 Ecotoxicity data

Initially, data were collected for the European Risk Assessment Report on coal tar pitch, high-temperature. An on-line literature search was performed on TOXLINE (literature from 1985 to 2001) and Current Contents (literature from 1997 to 2002) and was updated at regular time intervals up to 2008 by Current Contents or Scopus. In addition to this, all references in the RIVM e-tox base and EPA's ECOTOX database were evaluated, if available. Next to that, many references were retrieved by retrospective searching of cited references. Evaluated toxicity data are reported in a separate appendix to this report. Ecotoxicity studies were screened for relevant endpoints (i.e. those endpoints that have consequences at the population level of the test species). All ecotoxicity tests were then thoroughly evaluated with respect to the validity (scientific reliability) of the study. A detailed description of the evaluation procedure is given in the INS-Guidance (Van Vlaardingen and Verbruggen, 2007), sections 2.2.2 and 2.3.2. In short, the following reliability indices were assigned:

- Ri 1: Reliable without restriction
  'Studies or data … generated according to generally valid and/or internationally accepted testing guidelines (preferably performed according to GLP) or in which the test parameters documented are based on a specific (national) testing guideline … or in which all parameters described are closely related/comparable to a guideline method.'
- Ri 2: Reliable with restrictions
  'Studies or data … (mostly not performed according to GLP), in which the test parameters documented do not totally comply with the specific testing guideline, but are sufficient to accept the data or in which investigations are described which cannot be subsumed under a testing guideline, but which are nevertheless well documented and scientifically acceptable.'
- Ri 3: Not reliable
  'Studies or data … in which there are interferences between the measuring system and the test substance or in which organisms/test systems were used which are not relevant in relation to the exposure (e.g., unphysiologic pathways of application) or which were carried out or generated according to a method which is not acceptable, the documentation of which is not sufficient for an assessment and which is not convincing for an expert judgment.' Since most PAHs, especially the lower ones, are volatile substances, studies using an open system in which actual concentrations are not monitored are rewarded Ri 3.
- 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.).'
- Ri 4*: Data from other sources
  'Studies or data … which are most likely copied from other sources'

All available studies were summarized in data tables, which are included as a database 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.
Endpoints with Ri 1 or 2 are accepted as valid, but this does not automatically mean that the endpoint is selected for the derivation of ERLs. The validity scores are assigned on the basis of scientific reliability, but valid endpoints may not be relevant for the purpose of ERL-derivation (e.g. due to inappropriate exposure times).
After data collection and validation, toxicity data were combined into an aggregated data table with one effect value per species according to section 2.2.6 of the INS-Guidance. When for a species several effect data were available, the geometric mean of multiple values for the same endpoint was calculated where possible. Subsequently, when several endpoints were available for one species, the lowest of these endpoints (per species) is reported in the aggregated data table.

2.3.2 *Physicochemical data*

The collected physicochemical properties were collected for the European Risk Assessment Report on coal tar pitch, high-temperature as well. Most data were retrieved from the Handbook of physical-chemical properties and environmental fate for organic chemicals (Mackay et al., 2006) and the references cited therein. The selection criteria were based on the INS-Guidance (Van Vlaardingen and Verbruggen, 2007) and preference was given to slow-stirring and generator-column methods for both solubility and the *n*-octanol-water partition coefficient (K_{ow}), and the gas saturation and effusion methods for the vapour pressure, and wetted-wall, gas-stripping, or headspace methods for Henry's law constant. The organic carbon-water partition coefficient (K_{oc}) was calculated from log K_{ow} by means of the QSAR equation from Karickhoff et al. (1979). This equation proved to be most suitable for describing sorption of PAHs to organic carbon (Verbruggen et al., 2008):

$$\log K_{oc} = \log K_{ow} - 0.21$$

2.4 Additional methodology and deviations from the guidance

2.4.1 *MAC$_{eco,\ marine}$*

The assessment factor for the MAC$_{eco,\ marine}$ value is based on:
- the assessment factor for the MAC$_{eco,\ water}$ value when acute toxicity data for at least two specific marine taxa are available, or
- the assessment factor for the MAC$_{eco,\ water}$ value with an additional assessment factor of 5 when acute toxicity data for only one specific marine taxon are available (analogous to the derivation of the MPC according to Van Vlaardingen and Verbruggen, (2007)), or
- the assessment factor for the MAC$_{eco,\ water}$ value with an additional assessment factor of 10 when no acute toxicity data are available for specific marine taxa.

If freshwater and marine data sets are not combined, the MAC$_{eco,\ marine}$ is derived on the marine toxicity data using the same additional assessment factors as mentioned above. It has to be noted that this procedure is currently not agreed upon. Therefore, the MAC$_{eco,\ marine}$ value needs to be re-evaluated once an agreed procedure is available.

2.4.2 *Equilibrium partitioning for soil and sediment*

Equilibrium partitioning (EqP) can be used to derive ERLs for soil and sediment from ERLs for water. If equilibrium partitioning is applied, an additional factor of 10 should be used for the derivation of the MPC of substances with a log K_{ow} higher than 5 (Van Vlaardingen and Verbruggen, 2007). This factor was introduced to take account of the possible role of food ingestion, both in sediment and soil. However, the increase in total uptake due to food ingestion in earthworms was non-exisiting for 1,2,3,4-tetrachlorobenzene, and pentachlorobenzene and only a factor 2 to 3 for hexachlorobenzene (Belfroid et al., 1994). This set of three compounds is actually too small to base a conclusion upon and in general, it has been shown that this additional uptake is actually very limited (Jager, 1998). Based on experimental data, this was confirmed for the PAHs in this report. Applying an additional factor of 10 would be an overestimation of the environmental risk limits, while without this factor environmental risk limits derived by equilibrium partitioning and from direct terrestrial and benthic toxicity data are in good accordance with each other.

Therefore, the additional factor of 10 for equilibrium partitioning is not applied in this report.

3 Derivation of environmental risk limits

3.1 Naphthalene

3.1.1 Substance identification and physicochemical properties

3.1.1.1 Identity

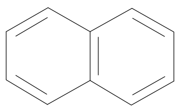

Figure 1: Structural formula of naphthalene.

Table 5: Identification of naphthalene

Parameter	***Value***
Common/trivial/other name	Naphthalene, naphthene
Chemical name	Naphthalene
CAS number	91-20-3
EC number	202-049-5
SMILES code	c12ccccc1cccc2

3.1.1.2 Physicochemical properties

Table 6: Physicochemical properties of naphthalene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	128.2	
Water solubility	[μg/L]	31900	Geometric mean of 7 values by generator-column method
log K_{OW}	[-]	3.34	Average of 1 value by generator-column and 1 by slow-stirring method
log K_{OC}	[-]	3.13	QSAR
Vapour pressure	[Pa]	10.8	Geometric mean of 8 values by gas saturation method
Melting point	[°C]	81	
Boiling point	[°C]	217.9	
Henry's law constant	[Pa.m^3/mol]	50.4	Geometric mean of 7 values by gas stripping method, 1 value by wetted-wall method and 1 value by headspace method

3.1.2 Water

Naphthalene is highly volatile. Many toxicity studies for naphthalene were rejected due to high uncertainty in exposure concentrations, either because analysis showed that the concentrations in static systems dropped very quick or because exposure concentrations were not analytically verified. Still, many valid toxicity data are available for naphthalene. The selected acute toxicity data for freshwater species include algae, an amphibian, crustaceans, a cyanophyte, insects, a mollusk and fish (Table 7). The selected acute toxicity data for marine species include seaweed, an annelid, a bacterium, crustaceans, mollusks and fish (Table 8). No higher plant was selected but a study with duckweed showed that naphthalene only causes about 10% effect up to the solubility of 32,000 μg/L (Ren et al., 1994). It can thus be concluded that duckweed is not a very sensitive species for naphthalene.

Table 7: Selected acute toxicity data of naphthalene to freshwater species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Algae	*Nitzschia palea*	2820
Algae	*Pseudokirchneriella subcapitata*	2960
Algae	*Scenedesmus vacuolatus*	3800
Amphibia	*Xenopus laevis*	2100
Crustacea	*Daphnia magna*	1896 [a]
Crustacea	*Diporeia* spp.	1587
Crustacea	*Gammarus minus*	3930
Cyanophyta	*Anabaena flos-aqua*	24,000
Insecta	*Chironomus riparius*	600 [b]
Mollusca	*Physa gyrina*	5020
Pisces	*Oncorhynchus mykiss*	2212 [c]
Pisces	*Pimephales promelas*	4572 [d]

Notes to Table 7
[a] Geometric mean of 2160 and 1664 µg/L for the most sensitive parameter (immobility) at a standard exposure time of 48 hours.
[b] Most sensitive lifestage exposed under light conditions including some UV-A.
[c] Geometric mean of 2100, 3220, and 1600 µg/L.
[d] Geometric mean of 1680, 1990, and 7900 µg/L.

Table 8: Selected acute toxicity data of naphthalene to marine species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Algae	*Champia parvula*	1378 [a]
Annelida	*Neanthes arenaceodentata*	1069
Bacteria	*Vibrio fischeri*	710 [b]
Crustacea	*Artemia salina*	3190
Crustacea	*Calanus finmarchicus*	2400
Crustacea	*Callinectes sapidus*	2301 [c]
Crustacea	*Elasmopus pectenicrus*	2680
Crustacea	*Eualis suckleyi*	1390
Crustacea	*Eurytemora affinis*	3800
Crustacea	*Hemigrapsus nudus*	1100 [d]
Crustacea	*Neomysis Americana*	825 [e]
Crustacea	*Oithona davisae*	4480 [f]
Crustacea	*Palaemonetes pugio*	2111
Crustacea	*Paracartia grani*	2467 [f]
Crustacea	*Parhyale hawaiensis*	6000
Mollusca	*Mytilus edulis*	922
Pisces	*Fundulus heteroclitus*	5300
Pisces	*Oncorhynchus gorbuscha*	1200 [g]

Notes to Table 8
[a] Geometric mean of 1000 and 1900 µg/L for the most sensitive lifestage (tetrasporophyte).
[b] Geometric mean of 700 and 720 µg/L at standard exposure time (15 min).
[c] Lowest value at highest salinity of 30‰.
[d] Lowest value obtained with continuous exposure instead of intermittent exposure.
[e] Geometric mean of 800 and 850 µg/L at highest test temperature of 25 ºC.
[f] Most sensitive parameter (immobility).
[g] Most relevant exposure time (96 h) and probably also most relevant life-stage for acute toxicity testing.

To test for differences in sensitivity between freshwater and marine species, data were log-transformed first. Thereafter, a t-test with two-tailed distribution and equal variance was performed after running an F-test to test for equal variances. No significant differences were observed in the sensitivity of freshwater and marine species in acute toxicity tests (F-test 0.29; t-test 0.13). It is therefore considered justified to calculate a species sensitivity distribution with the acute toxicity data on basis of the combined dataset for 30 species. This SSD is shown in Figure 2. The HC5 of this SSD is 650 µg/L, the HC50 is 2324 µg/L. The $MAC_{eco, water}$ is derived from the HC5(acute), default by applying an assessment factor of 10. However, the number of toxicity data and the taxonomic diversity is high and the differences in species sensitivity are low, which is characteristic of narcotic effects. The $MAC_{eco, water}$ should be protective of any acute toxicity effects. However, the values used in the SSD are 50% effective concentration. Therefore, an assessment is made between the 50% and 10% effective concentrations (EC50 and EC10). A direct comparison can be made for 9 species from 5 taxonomic groups (Table 9). The no-effect level is at most a factor of 5 lower than the 50% effect level. Therefore, an assessment factor of 5 is applied to the HC(acute) to derive the $MAC_{eco, water}$. The $MAC_{eco, water}$ is thus 130 µg/L. Because of the large number of marine data, including non standard species such as seaweed, annelids, or molluscs, an extra assessment factor for the $MAC_{eco, marine}$ is not necessary. The $MAC_{eco, marine}$ is 130 µg/L too.

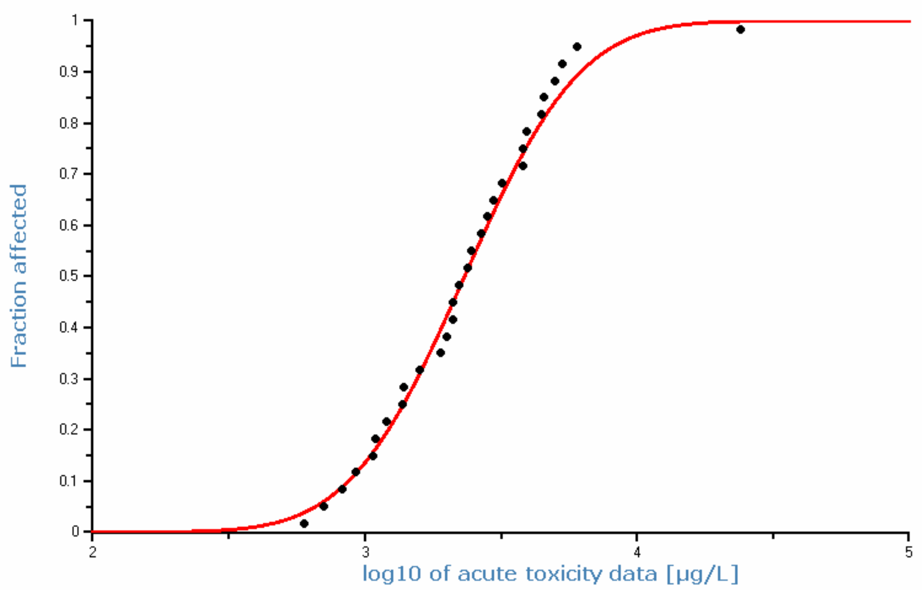

Figure 2: Species sensitivity distribution for the acute toxicity of naphthalene to freshwater and marine species

Chronic toxicity studies for naphthalene have often been performed in flow-through systems, with regular renewal of the aqueous phase or with tightly closed vials. This renders a relatively high number of valid toxicity data. The selected chronic data for naphthalene to freshwater species include algae, crustaceans, a higher plant and fish (Table 10). For marine species data are available for seaweed, a sea squirt species, crustaceans, including a crab species, echinoderms, a mollusc and fish (Table 11).

Table 9: Acute no effect levels (10% cut-off by means of EC10) versus 50% effect levels (EC50) for naphthalene

Taxon	***Species***	***EC50/EC10 or LC50/LC10***
Amphibia	*Xenopus laevis*	1.6
Algae	*Scenedesmus vacuolatus*	2.2
Algae	*Champia parvula*	1.4 – 2.1
Bacteria	*Vibrio fischeri*	4.8
Crustacea	*Calanus finmarchicus*	1.1
Crustacea	*Oithona davisae*	1.8
Crustacea	*Paracartia grani*	1.6
Crustacea	*Parhyale hawaiensis*	1.6
Cyanophyta	*Anabaena flos-aqua*	2.5

Table 10: Selected chronic toxicity data of naphthalene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Scenedesmus vacuolatus*	1700
Crustacea	*Ceriodaphnia dubia*	514
Crustacea	*Hyalella azteca*	1161
Macrophyta	*Lemna gibba*	32,000
Pisces	*Micropterus salmoides*	37
Pisces	*Oncorhynchus kisutch*	460 [a]
Pisces	*Oncorhynchus mykiss*	20
Pisces	*Pimephales promelas*	450 [b]

Notes to Table 10
[a] Most sensitive parameter (length).
[b] Most sensitive parameter (length and weight).

Table 11: Selected chronic toxicity data of naphthalene to marine species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Champia parvula*	811 [a]
Crustacea	*Cancer magister*	21 [b]
Crustacea	*Paracartia grani*	530 [c]
Echinodermata	*Paracentrotus lividus*	649 [d]
Echinodermata	*Strongylocentrotus droebachiensis*	738 [e]
Mollusca	*Mytilus galloprovincialis*	4037 [d]
Pisces	*Gadus morhua*	1000
Pisces	*Oncorhynchus gorbuscha*	260 [f]
Tunicata	*Ciona intestinalis*	610 [d]

Notes to Table 11
[a] Geometric mean of 1400 and 470 µg/L for the most sensitive lifestage (tetrasporophyte).
[b] Most sensitive strain (from Alaska).
[c] Most sensitive parameter (egg production).
[d] Lowest value with tests performed in the dark.
[e] Geometric mean of 940 and 580 µg/L.
[f] Most sensitive parameter (weight).

An LC50 of 110 (Black et al., 1983) or 120 µg/L (Milleman et al., 1984) is reported for an early life stage study (ELS) with rainbow trout exposed from 20 minutes after fertilization of the eggs until 4 days after hatching of the fry (after 23 d, total exposure 27 d). The presented data (Black et al., 1983) show a

clear dose-response relationship. The LC50 value of 117 μg/L derived from a dose-response relationship with a log-logistic equation (r^2=0.96) is similar to the values mentioned above. The EC10 for survival after 4 days post-hatching is 20 μg/L. Clearly, this is the lowest usable effect concentration for naphthalene in freshwater species. In the RAR of naphthalene the study of Black et al. (1983), was disregarded because the method could not be repeated with toluene and it generally gives much lower results than standard studies. After reconsideration, it was concluded in the RAR of coal tar pitch that the value could be used.
There are some differences between the studies with toluene and naphthalene. First, for toluene the difference with the other toxicity data is several orders of magnitude, while for naphthalene, there are several studies which show the onset of chronic effects or effects on sensitive life stages around the value of 20 μg/L. For the most sensitive strain of Dungeness crabs a NOEC of 21 μg/L was found in a 40-d study (Caldwell et al., 1977). In this study only two exposure concentrations are used. Although well-performed, the statistical power of this test is limited. For the marine herbivorous copepod *Eurytemora affinis* 1 concentration of 14 μg/L tested in a 15-d study resulted in significant effects (Ott et al., 1978). However, a 10-d study with the same species resulted in no significant effects up to 50 μg/L (Berdugo et al., 1977).
Second, the EC10 for toluene is also an order of magnitude lower than that for naphthalene, while naphthalene is a compound with a log K_{ow} that is 0.6 unit higher than that of toluene. For this reason, the EC10 for naphthalene would be expected to be lower than the EC10 for toluene, which is apparently not the case.
Further, both EC10s do not originate from the same publication, or at least toluene has been omitted from the publication. If a read-across is performed with the data for phenanthrene instead of toluene with data from the same study (Black et al., 1983), the data are very well in line with another study with the same species and with data for other species tested with phenanthrene. Therefore, the EC10 is considered to be useful in this case.
Chronic NOEC or EC10 values are very similar for freshwater and marine species and no significant differences are observed (F-test 0.19; t-test 0.99). Both datasets can therefore be combined. Valid chronic toxicity data are available for 17 species originating from 7 taxonomic groups. No selected value for an insect is available. However, in a full life-cycle study with the midge *Tanytarsus dissimilis*, it was concluded that concentrations below 500 μg/L resulted in minimal effects (Darville and Wilhm, 1984). However, details on the dose-response relationship for this species are missing. With this value missing, a species sensitivity distribution can in principle not be applied. For comparative purposes the figure is shown below (Figure 3). The HC5 is 25 μg/L and the HC50 is 520 μg/L. The data do not fit well to a log-normal distribution. Next to that, effects for 1 species are observed in 1 study and not in the other or differences exist even between different strains for the same species and there are some effects observed even below the lowest EC10. The wide range of NOEC or EC10 values for different species, also raise some question whether there are more specific modes of toxic action involved besides the baseline toxicity caused by narcosis. Part of the differences might also be explained from the difficulties in maintaining constant exposure concentration in toxicity experiments.
Because the uncertainties, the $MPC_{eco, water}$ is derived by applying an assessment factor of 10 to the lowest EC10, instead of using the outcome of the species sensitivity distribution. In the EU-RAR no chronic toxicity data for algae were available. Hence, an assessment factor of 50 was applied. Useful data for algae are now available (e.g.Walter et al., 2002). Therefore, the use of an assessment factor of 10 instead of 50 seems to be justified, certainly because of the extensive dataset with chronic data. The lowest usable effect concentration for

freshwater species is the EC10 from the ELS study with *Oncorhynchus mykiss* of 20 µg/L. The $MPC_{eco, water}$ is thus 2.0 µg/L. This value is almost identical to the PNEC value derived in the EU-RAR for naphthalene. However, an assessment factor of 10 has been used here instead of 50.
With 6 taxonomic groups for marine species, an assessment factor of 10 can be applied to the lowest NOEC as well. The $MPC_{eco, marine}$ is thus equal to the $MPC_{eco, water}$ of 2.0 µg/L. The SRC_{eco} is both for freshwater and marine water equal to the HC50 of 520 µg/L.

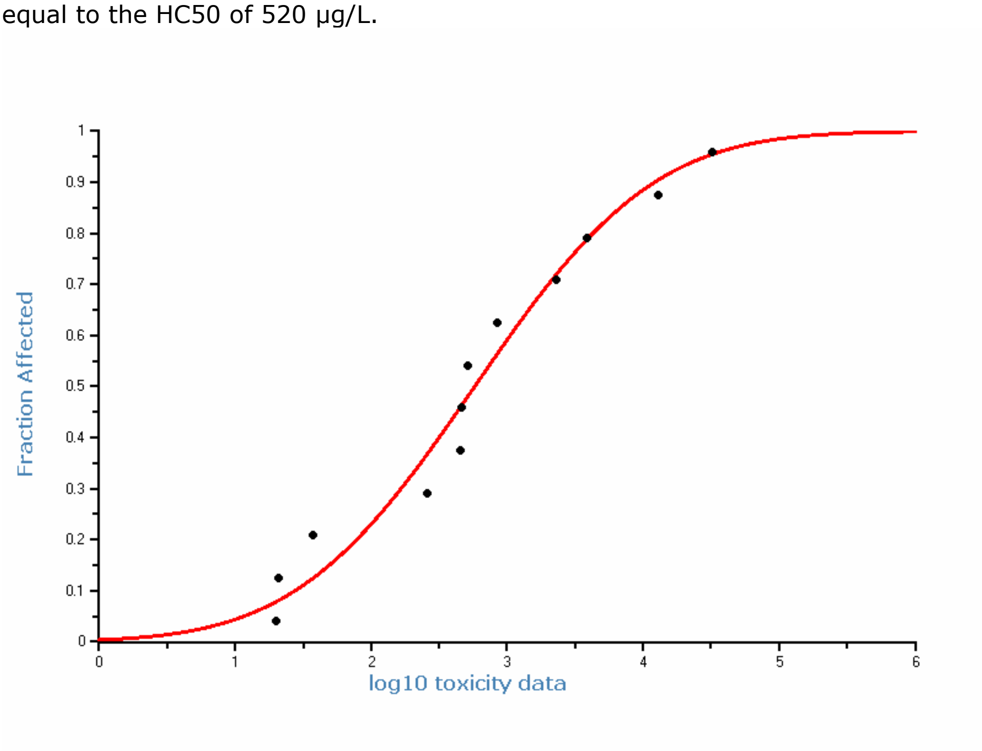

Figure 3: Species sensitivity distribution for the chronic toxicity of naphthalene to freshwater and marine species

3.1.3 Sediment

All available effect concentrations for benthic organisms relate to 50% effect. The EC50 for reburial of *Rhepoxynius abronius* after 10 days of exposure (Boese et al., 1998) is 1700 mg/kg_{dw}, recalculated to Dutch standard sediment with an organic carbon matter of 10%. Irradiation of the crustaceans with UV light had no effect on this parameter. It should be noted that although this value is an EC50, the exposure time (10-d) as well as the endpoint (reburial) are rather chronic than acute. Nevertheless, the difference with the LC50 is negligible.

Table 12: Selected acute toxicity data of naphthalene to benthic species

Taxon	***Species***	***LC50/EC50 [$mg/kg_{standard\ sediment}$]***
Crustacea	*Rhepoxynius abronius*	1712

With an assessment factor of 1000, an $MPC_{eco, sediment}$ of 1.7 $mg/kg_{dw, standard\ sed}$ would be derived. Because the MPC is based on 1 acute effect concentration, this MPC has to be compared with one derived by equilibrium partitioning, which is 0.16 mg/kg_{dw}. This value of 0.16 mg/kg_{dw} is therefore the final $MPC_{eco, sediment}$. Because the $MPC_{eco, marine}$ is equal to the $MPC_{eco, water}$ the $MPC_{eco, marine\ sediment}$ is equal to the $MPC_{eco, sediment}$ as well.

The $SRC_{eco, sediment}$ is derived by comparing the direct acute EC50 divided by a factor of 10 with the value derived by equilibrium partitioning. The value derived by equilibrium partitioning is the lowest. This value of 42 $mg/kg_{dw, standard sed}$ is the $SRC_{eco, sediment}$.

3.1.4 Soil

Concentrations of naphthalene in soil rapidly diminish. The concentrations at the end of a 28-d experiment with the pot worm *Enchytraeus crypticus* and the springtail *Folsomia candida* were only 1 to 10% of the actual initial concentrations (Bleeker et al., 2003; Droge et al., 2006). In a similar test with the springtail *Folsomia fimetaria* the concentrations at the end of the 21-d experiment were 4 to 10% of the actual initial concentrations (Sverdrup et al., 2001). In a test on microbial processes (Kirchmann et al., 1991) the concentrations dropped to 9 and 2% of the actual initial concentration after 5 and 10 days in the highest concentration (21 mg/kg_{dw}) and to 13 and 8% in the lowest concentration (0.1 mg/kg_{dw}).
Time-weighted average concentrations for these studies were estimated to be 24% over 28 days (Bleeker et al., 2003; Droge et al., 2006), 33% over 21 days (Sverdrup et al., 2001), and 34-38% over 7 days (Kirchmann et al., 1991). It appears that the rate of disappearance varies considerably between the studies. Because of the rapid disappearance of naphthalene in all studies, time-weighted average concentrations are preferred to base the effect concentration upon. Studies that have only measured initial concentrations are prone to errors and especially studies, in which concentrations have not been verified, should be considered as invalid.
Selected terrestrial toxicity data are available for 1 annelid species, 2 springtail species, and microbial processes (Table 13). Effect concentrations from terrestrial studies are first transferred to values for standard soil containing 10% organic matter by correcting for the organic carbon content. The lowest usable effect concentration is the NOEC of 6.9 $mg/kg_{dw, standard soil}$ for reproduction of the springtail *Folsomia candida* from a 28-d study (Bleeker et al., 2003). No value was selected for terrestrial plants. For lettuce (*Lactuca sativa*) a NOEC of 230 and an EC10 of 340 $mg/kg_{dw, standard soil}$ are available based on nominal concentrations. However, at 100 mg/kg_{dw} (714 $mg/kg_{dw, standard soil}$) the initial concentration appeared to be only 46%, while at 10 mg/kg_{dw} this measured initial concentration was only 10%. After the test period of 14 days, the concentration at both levels had dropped below the detection limit of 0.2 mg/kg_{dw}. This means that the time weighted average concentrations over this period can be at most 5 to 8% of the nominal concentration. Nevertheless, this is still amply higher than the value for *Folsomia candida*. It is therefore concluded that terrestrial plants are not the most sensitive species for naphthalene.

Table 13: Selected chronic toxicity data of naphthalene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [$mg/kg_{standard soil}$]***
Annelida	*Enchytraeus crypticus*	17
Insecta	*Folsomia candida*	6.9
Insecta	*Folsomia fimetaria*	24
Process/activity	respiration, nitrogen mineralization, nitrification	≥24

With terrestrial plants included the toxicity data cover primary producers, consumers, and decomposers. Therefore, an assessment factor of 10 can be applied to the lowest EC10. This results in an $MPC_{eco, soil}$ of 0.69 $mg/kg_{dw, standard soil}$. The $SRC_{eco, soil}$ based on the chronic data for three species is 14 $mg/kg_{dw, standard soil}$.

3.2 Acenaphthylene

3.2.1 Substance identification and physicochemical properties

3.2.1.1 Identity

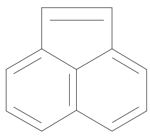

Figure 4: Structural formula of acenaphthylene

Table 14: Identification of acenaphthylene

Parameter	***Value***
Common/trivial/other name	Acenaphthylene
Chemical name	Acenaphthylene
CAS number	208-96-8
EC number	205-917-1
SMILES code	c1ccc2cccc3c2c1C=C3

3.2.1.2 Physicochemical properties

Table 15: Physicochemical properties of acenaphthylene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	152.2	
Water solubility	[μg/L]	16,100	Generator-column method
log K_{OW}	[-]	3.55	HPLC-RT
log K_{OC}	[-]	3.34	QSAR
Vapour pressure	[Pa]	0.89	Gas saturation method
Melting point	[°C]	91.8	
Boiling point	[°C]	280	
Henry's law constant	[Pa.m^3/mol]	11.9	Geometric mean of two values by the gas stripping method and one by the wetted-wall method

3.2.2 Water

Very few data are available for acenaphthylene. The selected acute toxicity data for freshwater species are presented in Table 16. For all studies the stability of the aqueous concentration is not reported. In the acute toxicity study 48-h with *Daphnia magna*, concentrations were measured (Bisson et al., 2000). In a 96-h acute toxicity study with the Japanese Medaka, test solutions were renewed but it is unclear whether or not concentrations were measured (Yoshioka and Ose, 1993).

Table 16: Selected acute toxicity data of acenaphthylene to freshwater species

Taxon	***Species***	***LC50 or EC50 [μg/L]***
Crustacea	*Daphnia magna*	1800
Pisces	*Oryzias latipes*	6400

The only selected value for marine species is shown in Table 17. In a short-term bioluminescence test with *Vibrio fischeri*, illumination with simulated solar radiation had no effect on the EC50 (340 µg/L versus 330 µg/L in the dark) (El-Alawi et al., 2001). Concentrations in these tests were not verified, but considering the exposure time (15 minutes) this is not considered invalidating the test.

Table 17: Selected acute toxicity data of acenaphthylene to marine species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Bacteria	*Vibrio fischeri*	330 [a]

Notes to Table 17
[a] Geometric mean of 330 and 340 µg/L at standard exposure time (15 min).

Strictly, the base set, which consists of acute data for algae, *Daphnia*, and fish, is not complete, because an acute toxicity study with algae is missing. However, a 72-h static study with *Pseudokirchneriella subcapitata* was performed but only the EC10 value is reported (Bisson et al., 2000). For algae, the EC50 is derived from the same study as the NOEC or EC10. The EC50 must therefore be higher than this EC10 value. Therefore, the base set is considered to be complete.
If there is no significant difference between freshwater and marine species, the data are combined. In this case there are insufficient data for a meaningful statistical test. Therefore, the data are assumed to be similar as for the other PAHs. The most sensitive species in acute tests is the bacterium species *Vibrio fischeri*. The $MAC_{eco,\ water}$ is based on this value. Normally an assessment factor of 100 is applied to this value. However, the presumed mode of toxic action of acenaphthylene in ecotoxicity studies is narcosis, at least in acute tests. Further, the EC50 for *Vibrio fischeri* is considerably lower than the other EC50s and only a factor of 4 to 6 higher than the chronic values (Table 18). Therefore, an assessment factor of 10 seems justified. The $MAC_{eco,\ water}$ thus is 33 µg/L. Because the data set does not contain a marine species, other than *Vibrio fischeri*, an extra assessment factor of 10 is applied for the marine environment. The $MAC_{eco,\ marine}$ is thus 3.3 µg/L.
Two long term toxicity studies with acenaphthylene are available (Table 18), a 72-h static study with *Pseudokirchneriella subcapitata* and a 7-d renewal reproduction study with *Ceriodaphnia dubia*. In both studies, concentrations were experimentally determined (Bisson et al., 2000).

Table 18: Selected chronic toxicity data of acenaphthylene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Pseudokirchneriella subcapitata*	82
Crustacea	*Ceriodaphnia dubia*	64

Two chronic NOECs for 2 trophic levels are available. These are the EC10 for growth of the algae *Pseudokirchneriella subcapitata* and for reproduction of the crustacean *Ceriodaphnia dubia*. To apply an assessment factor of 50 to these data, the group showing the lowest L(E)50 should be included in the data. It can be questioned if algae would be the trophic level showing the lowest L(E)C50, because the bacterium species *Vibrio fischeri*, which appeared to be the most sensitive species in acute studies, has an EC50 of 330 to 340 µg/L, which is only a factor of 4 higher than the EC10 for *Pseudokirchneriella subcapitata*. However, chronic data for any species of bacteria are not considered in the derivation of the MPC for water in the case that assessment factors are used.
The 30-min EC50 and EC10 values for *Vibrio fischeri* were reported based on measured concentrations (Loibner et al., 2004). The EC10 was 180 µg/L. If the

short term EC10 for bioluminescence is considered as a representative measure of growth, growth of *Vibrio* is not inhibited at concentrations below the lowest EC10 value for *Ceriodaphnia dubia*. Also the EC10 for *Pseudokirchneriella subcapitata* is lower than the EC10 for *Vibrio fischeri*. Some long-term experiments were performed with *Vibrio fischeri* as well (El-Alawi et al., 2001). Growth and bioluminescence were examined after 18 hours of exposure. The tests were performed in a complex medium, and therefore, they are not considered to be representative of the aqueous environment. However, from the test it appeared that bioluminescence is almost 1:1 correlated with growth of the bacteria.
Therefore, an assessment factor of 50 seems to be justified and can be applied to the lowest EC10 of 64 µg/L for *Ceriodaphnia dubia*. The $MPC_{eco,\ water}$ then becomes 1.3 µg/L. With no additional NOECs or EC10s for marine species, an assessment factor of 500 is applied for the marine environment. The $MPC_{eco,\ marine}$ thus becomes 0.13 µg/L.
The $SRC_{eco,\ water}$ is derived by comparing the geometric mean of the acute toxicity data, divided by a factor of 10, and the geometric mean of the chronic toxicity data. The geometric mean of the chronic toxicity data is the lowest value. The $SRC_{eco,\ water}$ is 72 µg/L.

3.2.3 Sediment

No data for benthic organisms are available. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ sediment}$ is 0.17 $mg/kg_{dw,\ standard\ sed}$. For the marine environment, this number is a factor of 10 lower. The $MPC_{eco,\ marine\ sediment}$ is 0.017 $mg/kg_{dw,\ standard\ sed}$. The $SRC_{eco,\ sediment}$ is 9.5 $mg/kg_{dw,\ standard\ sed}$.

3.2.4 Soil

Only 1 toxicity test with terrestrial species is available for acenaphthylene (Table 19). On the basis of this test an $MPC_{eco,\ soil}$ of 0.51 $mg/kg_{dw,\ standard\ soil}$ is derived. Because there is only 1 value, the MPC has to be derived by equilibrium partitioning as well. A value of 0.17 $mg/kg_{dw,\ standard\ soil}$ is derived, which is lower than the value derived from the study with springtails. The $MPC_{eco,\ soil}$ is thus equal to 0.17 $mg/kg_{dw,\ standard\ soil}$.

Table 19: Selected chronic toxicity data of acenaphtylene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard\ soil}$]***
Insecta	*Folsomia fimetaria*	51

Also the $SRC_{eco,\ soil}$ is derived by comparing the terrestrial value with a value derived by equilibrium partitioning: 51 versus 9.4 $mg/kg_{dw,\ standard\ soil}$. The $SRC_{eco,\ soil}$ is thus 9.4 $mg/kg_{dw,\ standard\ soil}$.

3.3 Acenaphthene

3.3.1 Substance identification and physicochemical properties

3.3.1.1 Identity

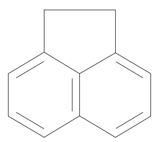

Figure 5: Structural formula of acenaphthene

Table 20: Identification of acenaphthene

Parameter	***Value***
Common/trivial/other name	Acenaphthene, ethylenenaphthalene, periethylenenaphthalene, 1,2-dihydro-acenaphthalene
Chemical name	1,8-hydroacenaphthylene
CAS number	83-32-9
EC number	201-469-6
SMILES code	c1ccc2cccc3c2c1CC3

3.3.1.2 Physicochemical properties

Table 21: Physicochemical properties of acenaphthene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	154.2	
Water solubility	[μg/L]	4160	Geometric mean of 7 values by generator-column method
log K_{OW}	[-]	3.92	Shake-flask method
log K_{OC}	[-]	3.71	QSAR
Vapour pressure	[Pa]	0.35	Geometric mean of 2 values by gas saturation method
Melting point	[°C]	93.4	
Boiling point	[°C]	279	
Henry's law constant	[Pa.m^3/mol]	13.9	Geometric mean of 5 values by gas stripping method, 1 value by wetted-wall method and 1 value by headspace method

3.3.2 Water

Acute toxicity tests with freshwater species and acenaphthene have been performed with crustaceans (*Daphnia*) and fish (Table 22). The lowest EC50s are for the fish species *Salmo trutta* and *Oncorhynchus mykiss* from studies with continuous flow-system and measured concentrations (Holcombe et al., 1983).

Table 22: Selected acute toxicity data of acenaphthene to freshwater species

Taxon	***Species***	***LC50 or EC50 [μg/L]***
Crustacea	*Daphnia magna*	958
Pisces	*Ictalurus punctatus*	1720
Pisces	*Oncorhynchus mykiss*	670
Pisces	*Pimephales promelas*	986 [a]
Pisces	*Salmo trutta*	580

Notes to Table 22
[a] Geometric mean of 608 and 1600 μg/L.

Acute toxicity data for marine species are available for bacteria, molluscs and fish (Table 23). Illumination with simulated solar radiation had no effect on the EC50 for the bacterium species *Vibrio fischeri* (830 μg/L versus 810 μg/L in the dark) (El-Alawi et al., 2001).
There is no significant difference between the freshwater and marine acute toxicity data (F-test 0.12, t-test 0.88). Therefore, data can be combined. The lowest value is for the marine species *Mytilus edulis*. The EC50 for this species is 382 μg/L. However, no EC50 for algae is reported. A valid toxicity study with *Pseudokirchneriella subcapitata* is available (Bisson et al., 2000) for which only the EC10 of 38 μg/L is reported (Table 24). The EC50 must therefore be higher than this value. However, it is not likely that the EC50 will be higher than the

value for the mollusc species, which is a factor of 10 higher than the EC10 for algae. This has to be taken into account in deriving the $MAC_{eco, water}$. Therefore, the default assessment factor of 100 is not lowered to 10 in this case. The $MAC_{eco, water}$ is then 3.8 µg/L. One EC50 is available for a typical marine species (mollusc). The extra assessment factor for the $MAC_{eco, marine}$ is therefore 5 instead of 10. Then, the $MAC_{eco, marine}$ is 0.76 µg/L.

Table 23: Selected acute toxicity data of acenaphthene to marine species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Bacteria	*Vibrio fischeri*	820 [a]
Mollusca	*Mytilus edulis*	382
Pisces	*Cyprinodon variegates*	3100

Notes to Table 23
[a] Geometric mean of 810 and 830 µg/L at standard exposure time (15 min).

With the toxicity study with algae in the chronic data, the base set can be considered complete. Besides algae, chronic toxicity data are available for a crustacean, an insect and fish (Table 24). The crustacean (Bisson et al., 2000) and the insect species (Meier et al., 2000) both have EC10 values that are almost identical to the value for algae. Two independent ELS tests with *Pimephales promelas* were carried out, one with dimethylformamide as solvent and one without carrier (Cairns and Nebeker, 1982). The fish were exposed by a flow-through system and concentrations were measured.

Table 24: Selected chronic toxicity data of acenaphthene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Pseudokirchneriella subcapitata*	38
Crustacea	*Ceriodaphnia dubia*	42
Insecta	*Paratanytarsus parthenogeneticus*	39
Pisces	*Pimephales promelas*	289 [a]

Notes to Table 24
[a] Geometric mean of 190 and 440 µg/L for the most sensitive endpoint (wet weight).

The only available valid chronic study with marine species is a flow-through ELS study with the marine fish *Cyprinidon variegatus* (Ward et al., 1981) (Table 25).

Table 25: Selected chronic toxicity data of acenaphthene to marine species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Pisces	*Cyprinodon variegatus*	610

The algae species *Pseudokirchneriella subcapitata* is the most sensitive species tested, and although the EC50 for this species is missing, it will most likely also be the species with the lowest EC50 (see discussion above). Hence, an assessment factor of 10 can be applied to the lowest NOEC or EC10. The $MPC_{eco, water}$ then becomes 3.8 µg/L. No additional chronic toxicity data for typically marine species are available. Therefore, an assessment factor of 100 will be applied to the lowest NOEC or EC10 to derive the $MPC_{eco, marine}$. This $MPC_{eco, marine}$ thus is 0.38 µg/L. The $SRC_{eco, water}$ is derived from the geometric mean of the chronic toxicity data, which is 100 µg/L.

3.3.3 Sediment

The marine crustacean *Rhepoxynius abronius* is the only benthic species tested with acenaphthene (Swartz et al., 1997; Boese et al., 1998). In this case reburial was not strongly influenced by irradiation with UV. This is similar to the results obtained for naphthalene and phenanthrene but different from the results for fluoranthene and pyrene, for which a significant photoactivation by UV radiation was found (Boese et al., 1997).
The lowest endpoint, is therefore the EC10 for mortality, derived from the data presented by Swartz et al. (1997).

Table 26: Selected chronic toxicity data of acenaphthene to benthic species

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard\ sediment}$]***
Crustacea	*Rhepoxynius abronius*	97 [a]

Notes to Table 26
[a] Geometric mean of 95 and 99 mg/kg$_{dw,\ standard\ sed}$, recalculated to standard sediment with 10% organic matter.

One chronic toxicity study is available for benthic species. In this case, the MPC for freshwater sediment will be derived with an assessment factor of 100. After application of this factor, the $MPC_{eco,\ sediment}$ becomes 0.97 mg/kg$_{dw}$.
For marine sediment an assessment factor of 1000 should be applied. The $MPC_{eco,\ marine\ sediment}$ therefore is 0.097 mg/kg$_{dw}$.
The $SRC_{eco,sediment}$ is derived by comparing the value of the NOEC for the benthic species with a value derived by equilibrium partitioning. The value derived by equilibrium partitioning is 31 mg/kg$_{dw}$ and consequently, the $SRC_{eco,\ sediment}$ is 31 mg/kg$_{dw}$.

3.3.4 Soil

Two studies with terrestrial species are available for acenaphthene. The first study is a 14-d study for germination and shoot growth of *Lactuca sativa* (Hulzebos et al., 1993) The EC50 for acenaphthene is 139 mg/kg$_{dw}$, recalculated to a soil with 10% organic matter. No dose-response data or NOEC or EC10 are given in the publication. However, in an unpublished underlying report the NOEC is stated to be 5.6 mg/kg$_{dw}$ recalculated to a soil with 10% organic matter. However, the concentrations of acenaphthene were not experimentally determined. Given the highly volatile character of the substance in combination with the analytical results for naphthalene showing less than 50% recovery at the start of the test under the same conditions (Adema and Henzen, 1990), this study sould be considered as invalid.
The EC10 from a 21-d reproduction study with *Folsomia fimetaria* (Sverdrup et al., 2002) was 68 mg/kg$_{dw}$, recalculated to a soil with 10% organic matter. The concentrations in the original study are expressed as initial measured concentrations, but the concentrations were recalculated to time weighted average concentrations to take the loss of the substance during the 28-d exposure period into account.
Valid chronic toxicity data (Table 27) are available for springtails only. Therefore, an assessment factor of 100 can be applied to the lowest NOEC or EC10. This value has to be compared with a value derived by equilbibrium partitioning. The value derived by equilibrium partitioning is 1.15 mg/kg$_{dw}$. Therefore, the $MPC_{eco,\ soil}$ is 0.68 mg/kg$_{dw}$.

Table 27: Selected chronic toxicity data of acenaphtene to terrestrial species and processes

Taxon	*Species*	*NOEC/EC10 [mg/kg$_{standard\ soil}$]*
Insecta	*Folsomia fimetaria*	68

Similar to the $SRC_{eco,sediment}$, $SRC_{eco,soil}$ is derived by comparing the value of the NOEC for the terrestrial species with a value derived by equilibrium partitioning. The value derived by equilibrium partitioning is 31 mg/kg_{dw} and consequently, the $SRC_{eco,\ soil}$ is 31 mg/kg_{dw}.

3.4 Fluorene

3.4.1 Substance identification and physicochemical properties

3.4.1.1 Identity

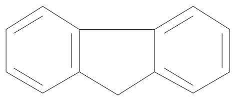

Figure 6: Structural formula of fluorene

Table 28: Identification of fluorene

Parameter	*Value*
Common/trivial/other name	Fluorene, 2,3-benzindene, diphenylenemethane, 9H-fluorene
Chemical name	diphenylenemethane
CAS number	86-73-7
EC number	201-695-5
SMILES code	c12ccccc1c3ccccc3C1

3.4.1.2 Physicochemical properties

Table 29: Physicochemical properties of fluorene

Parameter	*Unit*	*Value*	*Remark*
Molecular weight	[g/mol]	166.2	
Water solubility	[µg/L]	1880	Geometric mean of five values by the generator-column method
log K_{OW}	[-]	4.18	Two values by the shake-flask method
log K_{OC}	[-]	3.97	QSAR
Vapour pressure	[Pa]	0.084	Geometric mean of two values by the gas saturation method
Melting point	[°C]	114.8	
Boiling point	[°C]	295	
Henry’s law constant	[Pa.m^3/mol]	8.7	Geometric mean of six values by the gas/ batch stripping method and one by the wetted-wall method

3.4.2 Water

Reliable acute toxicity data for fluorene to freshwater species are available for crustaceans, an insect species and fish (Table 30). No EC50 for algae is available. However, an EC10 for algae is reported from which it appears that algae are not very sensitive in this case (Bisson et al., 2000). For the marine environment selected data are available for an annelid and a bacterium species and two crustaceans (Table 31). There are no significant differences between the freshwater and marine species (F-test 0.58, t-test 0.17). Therefore, data can be combined.

Table 30: Selected acute toxicity data of fluorene to freshwater species

Taxon	Species	LC50 or EC50 [µg/L]
Crustacea	*Daphnia magna*	339 [a]
Crustacea	*Gammarus pseudolimnaeus*	346
Insecta	*Chironomus riparius*	1539
Pisces	*Lepomis macrochirus*	525
Pisces	*Oncorhynchus mykiss*	473

Notes to Table 30
[a] Geometric mean of 408 and 282 µg/L.

Table 31: Selected acute toxicity data of fluorene to marine species

Taxon	Species	LC50 or EC50 [µg/L]
Annelida	*Neanthes arenaceodentata*	1000
Bacteria	*Vibrio fischeri*	756 [a]
Crustacea	*Oithona davisae*	1660 [b]
Crustacea	*Palaemonetes pugio*	616

Notes to Table 31
[a] Standard exposure time (15 min).
[b] Most sensitive endpoint (immobility).

The most sensitive species is *Daphnia magna*. The $MAC_{eco, water}$ is based on this value. Normally an assessment factor of 100 is applied to this value. However, the presumed mode of toxic action of fluorene in ecotoxicity studies is narcosis, at least in acute test. Furter, there are valid acute toxicity data for 9 species and the interspecies variation is low, i.e. all values are within a factor of 5. Therefore, an assessment factor of 10 seems to be justified. The $MAC_{eco, water}$ is 34 µg/L. Because the data set does contain an additional marine species, which is the annelid *Neanthes arenaceodentata*, an extra assessment factor of 5 is sufficient for the marine environment. The $MAC_{eco, marine}$ is thus 6.8 µg/L. Selected chronic toxicity data are available for an algal, three crustaceans, an insect and a fish species (Table 32). Additional data for marine species are available for the echinoderm *Paracentrotus lividus* (Table 33).

Table 32: Selected chronic toxicity data of fluorene to freshwater species

Taxon	Species	NOEC or EC10 [µg/L]
Algae	*Pseudokirchneriella subcapitata*	820
Crustacea	*Ceriodaphnia dubia*	25
Crustacea	*Daphnia magna*	15
Crustacea	*Hyalella azteca*	327
Insecta	*Chironomus riparius*	142
Pisces	*Lepomis macrochirus*	42 [a]

Notes to Table 32
[a] Most sensitive endpoint (growth).

Table 33: Selected chronic toxicity data of fluorene to marine species

Taxon	Species	NOEC or EC10 [µg/L]
Echinodermata	*Paracentrotus lividus*	492 [a]

Notes to Table 33
[a] Under both dark and light conditions.

The lowest value is for *Daphnia magna*, which is the same species that had the lowest acute value. The $MPC_{eco, water}$ is derived by applying an assessment factor of 10 to the lowest chronic value. The resulting $MPC_{eco,\ water}$ is 1.5 µg/L. Because there is one chronic value for an additional marine species, the assessment factor for the $MPC_{eco,\ marine}$ is 50. This results in an $MPC_{eco,\ marine}$ of 0.30 µg/L. The $SRC_{eco,\ water}$ is calculated as the geometric mean of the chronic data and is 117 µg/L.

3.4.3 Sediment

No data for benthic organisms are available. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ sediment}$ is 0.83 $mg/kg_{dw,\ standard\ sed}$. For the marine environment, this number is a factor of 5 lower. The $MPC_{eco,\ marine\ sediment}$ is 0.17 $mg/kg_{dw,\ standard\ sed}$. The $SRC_{eco,\ sediment}$ is 64 $mg/kg_{dw,\ standard\ sed}$.

3.4.4 Soil

Apart from acute toxicity to four species of earthworms (Neuhauser et al., 1986a), selected chronic toxicity data are available for seven terrestrial species and for nitrification (Table 34). The species include two annelids, an isopod, a springtail and four plant species.

Table 34: Selected chronic toxicity data of fluorene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [$mg/kg_{standard\ soil}$]***
Annelida	*Eisenia veneta*	114
Annelida	*Enchytraeus crypticus*	92
Crustacea	*Oniscus asellus*	23 [a]
Insecta	*Folsomia fimetaria*	16 [b]
Macrophyta	*Lolium perenne*	817 [c]
Macrophyta	*Sinapsis alba*	115 [c]
Macrophyta	*Trifolium pratense*	67 [c]
Microbial process	nitrification	121

Notes to Table 34
[a] Most sensitive endpoint (growth of females) corrected for time weighted average concentrations; NOECs much lower, EC10 is preferred.
[b] Most sensitive endpoint (reproduction) corrected for time weighted average concentrations.
[c] Most sensitive endpoint (fresh weight).

Fluorene is a substance that disappears rather quickly from the test system. In a test with the isopods *Oniscus asellus* and *Porcellia scaber*, only 20% of the initial concentration was left in food substrate consisting of poplar leaves enriched with dog food after 6 days of exposure (Van Brummelen et al., 1996). In a test with the springtail *Folsomia fimetaria* the concentrations at the end of the 21-d experiment were 31 to 35% of the actual initial concentrations (Sverdrup et al., 2001). In a test with the snail *Helix aspersa* the concentrations at the end of the 28-d experiment were only 16% of the actual initial concentrations (Sverdrup et al., 2006).
Time-weighted average concentrations for these studies were 46% over 28 days (Sverdrup et al., 2006), 58% over 21 days (Sverdrup et al., 2001) and 57% over 1 week (Van Brummelen et al., 1996). Because of the rapid disappearance of fluorene in some studies, time-weighted average concentrations are preferred to base the effect concentration upon. Studies that have only measured initial concentrations and especially studies, in which concentrations have not been verified should be used with caution.

The lowest value for fluorene is the EC10 for reproduction of *Folsomia fimetaria*. An assessment factor of 10 is applied to this value to derive the $MPC_{eco,\ soil}$ of 1.6 mg/kg_{dw}. The $SRC_{eco,\ soil}$ is calculated as the geometric mean of the chronic terrestrial toxicity data for the 7 species and is 82 mg/kg_{dw}.

3.5 Phenanthrene

3.5.1 Substance identification and physicochemical properties

3.5.1.1 Identity

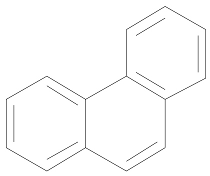

Figure 7: Structural formula of phenanthrene

Table 35: Identification of phenanthrene

Parameter	***Value***
Common/trivial/other name	Phenanthrene, o-diphenyleneethylene
Chemical name	Phenanthrene
CAS number	85-01-8
EC number	201-581-5
SMILES code	c12ccccc1c3ccccc3cc2

3.5.1.2 Physicochemical properties

Table 36: Physicochemical properties of phenanthrene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	178.23	
Water solubility	[μg/L]	1034	Geometric mean of seven values by the generator-column method
log K_{OW}	[-]	4.502	Geometric mean of three values by the slow-stirring method
log K_{OC}	[-]	4.292	QSAR
Vapour pressure	[Pa]	0.018	Geometric mean of five values by the gas saturation method
Melting point	[°C]	99.2	
Boiling point	[°C]	340	
Henry's law constant	[Pa.m^3/mol]	3.8	Geometric mean of seven values by the gas stripping method, one by the headspace method and one by the wetted-wall method

3.5.2 Water

Many acute toxicity data for phenanthrene are available. A strict selection has been performed on the available data, because phenanthrene concentrations are not stable in aquatic test systems. The selected acute toxicity data for freshwater species are listed in Table 37.
Selected toxicity data for marine species are shown in Table 38. In a toxicity experiment with three marine European crustaceans low LC50s were observed. The LC50 for *Corophium multisetosum*, *Gammarus aequicauda*, and *Gammarus locusta* were 215, 174, and 148 μg/L, respectively (Sanz-Lazaro et al., 2008). It is noteworthy that although these values are based on nominal concentrations,

the values are lower than for the selected values in Table 38 for other marine crustaceans.

Table 37: Selected acute toxicity data of phenanthrene to freshwater species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Algae	*Nitzschia palea*	870
Algae	*Pseudokirchneriella subcapitata*	233 [a]
Algae	*Scenedesmus vacuolatus*	590
Crustacea	*Daphnia magna*	700
Crustacea	*Daphnia pulex*	100
Crustacea	*Diporeia* spp.	74 [b]
Crustacea	*Gammarus minus*	460
Cyanophyta	*Anabaena flos-aqua*	1300
Insecta	*Chironomus riparius*	41 [c]

Notes to Table 37
[a] Geometric mean of 180 and 302 µg/L for the growth rate (most relevant parameter) under optimal growth conditions (2 d, pH restricted to 7.0-7.3).
[b] Longest exposure time of 5 d.
[c] Most sensitive life-stage (1st instar) illuminated with a mercury light source 330-800 nm, including some UV-A.

Table 38: Selected acute toxicity data of phenanthrene to marine species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Annelida	*Neanthes arenaceodentata*	187
Bacteria	*Vibrio fischeri*	310 [a]
Crustacea	*Acartia tonsa*	422
Crustacea	*Artemia salina*	520
Crustacea	*Oithona davisae*	522 [b]
Crustacea	*Palaemonetes pugio*	360
Mollusca	*Mytilus edulis*	148

Notes to Table 38
[a] Geometric mean of 530, 530, 510, 520, 144, 142, and 182 µg/L for standard exposure time (15 min).
[b] Most sensitive endpoint (mortality).

There are no reliable acute toxicity studies with fish. There is one 96-h toxicity test with fry of rainbow trout (*Oncorhynchus mykiss*) tested in freshwater under static conditions (Edsall, 1991), and one 96-h toxicity test with the marine fish sheepshead minnow (*Cyprinodon variegatus*) with renewal of the solution every 24 hours (Moreau et al., 1999). Concentrations were not verified in these studies. The LC50s based on nominal concentrations were 3200 µg/L for rainbow trout and 478 µg/L for sheepshead minnow.
There are no reliable toxicity data for aquatic plants. In toxicity tests with duckweed (*Lemna gibba*) EC50s based on nominal concentrations were all far above the solubility limit of 1034 µg/L (Huang et al., 1993; Huang et al., 1995; McConkey et al., 1997).
There is no significant difference between the freshwater and marine acute toxicity data, although the variance in the freshwater data is larger than in the marine data (F-test 0.05, t-test 0.86). However, this is likely due to the inclusion of other taxonomic groups. Therefore, the datasets can be combined. There are no reliable toxicity data for fish or other vertebrates and for aquatic plants. However, from two fish species tested and one aquatic plant, these groups do not appear particularly sensitive. Therefore, the $MAC_{eco, water}$ and the

$MAC_{eco, marine}$ can be derived from a species sensitivity distribution (Figure 8). The HC5 of the acute toxicity data is 67 µg/L, which is above the lowest value of 41 µg/L for *Chironomus riparius*. The HC50 is 307 µg/L. The goodness-of-fit is accepted at all significance levels. The $MAC_{eco, water}$ is derived from the HC5(acute), default by applying an assessment factor of 10. The number of toxicity data and the taxonomic diversity is high and the differences in species sensitivity are low, which is characteristic of narcotic effects. The $MAC_{eco, water}$ should be protective of any acute effects. However, the values used in the SSD are 50% effective concentration. Therefore, an assessment is made between the 50% and 10% effective concentrations (EC50 and EC10). A direct comparison can be made for 8 species from 4 taxonomic groups (Table 39). The ratio between the EC50 and EC10 varies widely. Moreover, such data have not been generated for the most sensitive taxonomic group, which are the insects. Therefore, an assessment factor of 10 is applied to the HC5(acute) to derive the $MAC_{eco, water}$. The $MAC_{eco, water}$ is thus 6.7 µg/L. Because of the number of marine data, including non standard species such as annelids and molluscs, an extra assessment factor for the $MAC_{eco, marine}$ is not necessary. The $MAC_{eco, marine}$ is 6.7 µg/L too.

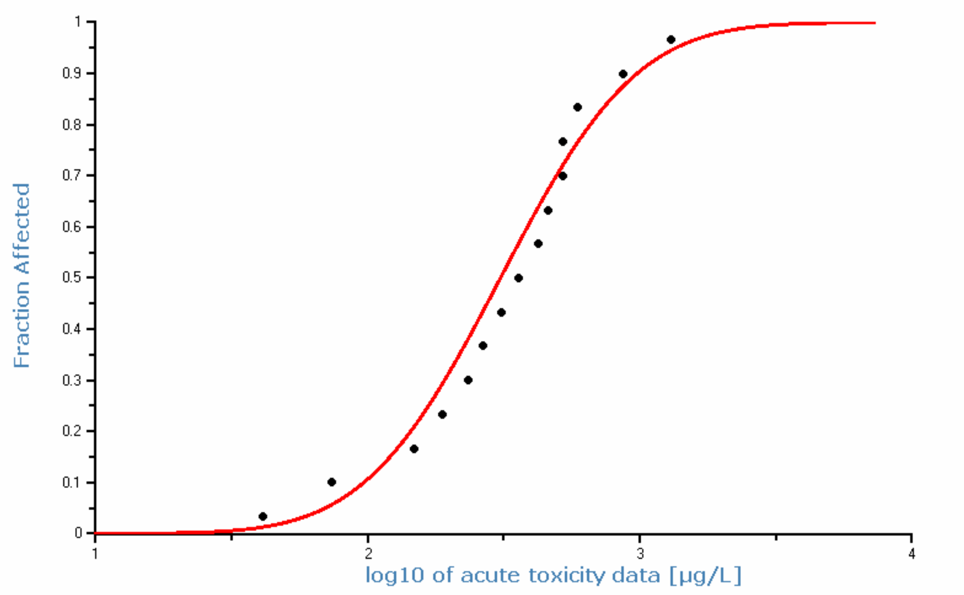

Figure 8: Species sensitivity distribution for the acute toxicity of phenanthrene to freshwater and marine species

Selected chronic toxicity data for freshwater species are shown in Table 40. Insects, which were the most sensitive species tested in acute toxicity tests, are not among the selected data. For the two most sensitive species tested in acute tests some data are available. In a 28-d sediment test with *Chironomus riparius* overlying water concentrations were also measured (Bleeker et al., 2003). The LOEC for emergence was 43 µg/L, which is above most of the NOECs or EC10s in Table 40. Survival and immobility of *Diporeia* species was also tested in a 10-d and 28-d test (Landrum et al., 2003). The 10-d EC50 for immobility was 38 µg/L, while the 10-d and 28-d LC50 were 168 and 95 µg/L, respectively.

Although the latter values for lethality and immobility might be rather insensitive, these results are higher then most NOECs or EC10s in Table 40.

Table 39: Acute no effect levels (10% cut-off by means of EC10) versus 50% effect levels (EC50) for phenanthrene

Taxon	***Species***	***EC50/EC10 or LC50/LC10***
Algae	*Pseudokirchneriella subcapitata*	6.5-18
Algae	*Scenedesmus vacuolatus*	3.9
Bacteria	*Vibrio fischeri*	3.7-24
Crustacea	*Daphnia magna*	1.3-2.6
Crustacea	*Daphnia pulex*	2.5
Crustacea	*Acartia tonsa*	1.3
Crustacea	*Oithona davisae*	2.1-2.7
Cyanophyta	*Anabaena flos-aqua*	2.5

Table 40: Selected chronic toxicity data of phenanthrene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Nitzschia palea*	870
Algae	*Pseudokirchneriella subcapitata*	15 [a]
Algae	*Scenedesmus vacuolatus*	150
Crustacea	*Ceriodaphnia dubia*	13
Crustacea	*Daphnia magna*	18 [b]
Crustacea	*Daphnia pulex*	13 [c]
Crustacea	*Hyalella azteca*	155
Pisces	*Danio rerio*	14 [d]
Pisces	*Micropterus salmoides*	11
Pisces	*Oncorhynchus mykiss*	23 [d]
Pisces	*Oryzias latipes*	93 [e]

Notes to Table 40

[a] Geometric mean of 10 and 24 µg/L for the growth rate (most relevant parameter) under optimal growth conditions (2 d, pH restricted to 7.0-7.3).

[b] Most sensitive parameter (reproduction) determined under most reliable exposure regime (intermittent flow).

[c] Most sensitive parameter (reproduction).

[d] Most sensitive parameter (weight).

[e] Most sensitive parameter (malformations).

Selected chronic toxicity data for marine species are shown in Table 41. The selected marine data are statistically higher than the freshwater data (F-test 0.67, t-test 0.04). This is most likely due to the fact that the taxonomic groups echinoderms and tunicates are not particularly sensitive. Therefore, both sets of data are still combined.
Because acute and chronic toxicity data are available for algae, *Daphnia*, and fish, an assessment factor can be applied to the lowest NOEC or EC10. This is the EC10 of 11 µg/L for *Micropterus salmoides*. The resulting $MPC_{eco,\ water}$ is 1.1 µg/L. Because chronic data are available for additional taxonomic groups for the marine environment, the same assessment factor can be applied for the $MPC_{eco,\ marine}$, which is 1.0 µg/L too. The $SRC_{eco,\ water}$ is equal to the geometric mean of the chronic toxicity data and is 43 µg/L.

Table 41: Selected chronic toxicity data of phenanthrene to marine species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Crustacea	*Acartia tonsa*	69 [a]
Echinodermata	*Arbacia punctulata*	164
Echinodermata	*Paracentrotus lividus*	105 [b]
Mollusca	*Mytilus galloprovincialis*	29 [c]
Tunicata	*Ciona intestinalis*	262 [b]

Notes to Table 41
[a] Most sensitive parameter (recruitment) determined under most reliable exposure regime (intermittent flow).
[b] Determined with a photoperiod 14:10 h light:dark by cool daylight lamps (380-780 nm, PAR) with an intensity of 70 µE/m^2/s.
[c] Determined in the dark.

3.5.3 Sediment

Selected toxicity data for benthic organisms are shown in Table 42, recalculated to standard sediment with 10% organic matter. The crustaceans *Rhepoxynius abronius* and *Schizopera knabeni* are marine species while the annelid *Limnodrilus hoffmeisteri* inhabits mostly brackish sediments. The rest of the species live in freshwater sediments.

Table 42: Selected chronic toxicity data of phenanthrene to benthic species

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard\ sediment}$]***
Annelida	*Limnodrilus hoffmeisteri*	168 [a]
Annelida	*Lumbriculus variegatus*	26
Crustacea	*Hyalella azteca*	167 [b]
Crustacea	*Rhepoxynius abronius*	122 [c]
Crustacea	*Schizopera knabeni*	7.8 [d]
Insecta	*Chironomus riparius*	91 [e]

Notes to Table 42
[a] Most sensitive parameter (sediment egestion).
[b] Geometric mean of 339, 113, and 122 mg/kg$_{dw,\ standard\ sed}$, recalculated to standard sediment with 10% organic matter, for the most sensitive parameter (length).
[c] Geometric mean of 125 and 120 mg/kg$_{dw,\ standard\ sed}$, recalculated to standard sediment with 10% organic matter.
[d] Most sensitive parameter (reproduction).
[e] Geometric mean of 84, 114, and 79 mg/kg$_{dw,\ standard\ sed}$, recalculated to standard sediment with 10% organic matter for the parameter emergence/mortality in a 28-d study.

With 6 chronic data from 3 taxonomic groups equally distributed over freshwater and marine species, a minimum assessment factor of 10 can be applied to derive the MPC$_{eco,\ sediment}$ and MPC$_{eco,\ marine\ sediment}$. The resulting value is 0.78 mg/kg$_{standard\ sediment}$. The SRC$_{eco,\ sediment}$ is derived from the geometric mean of these benthic data and is 63 mg/kg$_{standard\ sediment}$.

3.5.4 Soil

Also for phenanthrene concentrations in soil rapidly diminish. The recovery after the 21-d exposure period in a test with the earthworm *Eisenia fetida* was only 2.0-12% of the initial concentrations (Bowmer et al., 1993). The concentrations at the end of a 28-d experiment with the pot worm *Enchytraeus crypticus* and the springtail *Folsomia candida* were 5 to 35% of the actual initial concentrations

(Bleeker et al., 2003; Droge et al., 2006). In a similar test with the springtail *Folsomia fimetaria* the concentrations at the end of the 21-d experiment were 65 to 78% of the actual initial concentrations (Sverdrup et al., 2001). In a test with the isopods *Oniscus asellus* and *Porcellia scaber*, only 2.9% of the initial concentration was left in food substrate consisting of poplar leaves enriched with dog food after 6 days of exposure (Van Brummelen et al., 1996). In a test with the snail *Helix aspersa* the concentrations at the end of the 28-d experiment were only 4% of the actual initial concentrations (Sverdrup et al., 2006). On the other hand, the recovery at the beginning and end of a week exposure in a study with the springtail *Folsomia candida*, where the soil was renewed every week, ranged from 84 to 115% (Bowmer et al., 1993).
Time-weighted average concentrations for these studies were 33% over 21 days (Bowmer et al., 1993), 52% over 28 days (Bleeker et al., 2003; Droge et al., 2006), 30% over 28 days (Sverdrup et al., 2006), 85% over 21 days (Sverdrup et al., 2001), 29% over 1 week (Van Brummelen et al., 1996) and almost 100% over 1 week (Bowmer et al., 1993). It appears that the rate of disappearance varies considerably between the studies. However, because of the rapid disappearance of phenanthrene in some studies, time-weighted average concentrations are preferred to base the effect concentration upon. Studies that have only measured initial concentrations and especially studies, in which concentrations have not been verified should be used with caution.
Chronic toxicity data for phenanthrene in soil are available for annelids, collembola, terrestrial plants, and microbial processes. The EC10 for reproduction of *Eisenia fetida* (Bowmer et al., 1993) is the lowest EC10 or NOEC. This value is almost equal to the geometric mean of 33 and 41 $mg/kg_{dw, standard soil}$ for the springtail *Folsomia candida*. Because chronic data are available for 8 species and 1 terrestrial process, covering all trophic levels, an assessment factor of 10 can be applied to derive the $MPC_{eco, soil}$. The $MPC_{eco, soil}$ is thus 3.6 $mg/kg_{dw, standard soil}$. The $SRC_{eco, soil}$ is derived from the geometric mean of the data for the 8 species and is 90 $mg/kg_{dw, standard soil}$.

Table 43: Selected chronic toxicity data of phenanthrene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard soil}$]***
Annelida	*Eisenia fetida*	36 [a]
Annelida	*Eisenia veneta*	92
Annelida	*Enchytraeus crypticus*	87 [b]
Insecta	*Folsomia candida*	37 [c]
Insecta	*Folsomia fimetaria*	72 [b]
Macrophyta	*Sinapsis alba*	98 [d]
Macrophyta	*Trifolium pretense*	88 [d]
Macrophyta	*Lolium perenne*	645 [d]
Microbial process	nitrification	154

Notes to Table 43
[a] Most sensitive endpoint (total offspring) derived from presented data based on time weighted average concentrations.
[b] Most sensitive endpoint (reproduction) corrected for time weighted average concentrations.
[c] Geometric mean of 33 and 41 mg/kg_{dw} for most sensitive endpoint (reproduction) corrected for time weighted average concentrations.
[d] Most sensitive endpoint (fresh weight).

3.6 Anthracene

3.6.1 Substance identification and physicochemical properties

3.6.1.1 Identity

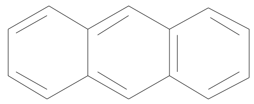

Figure 9: Structural formula of anthracene

Table 44: Identification of anthracene

Parameter	***Value***
Common/trivial/other name	Anthracene, paranaphthalene
Chemical name	Anthracene
CAS number	120-12-7
EC number	204-371-1
SMILES code	c12ccccc1cc3ccccc3c2

3.6.1.2 Physicochemical properties

Table 45: Physicochemical properties of anthracene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	178.23	
Water solubility	[µg/L]	47	Geometric mean of thirteen values by the generator-column method
log K_{OW}	[-]	4.68	Slow-stirring method
log K_{OC}	[-]	4.47	QSAR
Vapour pressure	[Pa]	0.0014	Geometric mean of nine values by the gas saturation method
Melting point	[°C]	215.8	
Boiling point	[°C]	340	
Henry's law constant	[Pa.m^3/mol]	5.0	Geometric mean of five values by the gas stripping method, one by the headspace method and one by the wetted-wall method

3.6.2 Water

Many acute toxicity data for anthracene are available. Anthracene appears to be extremely phototoxic. Most of the selected toxicity data for freshwater species (Table 46) are conducted under UV light. These acute effects are observed when organisms exposed to anthracene are irradiated by a source of ultraviolet radiation for a relatively short period of time (e.g. half an hour). The strongest effects are observed for natural sunlight.
The UV intensity of sunlight on a clear day was measured to be 4245 µW/cm^2 (Allred and Giesy, 1985), with 484 µW/cm^2 UV-B (Oris et al., 1984). In this study, adult *Daphnia pulex* were exposed to anthracene in the dark for 24 hours. Then they were exposed to full sunlight for half an hour. A dose-response relationship can not be easily determined, because there is only one exposure concentration that did not result in 100% effect. For exposure to full sunlight, the LC50 is estimated to be 1.0 µg/L. Exposure on a partly clouded day or a completely clouded day, or with various UV filters, yielded EC50s ranging from 5.1 to 20 µg/L. From the presented figures it can be concluded that all treatments with different UV intensities result in very steep dose-response relationships. If first the LC50 is estimated and exposure concentrations are

expressed as a ration of this LC50 for each light intensity, then a clear dose-response relationship can be derived (see Figure 10).

Table 46: Selected acute toxicity data of anthracene to freshwater species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Algae	*Pseudokirchneriella subcapitata*	3.9 [a]
Crustacea	*Daphnia pulex*	1.0 [b]
Insecta	*Aedes aegypti*	27 [c]
Insecta	*Chironomus riparius*	2.5 [d]
Mollusca	*Utterbackia imbecilis*	1.9 [e]
Pisces	*Lepomis macrochirus*	1.3 [f]

Notes to Table 46

[a] Most relevant parameter (growth rate), determined under constant lighting with 'white fluorescent bulbs' with a filter to eliminate UV-A+B (<390 nm) and UV-A produced by blacklights, with an intensity of 765 µW/cm^2; UV-B radiation was filtered from the blacklight spectrum. Algae were preincubated with anthracene for 12 hours in the dark.

[b] Incubated for 24 hours followed by 30 minutes irradiation with natural sunlight on a clear day with a UV intensity of 4245 µW/cm^2.

[c] 24 hours exposure to anthracene in the dark, followed by 24 hours exposure under UV light regime from simulated sunlight with an UV-B intensity of 150 µW/cm^2.

[d] Illuminated with mercury light source 330-800 nm, including some UV-A.

[e] 4 hours exposure under ambient laboratory lighting (UV-A <2 µW/cm^2) followed by 24 hours exposure with UV-A (320-400 nm) with an intensity of 70.0±0.5 µW/cm^2.

[f] 24 hours exposure to anthracene in the dark followed constant illumination with UV-A+B and visible light, spectrum 91% equal to natural sunlight; UV-A and UV-B intensities are 108 and 6.7 µW/cm^2; total intensity approximately equal to 0.5 and 1 m depth in an eutrophic lake.

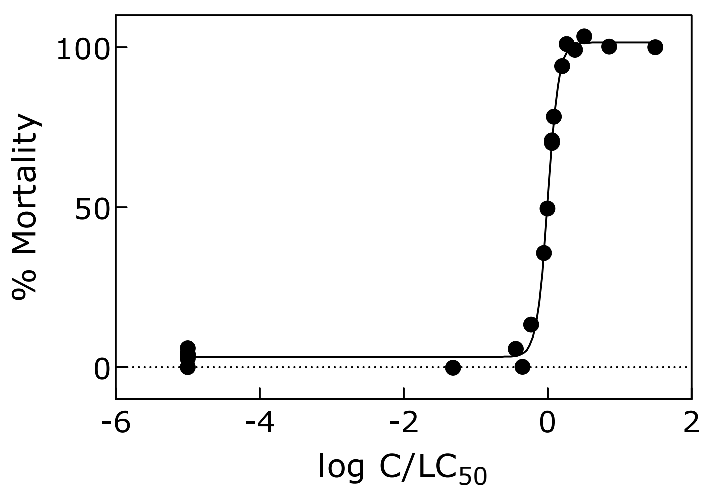

Figure 10: Dose-response curve for D. pulex exposed to anthracene (24 hours) and natural sunlight (½ hour), successively (Allred & Giesy, 1985)

The importance of exposure to UV light is illustrated by the data for *Daphnia magna* as well. The lowest acute value for immobility of *Daphnia magna* is the EC50 of 11 µg/L after exposure for 48 hours with a 16:8 light:dark photoperiod

with visible, UV-A (320-400 nm) and UV-B (290-320 nm) with an intensities of 61, 4.4, and 0.45 µmol/m^2/s. At similar intensities without the UV-B component, the EC50 was 20 µg/L (Lampi et al., 2006). However, in this study with *Daphnia magna* the concentrations were not verified. In another study with *Daphnia magna* under normal laboratory lighting, concentrations were verified, but the EC50 was higher than the highest tested concentration of 25 µg/L (Bisson et al., 2000).
The reported 24-h LC50 for 3rd-4th instar larvae of the midge *Aedes aegypti*, with 6 hours of exposure in the sunlight, was even lower than 1 µg/L (Borovsky et al., 1987). However, the exposure concentrations were not measured, which renders the study less reliable. Further, in the same study the closely related species *Aedes taeniorhynchus* showed a much higher LC50, which is far above the solubility limit. Under simulated sunlight a reliable study with *Aedes aegypti* resulted in an LC50 of 27 µg/L (Table 46), although the UV intensity is less than under full sunlight.
Also for marine species the most severe effects are observed under UV light (Table 47). The few marine species have a comparable sensitivity (F-test 0.28, t-test 0.19).

Table 47: Selected acute toxicity data of anthracene to marine species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Crustacea	*Mysidopsis bahia*	3.6 [a]
Mollusca	*Mulinea lateralis*	69 [a]

Notes to Table 47
[a] Test performed under ultraviolet light with 397±35.1 µW/cm^2 UV-A (365±36 nm) and 134±22.8 µW/cm^2 UV-B (310±34 nm) with a photoperiod of 16:8 hours light:dark.

Anthracene is very phototoxic and toxic effects (LC50s) are observed at concentrations lower or equal to the lowest chronic effect concentrations. Ultraviolet radiation in the most sensitive chronic toxicity studies was less harsh (Table 48). A clear effect of the phototoxicity of anthracene can be observed for the algae species *Pseudokirchneriella subcapitata*. Algae exposed under UV light yielded an EC10 for growth rate of 1.5 of µg/L (Gala and Giesy, 1992), while the same species had an EC10s for growth rate of 7.8 µg/L under normal laboratory lighting (Bisson et al., 2000), or low UV intensity (Gala and Giesy, 1992).
There are no selected chronic data for marine species. In two 48-h studies with fertilized eggs of the echinoderm *Psammechinus miliaris* and the mollusc *Crassostrea gigas* the development of the larvae was examined (AquaSense, 2005). No effects were observed for tested concentrations up to 2.8 µg/L. This value is far below the aqueous solubility but higher than the lowest effect levels. In a similar study with embryos of the mollusc *Mulinea lateralis* the EC50 for development was higher than 6.5 µg/L, under ultraviolet light with 397±35.1 µW/cm^2 UV-A (365±36 nm) and 134±22.8 µW/cm^2 UV-B (310±34 nm) with a photoperiod of 16:8 hours light:dark.
Because acute and chronic toxicity data are available for algae, *Daphnia*, and fish, an assessment factor of 10 could in principle be applied. However, the lowest reliable value is the EC50 for phototoxicity to *Daphnia pulex*. Therefore, the $MPC_{eco, water}$ is based on this value and becomes 0.1 µg/L. Because of the steepness of the dose-response relationship, it is still considered appropriate to apply an assessment factor of 10, although the EC50 is an effect level and not a NOEC.

Table 48: Selected chronic toxicity data of anthracene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Pseudokirchneriella subcapitata*	1.5 [a]
Algae	*Scenedesmus vacuolatus*	16
Crustacea	*Daphnia magna*	1.9 [b]
Pisces	*Pimephales promelas*	6.7 [c]

Notes to Table 48

[a] Most relevant parameter (growth rate), determined under constant lighting with 'white fluorescent bulbs' with a filter to eliminate UV-A+B (<390 nm) and UV-A produced by blacklights, with an intensity of 765 µW/cm^2; UV-B radiation was filtered from the blacklight spectrum. Algae were preincubated with anthracene for 12 hours in the dark.

[b] Most sensitive parameter (reproduction) determined under UV radiation with an intensity of 117 µW/cm^2 and a ratio UV-A:UV-B of 8:1, and visible light by 'white fluorescent lamps' with a light regime of 16 hours light and 8 hours dark.

[c] Most sensitive parameter (hatching) determined under UV radiation with an intensity of 67.94±9.02 µW/cm^2 at 365±36 nm (UV-A) and 6.71±0.81 µW/cm^2 at 310±34 nm (UV-B), and fluorescent light with a light regime of 16 hours light and 8 hours dark.

Because chronic (limited tests, see above) and acute data are available for additional taxonomic of marine species, the $MPC_{eco,\ marine}$ is the same. Because acute toxic effects are the most sensitive effects, the $MAC_{eco,\ water}$ and $MAC_{eco,\ marine}$ are the same as well. The $SRC_{eco,\ water}$ is equal to the geometric mean of the chronic toxicity data and is 4.2 µg/L, which is in its turn only slightly lower than the geometric mean of the acute toxicity data.

3.6.3 Sediment

Selected toxicity data for benthic organisms are shown in Table 42, recalculated to standard sediment with 10% organic matter. Besides these two chronic values there is one 10-d LC50 for *Hyalella azteca* of 50 $mg/kg_{dw,\ standard\ sed}$, recalculated to standard sediment with 10% organic matter (Hatch and Burton Jr., 1999).

Table 49: Selected chronic toxicity data of anthracene to benthic species

Taxon	***Species***	***NOEC/EC10 [$mg/kg_{standard\ sediment}$]***
Annelida	*Lumbriculus variegatus*	2.3
Insecta	*Chironomus riparius*	4.3 [a]

Notes to Table 42

[a] Most sensitive parameter (mortality/emergence).

With two chronic data from two taxonomic groups, an assessment factor of 50 can be applied to derive the $MPC_{eco,\ sediment}$ and $MPC_{eco,\ marine\ sediment}$. The resulting value is 0.047 $mg/kg_{standard\ sediment}$. No data are available for marine organisms, and therefore an extra factor of 10 has to be applied. The $MPC_{eco,\ marine\ sediment}$ is 0.0047 $mg/kg_{standard\ sediment}$. $SRC_{eco,\ sediment}$ is derived from the geometric mean of these chronic benthic data and is 3.2 $mg/kg_{standard\ sediment}$.

3.6.4 Soil

Many toxicity data with terrestrial species are available for anthracene. From several studies, it appears that anthracene concentrations are rather stable in the used test systems (Bleeker et al., 2003; Droge et al., 2006; Sverdrup et al.,

2002). Because nominal concentrations are retrieved in the test systems, this improves the reliability of the data in general.
Chronic toxicity data for anthracene in soil are available for annelids, collembola, terrestrial plants, and microbial processes. Only a few studies resulted in useful NOEC or EC10 values (Table 50). The lowest endpoint is for reproduction of *Folsomia fimetaria* (Sverdrup et al., 2002). A similar effect concentration for the related species *Folsomia candida* was not found (Bleeker et al., 2003; Droge et al., 2006). Effects were not observed in the highest tested concentration of 1739 $mg/kg_{dw, standard soil}$, recalculated to a standard soil with 10% organic matter. However, due to the very low solubility of anthracene, pore water concentrations are possibly already saturated at concentrations around 75 $mg/kg_{dw, standard soil}$. No effects were observed for the pot worm *Enchytraeus crypticus* as well (Bleeker et al., 2003; Droge et al., 2006).

Table 50: Selected chronic toxicity data of anthracene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard soil}$]***
Annelida	*Eisenia andrei*	210 [a]
Insecta	*Folsomia fimetaria*	17 [b]

Notes to Table 50
[a] Subchronic endpoint growth.
[b] Most sensitive endpoint (reproduction) corrected for time weighted average concentrations.

In most tests with terrestrial plants no effects on growth of seedlings are observed, i.e. for 4 species (Mitchell et al., 1988). Growth of seedlings of *Avena sativa* has a 14-d EC50 of 150 $mg/kg_{dw, standard soil}$ (Mitchell et al., 1988), while in another study no effect on the growth of the same species was found (Römbke et al., 1995; Römbke et al., 1994). Growth of seedlings of *Cucumis sativus* had a 14-d EC50 of 3600 $mg/kg_{dw, standard soil}$ (Mitchell et al., 1988). The NOEC for shoot and root growth of *Lolium perenne* exposed for 40 days (Leyval and Binet, 1998) appeared to be smaller than 392 $mg/kg_{dw, standard soil}$, all values recalculated to a soil with 10% organic carbon. The latter study (Leyval and Binet, 1998) was performed with moderate visible light (PAR 400-700 nm at 130 $\mu mol/m^2/s$). At the lowest concentration 22 to 41% reduction in growth was observed. From the presented data at the 3 tested concentrations a reliable EC10 could not be derived.
In the study by Mitchell et al., (1988), it can be deduced from the figure for percentage emergence of seeds that the LC10 for *Avena sativa* should be significantly lower than 500 $mg/kg_{dw, standard soil}$. For the more sensitive effect of growth only the EC50 is presented. From the figure for time of emergence it is obvious that for 4 out of 6 plant species the NOEC lies below 50 $mg/kg_{dw, standard soil}$ (Mitchell et al., 1988).
Results on dehydrogenase are the only available values for terrestrial processes. Altough no dose-response relationships are available it can be concluded that concentrations of 33 $mg/kg_{dw, standard soil}$, recalculated to a standard soil with 10% organic matter, may lead to 20-25% effect (Römbke et al., 1995).
In principle, an assessment factor of 10 could be applied to the lowest NOEC or EC10, because data are available for annelids, insects, plants (macrophyta), and processes. However, for several plant species the NOECs are lower than the lowest tested concentration. The effect concentrations from chronic studies with macrophyta are one order of magnitude or even less higher than the EC10 for *Folsomia fimetaria*. Because it can not be excluded that the NOEC or EC10 for some plant species is lower than that of *Folsomia fimetaria*, an assessment

factor of 50 instead of 10 will be applied to the lowest effect concentration of the two remaining trophic levels, which is the EC10 for *Folsomia fimetaria*. The $MPC_{eco,\ soil}$ then becomes 0.34 $mg/kg_{dw,\ standard\ soil}$. The $SRC_{eco,\ soil}$ is calculated from the geometric mean of the two selected data and is 60 $mg/kg_{dw,\ standard\ soil}$. NOECs for terrestrial plants might be below this value, while NOECs for invertebrates are mostly above this value. Therefore, the derived value seems to be a good representation of the HC50.

3.7 Pyrene

3.7.1 Substance identification and physicochemical properties

3.7.1.1 Identity

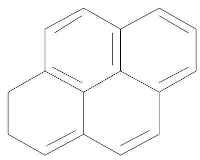

Figure 11: Structural formula of pyrene

Table 51: Identification of pyrene

Parameter	***Value***
Common/trivial/other name	Pyrene, benzo[*def*]phenanthrene
Chemical name	Pyrene
CAS number	129-00-0
EC number	204-927-3
SMILES code	c1ccc2ccc3cccc4ccc1c2c34

3.7.1.2 Physicochemical properties

Table 52: Physicochemical properties of pyrene.

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	202.25	
Water solubility	[μg/L]	124	Geometric mean of 5 values by generator-column method
Log K_{OW}	[-]	4.96	Average of 4 values by shake-flask method
Log K_{OC}	[-]	4.75	QSAR
Vapour pressure	[Pa]	$6.6 \cdot 10^{-4}$	Geometric mean of 2 values by gas saturation method
Melting point	[°C]	150.6	
Boiling point	[°C]	404	
Henry's law constant	[Pa.m^3/mol]	1.2	Geometric mean of 6 values by gas stripping method and 1 value by wetted-wall method

3.7.1.3 Water

Acute toxicity data for freshwater species tested with pyrene are available for algae, amphibians, crustaceans, cyanophytes, insects, plants, molluscs, and fish. However, only a few data can be considered as reliable, mostly because exposure concentrations were not verified or the solubility was exceeded in the test solutions. Also pyrene appears to be extremely phototoxic. This is not illustrated by all the data in Table 53, which are partly carried out under normal laboratory lighting.

Table 53: Selected acute toxicity data of pyrene to freshwater species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Algae	*Scenedesmus vacuolatus*	49
Crustacea	*Daphnia magna*	25
Insecta	*Chironomus riparius*	38 [a]
Mollusca	*Utterbackia imbecilis*	2.6 [b]

Notes to Table 53

[a] Test with UV filter which blocked most radiation (75±14%) below 400 nm, test under mercury light was less toxic.

[b] 4 hours exposure under ambient laboratory lighting (UV-A <2 µW/cm^2) followed by 24 hours exposure with UV-A (320-400 nm) with an intensity of 70.0±0.5 µW/cm^2.

The lowest value for *Daphnia magna* was observed after exposure of neonates for 24 hours with 16:8 hour light:dark, then at an UV intensity of 370±20 µW/cm^2 (295-365 nm; peak 340 nm) for 2 hours and 1 hour of recovery in the test medium. The EC50 for immobility was 1.38 µg/L (Wernersson, 2003). In a similar treatment (2 hours of recovery instead of 1, the EC50 for 4-d old daphnids was 5.7 µg/L (Wernersson and Dave, 1997). When exposed to UV-B radiation only (intensity 64 µW/cm^2) for 4 times 2 hours during 48 hours, the EC50 for immobility of neonates ranged from 1.8 to 20 µg/L at different hardness of the artificial test media and different concentrations of dissolved organic matter of natural waters (Nikkilä et al., 1999). The EC50s for *Daphnia magna* were 4.6 and 4.3 µg/L after exposure for 48 hours with a 16:8 light:dark photoperiod with visible, UV-A (320-400 nm) and UV-B (290-320 nm) light with intensities of 61, 4.4, and 0.45 µmol/m^2/s, respectively, and at similar intensities without the UV-B component, respectively (Lampi et al., 2006). In all these studies, no analysis of the compounds in water was performed. However, the EC50s are substantially lower than the EC50 determined under standard laboratory conditions (Bisson et al., 2000), which is presented in Table 53.
For the freshwater mollusc *Utterbackia imbecilis* the 24-h LC50 was 2.63 µg/L with UV-A radiation (320-400 nm) at an intensity of 70 µW/cm^2 (Weinstein and Polk, 2001). The reported concentrations were analytically verified as well. The same test under laboratory lighting resulted in an EC50 higher than 28 µg/L. These results illustrate the importance of phototoxicity for pyrene.
The only available data for fish are an unreliable LC50 of 220 µg/L for fathead minnows (*Pimephales promelas*) (Kagan et al., 1985) and a study with larvae of the same species, performed to determine the median lethal time (Oris and Giesy Jr., 1987). In the latter study, 7-d old larvae were exposed to a measured concentration of 25.6 µg/L pyrene for an incubation period of 24 hours in the absence of UV radiation and thereafter exposed for 96 hours to UV light with an intensity of 20 µW/cm^2 UV-B (290-336 nm) and 95 µW/cm^2 UV-A (336-400 nm). After the incubation time of 24 hours, the medium was renewed every 12 hours. The median lethal time was 3.2 hours, which means that much more than 50% mortality occurred in the test period of 120 hours and the LC50 would be far below this value.
Acute toxicity data for marine species are available for algae, annelids, bacteria, crustaceans, molluscs and cnidaria. The selected values are reported in Table 54. Also in this case, the lowest values are obtained in the presence of UV light (see notes to Table 54). The freshwater and marine acute toxicity data are not significantly different (F-test 0.76, t-test 0.33). Both data sets are therefore combined.

Table 54: Selected acute toxicity data of pyrene to marine species

Taxon	***Species***	***LC50 or EC50 [μg/L]***
Crustacea	*Acartia tonsa*	28 [a]
Crustacea	*Callinectes sapidus*	2.7 [b]
Crustacea	*Libinia dubia*	4.9 [b]
Crustacea	*Mysidopsis bahia*	0.89 [c]
Crustacea	*Oithona davisae*	107 [d]
Crustacea	*Panopeus herbstii*	11.4 [b]
Mollusca	*Mulinea lateralis*	1.68 [c]

Notes to Table 54

[a] Exposure under UV light with an intensity of 8 μW/cm^2 (UV-A) and 11.9 μW/cm^2 (UV-B).

[b] After exposure for 1 hour, transferred to filtered sea water with exposure to UV (UV-A (320-400 nm) 1979-2098 μW/cm^2 and UV-B (280-320 nm) 276-325 μW/cm^2) for 4 hours and 24 hours of recovery in filtered sea water for 24 hours in the dark.

[c] Test performed under ultraviolet light with 397±35.1 μW/cm^2 UV-A (365±36 nm) and 134±22.8 μW/cm^2 UV-B (310±34 nm) with a photoperiod of 16:8 hours light:dark.

[d] Most sensitive parameter (immobility).

When exposed for 2 hours in the dark followed by 1 hour with UV radiation (320-400 nm; peak 350 nm) at an intensity of 1300 μW/cm^2, the LC50 for nauplii of *Artemia salina* was 8 μg/L (Kagan et al., 1985; Kagan et al., 1987). When exposed for 2 hours in the dark followed by 8 hours with UV radiation (peak 312 nm) at an intensity of 975-1000 μW/cm^2, the LC50 for nauplii of *Artemia salina* was estimated from the presented figure to be 36 μg/L (Peachey and Crosby, 1996). The same treatment with sunlight (λ>290 nm) at an intensity of 407-1429 μW/cm^2 resulted in an EC50 of 3.4 μg/L (Peachey and Crosby, 1996). Although the reliability of these studies is limited, because concentrations were not verified, it could be concluded that the maximum intensity of the radiation is more important than the time of irradiation.
Of the crustaceans *Mysidopsis bahia* was the most sensitive species. Under ultraviolet light with an intensity of 397 μW/cm^2 UV-A and 134 μW/cm^2 UV-B with a photoperiod of 16:8 hours light:dark the LC50 was 0.89 μg/L. Under the same conditions, the LC50 for embryos-larvae of *Mulinea lateralis* was 0.23 μg/L, while the LC50 for juveniles of 1 to 1.5 mm of the same species was 1.68 μg/L (Pelletier et al., 1997). The embryo-larval assay is a rather chronic study, because it also takes the abnormalities in development of this sensitive life-stage into account.
In a very similar study, the shell development of embryos-larvae of the mollusc *Crassostrea gigas* was monitored after an exposure of 48 hours under UV light with an intensity of 456 μW/cm^2 UV-A and 6.3 μW/cm^2 UV-B with a photoperiod of 12:12 hours light:dark. The NOEC was 0.5 μg/L (Lyons et al., 2002) and the EC10 derived from the data 0.93 μg/L. Although the exposure time of this study is rather short (48 hours), the endpoint is a chronic one (shell development/malformation). Therefore, in the risk assessment this study can be considered as a chronic study. However, concentrations were not analytically verified.
For the $MAC_{eco,\ water}$ and $MAC_{eco,\ marine}$ the short-term LC50s are used. Although the endpoint of the embryo-larval assays is rather chronic, the exposure time is short. The EC50 of 0.23 μg/L for the mollusc *Mulinea lateralis* under UV enhanced conditions is the most sensitive acute endpoint. For pyrene the base set is not complete, because the studies with *Pimephales promelas* are limited.

The LC50 is below 25 µg/L, but this value is still amply above the LC50s for crustaceans and molluscs. Moreover, for other PAHs phototoxicity to these species appear to be the most sensitive endpoints as well. Therefore, an assessment factor of 10 is deemed sufficient for the derivation of the MAC_{eco}. Data are available for marine species such as molluscs and crabs. The $MAC_{eco, water}$ and $MAC_{eco, marine}$ thus are 0.023 µg/L.
Chronic toxicity data for freshwater species are available for algae, cyanophyta, crustaceans, insects, aquatic plants, and fish. The selected data are presented in Table 55, but these have not been generated in the presence of UV light. At 26 µg/L (measured concentration) slight toxic responses (malformations) were found for larvae of zebrafish (*Danio rerio*) towards the end of 48-h experiment (Petersen and Kristensen, 1998).

Table 55: Selected chronic toxicity data of pyrene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Pseudokirchneriella subcapitata*	1.2
Algae	*Scenedesmus vacuolatus*	21
Crustacea	*Ceriodaphnia dubia*	2.1
Crustacea	*Hyalella azteca*	26

For marine species, chronic data are available for bacteria, crustaceans, echinoderms, molluscs, fish, and tunicates. The selected data are presented in Table 56. Freshwater and marine chronic toxicity data are not significantly different (F-test 0.89, t-test 0.92). Both sets can therefore be combined.
For the tunicate *Ciona intestinalis*, no effects were observed up to the aqueous solubility, both under dark conditions and with a photoperiod 14:10 hours light:dark by cool daylight lamps (380-780nm, PAR) with an intensity of 70 $\mu E/m^2/s$ (Bellas et al., 2008). Slight toxic responses (malformations) were found towards the end of 48-h experiment as well at 24 and 47 µg/L for larvae the marine fish species herring (*Clupea harengus*) and Atlantic cod (*Gadus morhua*) (Petersen and Kristensen, 1998).

Table 56: Selected chronic toxicity data of pyrene to marine species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Crustacea	*Acartia tonsa*	1.7 [a]
Echinodermata	*Paracentrotus lividus*	23 [b]
Mollusca	*Mytilus galloprovincialis*	8.3 [b]
Taxon	***Species***	***LC50 or EC50 [µg/L]***
Mollusca	*Mulinea lateralis*	0.23 [c]

Notes to Table 56
[a] Exposure under UV light with an intensity of 8 $\mu W/cm^2$ (UV-A) and 11.9 $\mu W/cm^2$ (UV-B).
[b] Determined with a photoperiod 14:10 hours light:dark by cool daylight lamps (380-780nm, PAR) with an intensity of 70 $\mu E/m^2/s$.
[c] Test performed under ultraviolet light with 397±35.1 $\mu W/cm^2$ UV-A (365±36 nm) and 134±22.8 $\mu W/cm^2$ UV-B (310±34 nm) with a photoperiod of 16:8 hours light:dark.

The lowest NOEC or EC10 for freshwater species is the EC10 of 1.2 µg/L for *Pseudokirchneriella subcapitata*, a value which is also below the lowest acute LC50 for freshwater species. The marine and freshwater acute toxicity data for molluscs and crustaceans do not differ significantly. The lowest value for marine species is the EC50 of 0.23 µg/L under UV enhanced conditions for survival/

development of normal larvae of the clam *Mulinea lateralis*. No NOEC or EC10 is presented but in a very similar study on shell abnormalities of embryos-larvae of the Japanese oyster *Crassostrea gigas* it appears that the dose-response curve is very steep for this type of effect, similar to what is observed for other phototoxic effects.
Chronic data are available for many taxonomic groups including several additional groups for marine species. Although the tested fish species did not result in useful NOECs or EC10s, the slight effects are observed at concentrations that are well in excess of the NOEC and EC10s for crustaceans and molluscs. Also for other PAHs (anthracene, fluoranthene), this embryo-larval test belongs to the lowest values observed. Therefore, an assessment factor of 10 is considered sufficient. Because of the steepness of the dose-response relationship, it is still considered appropriate to apply an assessment factor of 10, although the EC50 is an effect level and not a NOEC. The $MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$ are then 0.023 µg/L. These values are equal to the $MAC_{eco,\ water}$ and $MAC_{eco,\ marine}$. The $SRC_{eco,\ water}$ is derived from the geometric mean of the chronic toxicity data including the EC50 value for *Mulinea lateralis*. The $SRC_{eco,\ water}$ is 4.2 µg/L.

3.7.2 Sediment

Toxicity studies with 2 freshwater oligochaetes are available. The lowest value for *Limnodrilus hoffmeisteri* is the EC10 from a 28-d reproduction study (Lotufo and Fleeger, 1996). However, this value was extrapolated from concentrations showing more than 40% effect. Therefore, the EC10 of 3.8 mg/kg_{dw} (32 $mg/kg_{dw,\ standard\ soil}$, recalculated to standard sediment with 10% organic matter) has a large uncertainty. Further, the reproduction falls rapidly with concentrations up to 210 mg/kg_{dw} (1770 $mg/kg_{dw,\ standard\ soil}$), but remains almost constant from 210 to 841 mg/kg_{dw} (1770-7070 $mg/kg_{dw,\ standard\ soil}$). It is plausible that the bioavailability of pyrene in the sediment is limited at the higher concentrations by the solubility in the pore water of sediment. Possibly, pore water concentrations are already saturated around 400 $mg/kg_{dw,\ standard\ soil}$. If the 2 highest concentrations are omitted from the determination of EC10, the resulting value of 26 mg/kg_{dw} (220 $mg/kg_{dw,\ standard\ soil}$) in standard sediment is much higher. Further, the reported EC25 values determined by bootstrapping, are not in accordance with the log-logistic fit by which the EC10 is derived. The EC25 values reported by Lotufo and Fleeger (1996) for sediment egestion from a 10-d and a 5-d study and for reproduction from a 28-d study are 51.6, 58.9, and 59.1, respectively, for a sediment with 1.2% organic carbon. With the derived EC50, which is rather certain because it is not an extrapolated value and the reported EC25, EC10s can be derived with a log-logistic model. For the endpoints mentioned above, these EC10 values recalculated to sediment with 10% organic carbon are 222, 217, and 255 mg/kg_{dw}, respectively. These values probably are more realistic.
The lowest reported endpoint for *Lumbriculus variegatus*, which is wet weight (Kukkonen and Landrum, 1994), has a much higher EC10 value. However, in this experiment, the worms were not fed, which resulted in weight loss during the experiment for all treatment groups, including the control. At high concentrations, sediment avoidance was observed, which resulted in an EC50 lower than the EC50 for wet weight. Therefore, the results of this test are not considered reliable, especially because at the EC10 values for wet weight and mortality (2300 and 3000 $mg/kg_{dw,\ standard\ soil}$) pore water concentration are probably saturated as well.
For marine sediment only the species *Rhepoxynius abronius* was tested. The EC50 for reburial was lower than 25 mg/kg_{dw} in standard sediment. The

organisms were irradiated with UV radiation before reburial was monitored (Boese et al., 1998). Because *Rhepoxynius abronius* is a subsurface burrower that typically does not extend body parts in overlying water (Swartz et al., 1990; Boese et al., 1997), this EC50 is not very useful in the risk assessment. Some 10-d experiments with *Rhepoxynius abronius* were performed (Swartz et al., 1997). The LC10s derived from the presented data are 45 and 154 $mg/kg_{dw\ standard\ sediment}$, the confidence limits of these values are rather small.

Table 57: Selected chronic toxicity data of pyrene to benthic species

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard\ sediment}$]***
Annelida	*Limnodrilus hoffmeisteri*	220 [a]
Crustacea	*Rhepoxynius abronius*	84 [b]

Notes to Table 57
[a] Geometric mean of 217 and 222 $mg/kg_{dw\ standard\ sediment}$ for most sensitive parameter (sediment egestion).
[b] Geometric mean of 45 and 154 $mg/kg_{dw\ standard\ sediment}$.

For freshwater sediment a reliable EC10 is avialable for oligochaetes (Table 57). For marine species one additional EC10 for a crustacean is available. This is the lowest value. Because chronic data for 2 different trophic levels are avialable, the assessment factor to derive the $MPC_{eco,\ sediment}$ is 50, which results in an $MPC_{eco,\ sediment}$ of 1.7 $mg/kg_{dw\ standard\ sediment}$. Because 1 test is with a freshwater sediment species and 1 with a marine sediment species, the assessment factor to be applied to derive the MPC for marine sediment is 100 instead of 500. This results in a $MPC_{eco,\ marine\ sediment}$ of 0.84 $mg/kg_{dw\ standard\ sediment}$. The $SRC_{eco,\ sediment}$ is calculated as the geometric mean of the 2 selected values and is 136 $mg/kg_{dw\ standard\ sediment}$.

3.7.3 Soil

Many toxicity data with terrestrial species are available for pyrene. From several studies, it appears that pyrene concentrations are rather stable in the used test systems (Sverdrup et al., 2001; Sverdrup et al., 2006). Because nominal concentrations are retrieved in the test systems, this improves the reliability of the data in general.
Many toxicity tests with species from five taxonomic groups and with terrestrial processes are available for pyrene. In the tests with the terrestrial algae species *Chlorococcum meneghini* the test was performed in quartz sand and normalization to organic matter is therefore not possible. The bioavailability of pyrene in this sand is high. The EC10 for cell number (optical density was 19 mg/kg_{dw} (Chung et al., 2007). For the snail *Helix aspersa* no effects were observed as (Sverdrup et al., 2006). For ryegrass (*Lolium perenne*) a reliable EC10 could not be derived from the data (Sverdrup et al., 2003), this species showed also no toxicity in quartz sand (Chung et al., 2007). For the rest of the species and processes the selected data are presented in Table 58.
With data for annelids (3 species), springtails (2 species) terrestrial plants (2 species) and microbial processes an assessment factor of 10 can be applied to the lowest NOEC or EC10. A value of 1.8 $mg/kg_{dw,\ standard\ soil}$ is derived for the $MPC_{eco,\ soil}$. The $SRC_{eco,\ soil}$ is calculated from the geometric mean of the 7 species and is 53 $mg/kg_{dw,\ standard\ soil}$.

Table 58: Selected chronic toxicity data of pyrene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard\ soil}$]***
Annelida	*Eisenia veneta*	140
Annelida	*Enchytraeus crypticus*	136 [a]
Annelida	*Lumbricus rubellus*	55 [b]
Insecta	*Folsomia candida*	18 [c]
Insecta	*Folsomia fimetaria*	33 [d]
Insecta	*Protaphorura armata*	18 [e]
Macrophyta	*Sinapsis alba*	101
Macrophyta	*Trifolium pratense*	55
Microbial process	nitrification	478

Notes to Table 58

[a] Geometric mean of 40 and 458 mg/kg$_{dw\ standard\ soil}$ for reproduction (most sensitive endpoint) based on EC10 and NOEC from 2 studies; NOEC and EC50 differed by a factor of 10.

[b] Most sensitive endpoint (cocoon production).

[c] Geometric mean of 1.6, 29 and 129 mg/kg$_{dw\ standard\ soil}$ for reproduction (number of juveniles).

[d] Most sensitive endpoint (reproduction) corrected for time weighted average concentrations.

[e] After 21 days expsorue in soil, 2 days counting/extraction, followed by 7 days in drought chamber at 98.2% RH and 2 days at 100% RH.

3.8 Fluoranthene

3.8.1 Substance identification and physicochemical properties

3.8.1.1 Identity

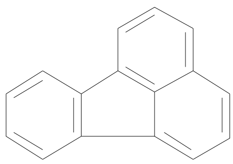

Figure 12: Structural formula of fluoranthene

Table 59: Identification of fluoranthene

Parameter	***Value***
Common/trivial/other name	Fluoranthene, 1,2-benzacenaphthene, benzo[*j*,*k*]fluorene, benz[*a*]acenaphthylene, fluoranthrene
Chemical name	1,2-benzacenaphthene
CAS number	206-44-0
EC number	205-012-4
SMILES code	c12c3cccc1c4ccccc4c2ccc3

3.8.1.2 Physicochemical properties

Table 60: Physicochemical properties of fluoranthene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	202.25	
Water solubility	[µg/L]	227	Geometric mean of 7 values by generator-column method
log K_{OW}	[-]	5.18	Average of 3 values by slow-stirring method
log K_{OC}	[-]	4.97	QSAR
Vapour pressure	[Pa]	0.00123	Gas saturation method
Melting point	[°C]	110.2	
Boiling point	[°C]	384	
Henry's law constant	[Pa.m^3/mol]	1.1	Geometric mean of 3 values by gas stripping method

3.8.2 Water

Many toxicity data with fluoranthene are available. In a lot of the studies the concentrations have been verified, which makes the number of reliable data considerable. The selected acute toxicity data are presented in Table 61. It appears that fluoranthene is very phototoxic as well. The lowest values in Table 61 are consequently performed in the presence of UV light. If lighting conditions were not representative for the species, these data have not been taken into account.
Also for marine species many data are available. The selected acute toxicity data are presented in Table 62. Again, the lowest values were obtained under UV lighting, but these values have only been selected if the lighting conditions are relevant for the species.
The sensitivity of acute toxicity data for freshwater and marine species appears to be equal (F-test 0.96, t-test 0.53). Therefore, all data from both tables are combined in a species sensitivity distribution for acute toxicity (Figure 13). A reduced goodness-of-fit can be anticipated, because results are included both from tests with strong phototoxic effects and from tests with less UV exposure or species that are not sensitive to phototoxicity. The goodness-of-fit is accepted at all levels by the Kolmogorov-Smirnov test included in ETX, but not at the 0.025 significance level and higher by the Anderson-Darling test and 0.05 and higher for the Cramer von Mises test. The value of 0.1 µg/L for the marine fish species winter flounder (*Pleuronectus americanus*) (Spehar et al., 1999) deviates from the rest, but is just not a significant outlier ($P > 0.05$). The HC5 of the distribution is 0.99 µg/L. The LC50 for the winter flounder is the only value that is below the HC5. The HC50 of this distribution is 23 µg/L.
Many chronic toxicity data are available as well. The selected data for freshwater species are presented in Table 63. Also in this case the lowest NOEC or EC10 values were obtained in the presence of UV light, although the UV intensity is less harsh in most of these studies. For marine species several studies are available too (Table 64). The chronic data sets are very similar too (F-test 0.40, t-test 0.41). The marine data complement the freshwater data and also for the chronic data a species sensitivity distribution can be performed. This distribution is shown in Figure 14. Goodness-of-fit is accepted by all tests at all significance levels. The HC5 of this distribution is 0.60 µg/L. There are no NOECs or EC10 values below the HC5. The HC50 is 12 µg/L.
The species sensitivity distributions for chronic and acute data are very similar, with a factor 2 to 3 difference between the 2 curves. In general, the MAC_{eco} would be derived from from the HC5 for acute LC50 and EC50 values by applying a factor of 10. This results in a value of 0.099 µg/L. The MPC_{eco} would

be derived by applying a factor of 1-5 to the HC5 for chronic NOEC or EC10 values. Due to the very low values of the phototoxic effects, the uncertainty is high. The lowest LC50 for winter flounder is 0.1 µg/L. Except from the LC50 for the winter flounder and the NOEC for the crustacean *Mysidopsis bahia* (Spehar et al., 1999), a few other studies report effect concentrations between 0.1 and 1 µg/L (i.e. a factor of 10 above the lowest value).
In a study with the marine benthic annelid *Monopylephorus rubroniveus* an LC50 of 0.7 µg/L (measured concentrations) was observed under exposure with UV-A (320-400 nm) with an intensity of 64.0 µW/cm^2 (Weinstein et al., 2003). However, this species is a sediment burrower and is under natural conditions not exposed to UV light. An EC10 of 0.80 µg/L was derived from the data for marine algae, exposed under a combination of visible and UV-A (~785 µW/cm^2) light, continusouly (Southerland and Lewitus, 2004). Concentrations in this study were not verified.
Under ultraviolet light with an intensity of 397 µW/cm^2 UV-A and 134 µW/cm^2 UV-B with a photoperiod of 16:8 hours light:dark the LC50 for embryos-larvae of *Mulinea lateralis* was 1.09 µg/L, while the LC50 for juveniles of 1 to 1.5 mm of the same species was 1.8 µg/L (Pelletier et al., 1997). The embryo-larval assay is a rather chronic study, because it also takes the abnormalities in development of this sensitive life-stage into account.
To take into account the uncertainties surrounding photoxicity, a maximum factor of 5 should be applied to the HC5 for chronic data. This also results in a value around 0.1 µg/L. For this reason the $MAC_{eco, water}$, $MAC_{eco, marine}$, $MPC_{eco, water}$ and $MPC_{eco, marine}$ are all set to 0.12 µg/L. The $SRC_{eco, water}$ is derived from the geometric mean of the chronic toxicity data and is 12 µg/L.

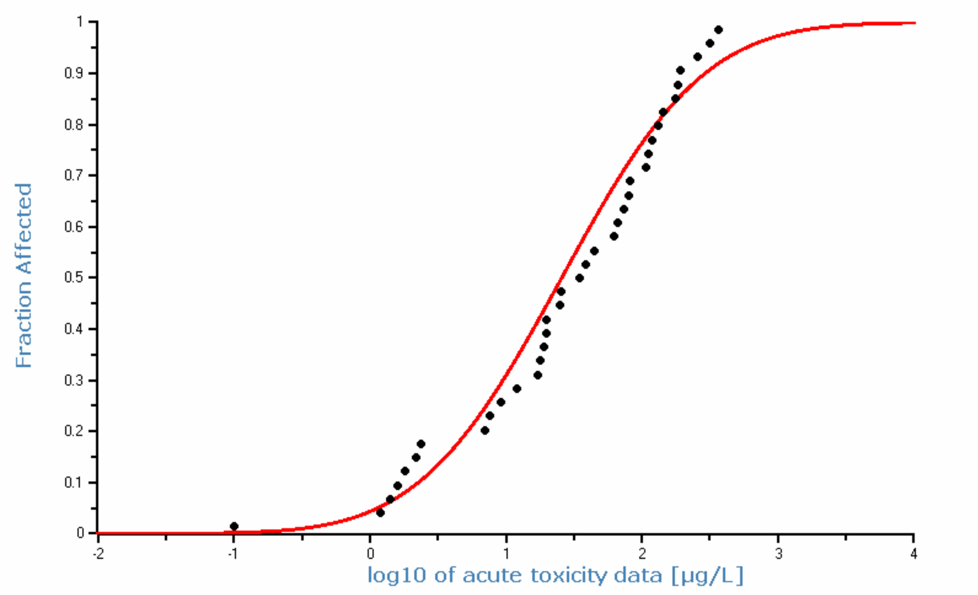

Figure 13: Species sensitivity distribution for the acute toxicity of fluoranthene to freshwater and marine species

Table 61: Selected acute toxicity data of fluoranthene to freshwater species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Algae	*Scenedesmus vacuolatus*	35 [a]
Amphibia	*Rana catesbeiana*	111
Amphibia	*Rana pipiens*	2.0 [b]
Amphibia	*Xenopus laevis*	193
Annelida	*Lumbriculus variegates*	1.2 [c]
Cnidaria	*Hydra americana*	2.2 [c]
Crustacea	*Ceriodaphnia dubia*	45
Crustacea	*Daphnia magna*	1.6 [d]
Crustacea	*Gammarus pseudolimnaeus*	108
Crustacea	*Hyalella azteca*	183 [e]
Insecta	*Chironomus tentans*	176
Mollusca	*Physella virgata*	82 [d]
Mollusca	*Utterbackia imbecilis*	2.4 [f]
Pisces	*Lepomis macrochirus*	12 [d]
Pisces	*Oncorhynchus mykiss*	7.7 [d]
Pisces	*Pimephales promelas*	9.2 [g]

Notes to Table 61

[a] Geometric mean of 36 and 34 µg/L.

[b] 48 hours exposure followed by 48 hours continuous irradiation with 782-829 µW/cm^2 UV-A and 130-153 µW/cm^2 UV-B.

[c] Exposure under laboratory ultraviolet light with 783-850 µW/cm^2 UV-A and 104 µW/cm^2 UV-B and a photoperiod of 12:12 hours light:dark.

[d] Exposure under laboratory ultraviolet light with 359-587 µW/cm^2 UV-A and 63-80 µW/cm^2 UV-B and a photoperiod of 12:12 hours light:dark.

[e] Gold light (0.17 µW/cm^2 UV-B, 0.09 µW/cm^2 UV-A, 167.72 µW/cm^2 visible); 16:8 hours light:dark. Gold light was considered most representative for this bottom dwelling organisms; geometric mean of 188.7 and 177 µg/L.

[f] Exposure with UV-A (320-400 nm), intensity 69.0±1.0 µW/cm^2 for 24 hours; renewal every 8 hours; 4 hours pre-exposed under ambient laboratory lighting; Geometric mean of 2.90, 2.44, and 2.00 µg/L.

[g] Geometric mean of 9.46, 6.83, and 12.2 µg/L. Exposure under laboratory ultraviolet light with 359-587 µW/cm^2 UV-A and 63-80 µW/cm^2 UV-B and a photoperiod of 12:12 hours light:dark or exposure under laboratory fluorescent light with UV radiation very similar to sunlight.

Table 62: Selected acute toxicity data of fluoranthene to marine species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Annelida	*Neanthes arenaceodentata*	258
Crustacea	*Acartia tonsa*	120
Crustacea	*Ampelisca abdita*	67
Crustacea	*Callinectes sapidus*	18 [a]
Crustacea	*Corophium insidiosum*	20 [b]
Crustacea	*Emerita analoga*	73 [b]
Crustacea	*Grandidierella japonica*	19 [b]
Crustacea	*Homarus americanus*	317
Crustacea	*Leptocheirus plumulosus*	20 [b]
Crustacea	*Libinia dubia*	17 [c]
Crustacea	*Menippe adina*	39 [d]
Crustacea	*Mysidopsis bahia*	1.4 [e]
Crustacea	*Oithona davisae*	133
Crustacea	*Palaemonetes spec.*	142
Crustacea	*Panopeus herbstii*	25.3 [f]
Crustacea	*Rhepoxynius abronius*	63 [g]
Mollusca	*Macomona liliana*	25 [h]
Mollusca	*Mulinea lateralis*	1.8 [i]
Mollusca	*Mytilus edulis*	80
Pisces	*Pleuronectus americanus*	0.1 [j]

Notes to Table 62

[a] After exposure for 1 hour, transferred to filtered sea water with exposure to UV (UV-A (320-400 nm) 2.095 mW/cm^2 and UV-B (280-320 nm) 0.325 mW/cm^2) for 4 hours and 24 hours of recovery in filtered sea water for 24 hours in the dark.

[b] After 96 hours exposure and 1 hour reburial, animals were transferred to unccontaminated seawater and irradiated for 1 hour with UV (UV-A 167 µW/cm^2 and UV-B 58 µW/cm^2), reburial in sediment was measured for 1 hour after the 1 hour UV irradiation.

[c] After exposure for 1 hour, transferred to filtered sea water with exposure to UV (UV-A (320-400 nm) 2.098 mW/cm^2 and UV-B (280-320 nm) 0.313 mW/cm^2) for 4 hours and 24 hours of recovery in filtered sea water for 24 hours in the dark.

[d] After exposure for 1 hour, transferred to filtered sea water with exposure to UV (UV-A (320-400 nm) 1.455 mW/cm^2 and UV-B (280-320 nm) 0.196 mW/cm^2) for 4 hours and 24 hours of recovery in filtered sea water for 24 hours in the dark.

[e] Laboratory ultraviolet light with 465-724 µW/cm^2 UV-A and 68-109 µW/cm^2 UV-B and a photoperiod of 16:8 hours light:dark.

[f] After exposure for 1 hour, transferred to filtered sea water with exposure to UV (UV-A (320-400 nm) 1.979 mW/cm^2 and UV-B (280-320 nm) 0.276 mW/cm^2) for 4 hours and 24 hours of recovery in filtered sea water for 24 hours in the dark

[g] After exposure in water for 96 hours, transfer to sediment with overlying water to measure reburial EC50 after 1 hour.

[h] Geometric mean of 12 and 51 µg/L. 16:8 light:dark photoperiod with fluorescent light, followed by 1 hour of UV exposure in clean seawater with 13 W/m^2 UV-A (320-400 nm) and 2.5 W/m^2 UV-B (290-330 nm). Sunny summer day in Hamilton NZ: 35 W/m^2 UV-A and 4.3 W/m^2 UV-B; at the end of the exposure period clams were transferred to beakers with fresh sediment.

[i] Ultraviolet light with 397±35.1 μW/cm^2 UV-A (365±36 nm) and 134±22.8 μW/cm^2 UV-B (310±34 nm) with a photoperiod of 16:8 hours light:dark
[j] Laboratory ultraviolet light with 465-724 μW/cm^2 UV-A and 68-109 μW/cm^2 UV-B and a photoperiod of 16:8 hours light:dark

Table 63: Selected chronic toxicity data of fluoranthene to freshwater species

Taxon	***Species***	***NOEC or EC10 [μg/L]***
Algae	*Pseudokirchneriella subcapitata*	8.6
Algae	*Scenedesmus vacuolatus*	14
Amphibia	*Ambystoma maculatum*	125
Amphibia	*Rana pipiens*	25
Amphibia	*Xenopus laevis*	25
Crustacea	*Ceriodaphnia dubia*	1.17 [a]
Crustacea	*Daphnia magna*	1.4 [b]
Crustacea	*Diporeia* spp.	6.5 [c]
Crustacea	*Hyalella azteca*	1.1 [d]
Insecta	*Chironomus tentans*	14 [e]
Macrophyta	*Lemna gibba*	130
Pisces	*Danio rerio*	18 [f]
Pisces	*Pimephales promelas*	1.4 [g]

Notes to Table 63
[a] Photoperiod 16:8 hours light:dark at less than 500 lux.
[b] Laboratory ultraviolet light with 283 μW/cm^2 UV-A and 47 μW/cm^2 UV-B and a photoperiod of 12:12 hours light:dark.
[c] Longest exposure duration of 28 days.
[d] Low intensity of UV enhanced light (7.54 μW/cm^2 UV-B, 102.08 μW/cm^2 UV-A, 289.24 μW/cm^2 visible) with a photoperiod of 16:8 hours light:dark.
[e] Geometric mean of 13 and 15 μg/L. Performed in the presensce of a sand substrate, gold light was used (0.17 μW/cm^2 UV-B, 0.09 μW/cm^2 UV-A, 167.72 μW/cm^2 visible) with an intensity of 16:8 hours light:dark.
[f] Most sensitive parameter (length), EC10 was calculated from presented data.
[g] Laboratory ultraviolet light was used with 612 μW/cm^2 UV-A and 82 μW/cm^2 UV-B and a photoperiod of 12:12 hours light:dark.

Table 64: Selected chronic toxicity data of fluoranthene to marine species

Taxon	***Species***	***NOEC or EC10 [μg/L]***
Crustacea	*Acartia tonsa*	41 [a]
Crustacea	*Mysidopsis bahia*	0.6 [b]
Echinodermata	*Paracentrotus lividus*	21 [c]
Mollusca	*Mytilus galloprovincialis*	34 [c]
Tunicata	*Ciona intestinalis*	242 [c]

Notes to Table 64
[a] Most sensitive parameter (hatching).
[b] Performed under laboratory ultraviolet light with 465-724 μW/cm^2 UV-A and 68-109 μW/cm^2 UV-B and a photoperiod of 16:8 hours light:dark.
[c] Lighting by cool daylight lamps (380-780nm, PAR) with an intensity of 70 μE/m^2/s and a photoperiod of 14:10 hours light:dark.

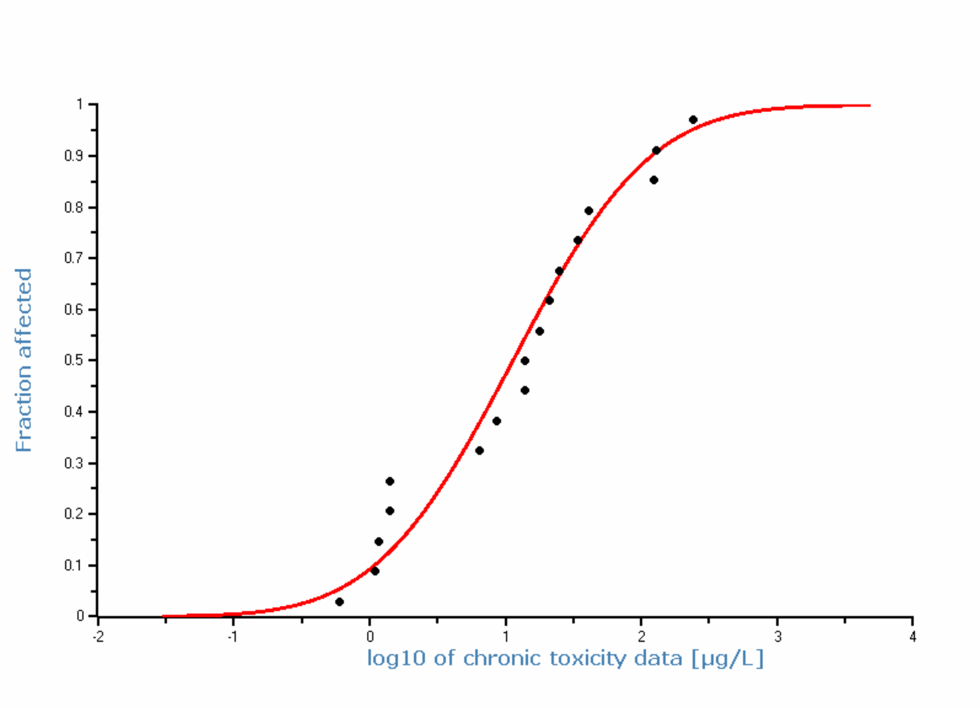

Figure 14: Species sensitivity distribution for the chronic toxicity of fluoranthene to freshwater and marine species

3.8.3 Sediment

For fluoranthene benthic toxicity data are available for both freshwater and marine benthic species. Selected data are shown in Table 65.

Table 65: Selected chronic toxicity data of fluoranthene to benthic species

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard\ sed}$]***
Annelida	*Stylaria lacustris*	112
Crustacea	*Corophium spinicorne*	108
Crustacea	*Hyalella azteca*	73 [a]
Crustacea	*Rhepoxynius abronius*	135 [b]
Crustacea	*Schizopera knabeni*	41 [c]
Crustacea	*Coullana* spec.	157 [d]
Insecta	*Chironomus tentans*	58
Insecta	*Chironomus riparius*	166 [e]

Notes to Table 65

[a] Geometric mean of 8.8 and 600 mg/kg$_{dw,\ standard\ sed}$ for mortality.

[b] Geometric mean of 58, 113, 83, 117, 235, 173, 218, 188, and 141 mg/kg$_{dw,\ standard\ sed}$ for mortality.

[c] Longest exposure duration (14-d) for most sensitive, relevant parameter (reproduction).

[d] Most sensitive, relevant parameter (mortality).

[e] NOEC for longest test duration (28-d emergence); 10-11 d LC50s range between 43 and 330-461 (four values) mg/kg$_{dw,\ standard\ sed}$ in two different studies.

Further several LC50s have been reported without a NOEC or EC10. Some 30-d tests with *Diporeia* species were carried out. At trace concentrations

(<1 mg/kg$_{dw\ standard\ sed}$) no effect was observed, at higher concentrations mortality was significantly different from controls (430-530 mg/kg$_{dw,\ standard\ sed}$) (Kane Driscoll et al., 1997a). These sediments had low organic matter content (0.37 and 0.53%). In a sediment with higher organic carbon (1.9%) (Kane Driscoll and Landrum, 1997), the concentrations normalised to a sediment with 10% organic matter up to 3000 mg/kg$_{dw,\ standard\ sed}$ showed no significant mortality. From these studies it can be estimated that the LC10 must lie in this range of tested concentrations.
Several tests with *Hyalella azteca* are available. Results of these studies vary widely. When recalculated to a sediment with 10% organic matter, LC50s (Kane Driscoll and Landrum, 1997; Hatch and Burton Jr., 1999; Suedel et al., 1993; Verrhiest et al., 2001; Wilcoxen et al., 2003) varied from 15 to 3800 mg/kg$_{dw\ standard\ sed}$ and NOECs for mortality (Kane Driscoll and Landrum, 1997; Kane Driscoll et al., 1997a; Verrhiest et al., 2001; Suedel and Rodgers Jr., 1996) varied from 8.8 to 600 mg/kg$_{dw\ standard\ sed}$. Studies are performed with a different percentage organic matter of the sediment ranging from 0.37 to 3.4% as well as with different exposure times ranging from 10 to 30 days. However, both parameters could not explain the large differences in toxicity.
Two chironomid species were tested. 10-d LC50 values for *Chironomus tentans* (Suedel et al., 1993) ranged from 40 to 102 mg/kg$_{dw}$, recalculated to a sediment with 10% organic matter. For *Chironomus riparius*, exposed for 10 or 11 days to fluoranthene in sediment (Stewart and Thompson, 1995; Verrhiest et al., 2001), these values ranged from 43 to 461 mg/kg$_{dw\ standard\ sed}$. For this species total emergence, emergence time and onset of emergence from a 28-d study were not more sensitive as endpoint as mortality (Stewart and Thompson, 1995). The NOEC for mortality and growth during a 10-d study (Verrhiest et al., 2001) was lower than 8.8 mg/kg$_{dw\ standard\ sed}$, recalculated to a sediment with 10% organic matter. Fluoranthene was also tested in a mixture together with phenanthrene and benzo[*k*]fluoranthene, with each compound comprising one third of the total PAH concentration. For this mixture, data are presented from which a clear dose-response relationship can be deduced. If the LC10 is determined with a log-logistic relationship, this value is 5.6 mg/kg$_{dw\ standard\ sed}$, on basis of the fluoranthene concentrations in this mixture, and normalised to sediment with 10% organic matter. Because of the additivity of the PAHs in this mixture (Verrhiest et al., 2001), the LC10 for fluoranthene alone will be higher than this value. All sediment concentrations were verified. Because the measured concentrations were higher than 77% of the nominal concentrations, the data by Verrhiest et al. (2001) are based on nominal concentrations.
For marine sediment toxicity studies have been performed with 1 species of annelids (*Arenicola marina*), 5 species of crustaceans (*Corophium volutator*, *Corophium spinicorne*, *Rhepoxynius abronius*, *Schizopera knabeni*, *Coullana* spec.), 1 mollusc (*Abra alba*), and 1 echinodermata species (*Echinocardium cordata*). Most species are tested with exposure times of 10 days. The test endpoints are often mortality. For *Corophium volutator* (Bowmer, 1994) a geometric mean of 10-d LC50 of 220 mg/kg$_{dw\ standard\ sed}$ was calculated for sediment with 10% organic matter. For *Corophium spinicorne* (Swartz et al., 1990) the 10-d LC50 was 160 mg/kg$_{dw\ standard\ sed}$ or higher. For the studies with *Rhepoxynius abronius* (Swartz et al., 1988; Swartz et al., 1997; Swartz et al., 1990; Boese et al., 1998; Cole et al., 2000; DeWitt et al., 1992) a geometric mean for the 10-d LC50 of about 270 mg/kg$_{dw}$ can be derived when calculated for a sediment with 10% matter. An EC50 for reburial was reported as well which, transferred to a sediment with 10% organic matter, is smaller than 39 mg/kg$_{dw\ standard\ sed}$ (Boese et al., 1998). Reburial is considered to be a better endpoint for chronic toxicity than mortality. In this case, after 10 days of exposure, the organisms were irradiated with UV radiation (UV-A (321-400 nm)

315±36 μW/cm^2; UV-B (280-320 nm) 128±12 μW/cm^2; visible light (401-700 nm) 3400±278 μW/cm^2) before reburial was monitored. However, in contrast to several other crustaceans, *Rhepoxynius abronius* is a subsurface burrower that typically does not extend body parts in overlying water (Swartz et al., 1990; Boese et al., 1997). Therefore, this EC50 is not very useful in the risk assessment. In contrast, the EC10 for mortality for this species is very useful, because from a comparison with data for reburial (Boese et al., 1997), it appears that mortality is almost equally sensitive as reburial under normal conditions.
For the *Schizopera knabeni* the LC50 decreases with increasing exposure times. Recalculated to a sediment with 10% organic matter, the 4-d LC50 (Lotufo, 1997) is larger than 8200 mg/kg$_{dw\ standard\ sed}$ and the 10-d LC50 (Lotufo, 1998) is 820 mg/kg$_{dw\ standard\ sed}$. For reproduction, the same effect was observed, only this parameter is more sensitive than mortality. The 10-d EC50 (Lotufo, 1998) is 210 mg/kg$_{dw\ standard\ sed}$, the 14-d EC50 is 150 mg/kg$_{dw\ standard\ sed}$. The EC10s are 58 and 41 mg/kg$_{dw\ standard\ sed}$ respectively. Another sensitive endpoint is the grazing rate of algae cells by this organism. From a 6-h study (Lotufo, 1997), an EC10 for grazing rate can be derived with a log-logistic model. Recalculated to sediment with 10% organic matter, this EC10 is 190 mg/kg$_{dw\ standard\ sed}$. When *Schizopera knabeni* were first exposed to fluoranthene for 24 hours and the grazing rate was monitored subsequently for 3 hours (Lotufo, 1998), the calculated EC10 is 9.2 mg/kg$_{dw\ standard\ sed}$. For a *Coullana* species the grazing rate was determined in the same way (Lotufo, 1998). The EC10 calculated from the results for this species was 39 mg/kg$_{dw\ standard\ sed}$. Reproduction and mortality from a 10-d study appeared to be less sensitive endpoints, but these parameters are considered environmentally more relevant.
Tests were also performed with the marine mollusc *Abra alba* and the echinoderm *Echinocardium cordatum*. The EC50 for defecation varied from 16.3 to >625 mg/kg$_{dw}$ in organic rich muddy sediment (Bowmer, 1994). For *Echicardium cordatum* the 10-d LC50s varied from 33 to 116 mg/kg$_{dw\ standard\ sed}$ in muddy fine sand (Bowmer, 1994). When possible, recalculation to sediment with 10% organic matter leads to LC50s of 1100 to 1700 mg/kg$_{dw\ standard\ sed}$.
It appears that the tested marine species are equally sensitive as freshwater species. The lowest effect concentration for fluoranthene in sediment was found for mortality and growth of *Chironomus riparius*. This was a LOEC and not a NOEC and no effect percentage was given. However, results for the same species vary widely. The lowest selected value is the EC10 for reproduction of the marine crustacean *Schizopera knabeni*. Also for this species a more sensitive endpoint was found (grazing after 1 day exposure) but this did apparently not affect reproduction in a longer exposure duration of 14 days. Therefore, reproduction is chosen as most sensitive of the relevant parameters. The MPC$_{eco,\ sediment}$ is based on this value. Because data are available for annelids, crustaceans, and insects, an assessment factor of 10 can be applied to this value. The MPC$_{eco,\ sediment}$ for fluoranthene in sediment then becomes 4.1 mg/kg$_{dw\ standard\ sed}$. For marine sediment, chronic studies are available for annelids, crustaceans and echinoderms. Therefore, the MPC$_{eco,\ marine\ sediment}$ has the same value of 4.1 mg/kg$_{dw\ standard\ sed}$. The SRC$_{eco,\ sediment}$ is equal to the geometric mean of the selected data and is 96 mg/kg$_{dw\ standard\ sed}$.

3.8.4 Soil

For fluoranthene several toxicity data in soil are available. For the earthworm *Eisenia fetida* (Schaub and Achazi, 1996) and the snail *Helix aspersa* (Sverdrup et al., 2006) no effects were observed. Also for the processes respiration and dehydrogenase no effects were observed (Eschenbach et al., 1991). For the rest of the species and processes the selected data are shown in Table 66.

Table 66: Selected chronic toxicity data of fluoranthene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard\ soil}$]***
Annelida	*Eisenia veneta*	415
Annelida	*Enchytraeus crypticus*	55
Insecta	*Folsomia fimetaria*	127 [a]
Macrophyta	*Sinapsis alba*	1411 [b]
Macrophyta	*Trifolium pratense*	199 [b]
Macrophyta	*Lolium perenne*	1067 [b]
Microbial process	nitrification	48

Notes to Table 66
[a] Most sensitive endpoint (reproduction) corrected for time weighted average concentrations.
[b] Most sensitive endpoint (fresh weight).

Selected data are available for all trophic levels. The $MPC_{eco,\ soil}$ can therefore be derived by applying an assessment factor of 10 to the lowest NOEC or EC10, which is the EC10 for the process of nitrification. The resulting $MPC_{eco,\ soil}$ is 4.8 mg/kg$_{dw\ standard\ soil}$.
For the $SRC_{eco,\ soil}$ the geometric mean of the data for the 6 selected species could be chosen. This is 310 mg/kg$_{dw\ standard\ soil}$. It must be noted that for 2 species no effects were observed, the highest tested concentration for the earthworm was however below this value of 310 mg/kg$_{dw\ standard\ soil}$.
At the same time, the lowest value for terrestrial processes and enzymatic activity is much lower, but for 2 other processes or enzymatic activities no effects were observed up to the highest tested concentration of 1400 mg/kg$_{dw\ standard\ soil}$, normalized to standard soil with 10% organic matter. In this study (Eschenbach et al., 1991), concentrations were not verified but from several other studies it appears that fluoranthene is rather stable in terrestrial test systems (Sverdrup et al., 2001; Sverdrup et al., 2006). Therefore, the geometric mean of the terrestrial processes and enzymatic activities is higher than the value for species. The $SRC_{eco,\ soil}$ is thus 310 mg/kg$_{dw\ standard\ soil}$.

3.9 Chrysene

3.9.1 Substance identification and physicochemical properties

3.9.1.1 Identity

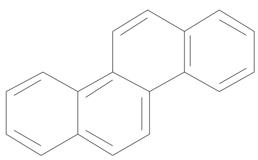

Figure 15: Structural formula of chrysene

Table 67: Identification of chrysene

Parameter	***Value***
Common/trivial/other name	Chrysene
Chemical name	Chrysene
CAS number	218-01-9
EC number	205-923-4
SMILES code	c12ccccc1c3ccc4ccccc4c3cc2

3.9.1.2 Physicochemical properties

Table 68: Physicochemical properties of chrysene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	228.29	
Water solubility	[µg/L]	1.61	Geometric mean of 6 values by generator-column method
log K_{OW}	[-]	5.81	Slow-stirring method
log K_{OC}	[-]	5.60	QSAR
Vapour pressure	[Pa]	$2.11 \cdot 10^{-6}$	Gas saturation method
Melting point	[°C]	255.5	
Boiling point	[°C]	448	
Henry's law constant	[Pa.m^3/mol]	0.24	Geometric mean of 1 value by gas stripping method and 1 value by headspace method

3.9.2 Water

Reliable chronic toxicity studies were performed with algae (Bisson et al., 2000), daphnids (both *Daphnia magna* (Hooftman, 1991) and *Ceriodaphnia dubia* (Bisson et al., 2000)) and fish (Hooftman and Evers-de Ruiter, 1992b), but no significant effects were observed for any species in a regular toxicity experiment around or below the aqueous solubility. The only study, that showed a considerable effect of chrysene, was a determination of the median lethal time for neonates of *Daphnia magna* (Newsted and Giesy, 1987). In this experiment, the daphnids were exposed to one concentration of chrysene (measured concentration of 0.7 µg/L). The test was performed as a static-renewal acute toxicity test. After 24 hours of exposure with a 16:8 light:dark photoperiod, the animals were exposed to UV light with an intensity of 25±3 µW/cm^2 UV-B (310±36 nm), 120±5 µW/cm^2 UV-A (365±36 nm), and 680±10 µW/cm^2 visible light (400 to 700 nm). The median lethal time after UV radiation started was 24 hours. Thus, after 48 hours, of which the last 24 hours were with UV radiation, 50% mortality of the daphnids occurred at 0.7 µg/L.
For marine species acute toxicity studies were performed with bacteria, annelids and crustaceans. No significant effects at or below the aqueous solubility were observed in any of these toxicity studies as well. Moreover, only one study with the luminescent bacterium species *Vibrio fischeri* can be considered as reliable (Loibner et al., 2004).
No acute toxicity data for algae and fish are available. However, for algae the EC10 and thus the EC50 for growth of *Pseudokirchneriella subcapitata* is higher than 1 µg/L. Due to the limited solubility of chrysene, no acute effects are expected for fish either. Besides that, an ELS study with the zebrafish *Brachydanio rerio* is available. Chronic studies were performed with algae, daphnids (2 species) and fish. Therefore an assessment factor of 10 to the lowest NOEC or EC10 can be applied. However, no effects were observed at all, although in the test with *Ceriodaphnia dubia* the highest tested measured concentration was 0.09 µg/L, which means that this species was not tested up to the water solubility of chrysene. The only study with a significant effect below

the aqueous solubility was 50% mortality after 48 hours at 0.7 μg/L. In this study, toxicity of chrysene was enhanced by irradiation with UV light, although the intensity was considerably less than natural sunlight. Sunlight or UV light comparable with sunlight was also used in the case of the lowest effect concentrations for anthracene and fluoranthene. Similar to these compounds an assessment factor of 10 is applied to the lowest effect concentration. The resulting $MPC_{eco,\ water}$ is thus 0.07 μg/L. No additional chronic toxicity data for typically marine species are available. Therefore, an assessment factor of 100 will be applied to derive the $MPC_{eco,\ marine}$. This $MPC_{eco,\ marine}$ thus is 0.007 μg/L. Because the MPC values are based on an acute study with *Daphnia* and no further information is available, the $MAC_{eco,\ water}$ and $MAC_{eco,\ marine}$ are set equal to their corresponding MPC values. Because no toxicity was observed up to the solubility in chronic studies, the $SRC_{eco,\ water}$ is set equal to the aqueous solubility. The $SRC_{eco\ water}$ thus is 1.6 μg/L.

3.9.3 Sediment

No data for benthic organisms are available. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ sediment}$ is 1.6 $mg/kg_{dw,\ standard\ sed}$, the $MPC_{eco,\ marine\ sediment}$ is 0.16 $mg/kg_{dw,\ standard\ sed}$, and the $SRC_{eco,\ sediment}$ is 38 $mg/kg_{dw,\ standard\ sed}$.

3.9.4 Soil

For soil 2 studies with 3 species are available. No effects were observed in a 14-d study with the earthworm *Eisenia fetida* (Bowmer et al., 1993), a 21-d study with the springtail *Folsomia candida* (Bowmer et al., 1993), and a 28-d study with the springtail *Folsomia fimetaria* (Sverdrup et al., 2002). However, pore water concentrations are possibly already saturated below 50 $mg/kg_{dw\ standard\ soil}$. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ soil}$ is 1.6 $mg/kg_{dw,\ standard\ soil}$, and the $SRC_{eco,\ soil}$ is 38 $mg/kg_{dw,\ soil}$.

3.10 Benz[*a*]anthracene

3.10.1 Substance identification and physicochemical properties

3.10.1.1 Identity

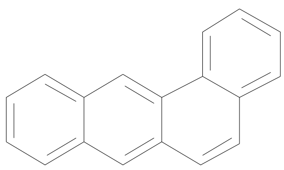

Figure 16: Structural formula of benz[a]anthracene

*Table 69: Identification of benz[*a*]anthacene*

Parameter	***Value***
Common/trivial/other name	Benz[*a*]anthracene, 1,2-benzanthracene, 2,3-benzophenanthrene, naphthanthracene, tetraphene
Chemical name	1,2-benzanthracene
CAS number	56-55-3
EC number	200-280-6
SMILES code	c12ccccc1cc3c4ccccc4ccc3c2

3.10.1.2 Physicochemical properties

Table 70: Physicochemical properties of benz[a]anthracene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	228.29	
Water solubility	[μg/L]	10.2	Geometric mean of 7 values by generator-column method
log K_{OW}	[-]	5.91	Slow-stirring method
log K_{OC}	[-]	5.70	QSAR
Vapour pressure	[Pa]	$2.71 \cdot 10^{-5}$	Gas saturation method
Melting point	[°C]	160.5	
Boiling point	[°C]	438	
Henry's law constant	[Pa.m^3/mol]	0.47	Geometric mean of 2 values by gas stripping method and 1 value by headspace method

3.10.2 Water

Selected acute toxicity data for benz[*a*]anthracene are shown in Table 71. For algae a 24-h EC50 based on cell number is available (Altenburger et al., 2004). The lowest acute value for immobility of *Daphnia magna* is the EC50 of 0.96 μg/L after exposure for 48 hours with a 16:8 light:dark photoperiod with visible light, UV-A (320-400 nm) and UV-B (290-320 nm) with an intensities of 61, 4.4, and 0.45 μmol/m^2/s. At similar intensities without the UV-B component, the EC50 was 1.48 μg/L (Lampi et al., 2006). In this study with *Daphnia magna* the concentrations were not verified, and therefore, this study is not included in Table 71. In another study with *Daphnia magna* concentrations were verified, but the highest tested concentration was 9.1 μg/L and no toxicity was observed (Bisson et al., 2000). In a study with *Daphnia pulex* in which the concentrations were verified as well, the EC50 was 10 μg/L (Trucco et al., 1983).
For fish, no standard acute toxicity data are available. A study with larvae of fathead minnows (*Pimephales promelas*) was performed to determine the median lethal time (Oris and Giesy Jr., 1987). 7-d old larvae were exposed to a measured concentration of 1.8 μg/L benz[*a*]anthracene for an incubation period of 24 hours in the absence of UV radiation and thereafter exposed for 96 hours to UV light with an intensity of 20 μW/cm^2 UV-B (290-336 nm), 95 μW/cm^2 UV-A (336-400 nm). After the incubation time of 24 hours, the medium was renewed every 12 hours. The median lethal time was 65 hours, which means that more than 50% mortality occurred in the test period of 120 hours.

Table 71: Selected acute toxicity data of benz[a]anthracene to freshwater species

Taxon	***Species***	***LC50 or EC50 [μg/L]***
Algae	*Scenedesmus vacuolatus*	14
Crustacea	*Daphnia pulex*	10

In tests with marine algae (Boney and Corner, 1962) and bacteria (El-Alawi et al., 2002; Johnson and Long, 1998; Loibner et al., 2004) adverse effects were only observed at concentrations far above the aqueous solubility, but in all these studies concentrations were not verified or experimental details about solubility in test media are missing. Consequently, no marine data have been selected.
From the tests with *Daphnia magna* and the test with *Pimephales promelas*, it can be concluded that benz[*a*]anthracene is more toxic in the presence of UV light than is reflected by the selected data in Table 71. EC50s in the presence of UV light are more likely in the order of 1 μg/L.

Reliable chronic toxicity studies with freshwater species are available for algae and crustaceans. However, for *Ceriodaphnia dubia* no toxicity was observed up to 9.1 µg/L and the 7-d EC10 is thus higher than this value (Bisson et al., 2000). The selected chronic data for the two algae species are shown in Table 72. The rest of the chronic toxicity data are well above the aqueous solubility and concentrations were not verified. In an ELS test with rice fish (*Oryzias latipes*) benz[*a*]anthracene was tested in glass bottles with Teflon lined caps (Rhodes et al., 2005). No analysis of the substance was however performed and the EC10 was 79 µg/L, which is far above the aqueous solubility. This study can therefore not be considered as reliable. Moreover, in the acute test with fathead minnows, more than 50% mortality occurred at 1.8 µg/L.

Table 72: Selected chronic toxicity data of benz[a]anthracene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Pseudokirchneriella subcapitata*	1.2
Algae	*Scenedesmus vacuolatus*	8.0

The determination of the lethal time for *Pimephales promelas* is an acute fish toxicity study, which completes the base-set, although no LC50 can be derived from the study. Chronic toxicity data are available for algae and crustaceans. Fish are possibly the most sensitive species of the base-set in acute toxicity tests. Therefore, an assessment factor of 100 should be applied to derive the $MPC_{eco,\ water}$. The lowest NOEC or EC10 is the EC10 of 1.2 µg/L for *Pseudokirchneriella subcapitata*. The $MPC_{eco,\ water}$ for freshwater is 0.012 µg/L. Because no studies with additional marine species are available, the $MPC_{eco,\ marine}$ is derived by applying an assessment factor of 1000. The $MPC_{eco,\ marine}$ is 0.0012 µg/L.

Two acute EC50s have been selected. However, from other not selected acute toxicity studies, it is clear that for fish and daphnids acute toxic effects due to phototoxicity occur at concentrations that lie in the same range as the chronic effects, which is about one order of magnitude below the selected acute toxicity data. Phototoxicity can be considered as a very sensitive acute effect. An assessment factor of 100 on the lowest selected acute value seems to be protective for the phototoxic effects on fish and daphnids as well. The $MAC_{eco,\ water}$ then becomes 0.10 µg/L. Because there are no reliable marine data, an additional factor of 10 is applied. The resulting $MAC_{eco,\ marine}$ is 0.010 µg/L. The value of the $SRC_{eco,\ water}$ could be taken equal to the geometric mean of the two available NOECs and is 3.1 µg/L. The $SRC_{eco,\ water}$ should represent the HC50. With fish probably being the most sensitive taxonomic group and crustaceans showing no effects up to (almost) the water solubility, the geometric mean of the two algae species seems a good representative for the HC50.

3.10.3 Sediment

The only available study with benthic organisms is a 10-d study with the marine crustacean *Rhepoxynius abronius* (Boese et al., 1998). No effects on reburial and mortality were observed up to concentrations of 64 $mg/kg_{dw,\ standard\ sed}$, normalized to standard sediment with 10% organic matter. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ sediment}$ is 0.35 $mg/kg_{dw,\ standard\ sed}$. For the marine environment, this number is a factor of 10 lower. The $MPC_{eco,\ marine\ sediment}$ is 0.035 $mg/kg_{dw,\ standard\ sed}$. The $SRC_{eco,\ sediment}$ is 91 $mg/kg_{dw,\ standard\ sed}$.

3.10.4 Soil

Toxicity tests with 5 terrestrial species from 3 taxonomic groups are available for benz[*a*]anthracene. In the tests with the pot worm *Enchytraeus crypticus* (Droge et al., 2006; Bleeker et al., 2003) and the springtails *Folsomia candida* (Droge et al., 2006; Bleeker et al., 2003) and *Folsomia fimetaria* (Sverdrup et al., 2002) no effects were observed on reproduction and mortality at measured concentrations of 2400 $mg/kg_{dw,\ standard\ soil}$ and above, normalized to standard soil with 10% organic matter. Pore water concentrations are possibly already saturated at concentrations around 300 mg/kg_{dw}. At the levels used in the test increasing or decreasing the concentrations has no effect anymore on the uptake of the substance from pore water. Also for the isopod *Porcellio scaber*, exposed through contaminated litter (Van Brummelen et al., 1996), no effects were observed up to concentrations normalized to 10% organic matter of 26 $mg/kg_{dw,\ standard\ soil}$. Only for the isopod *Oniscus asellus*, also exposed through contaminated litter (Van Brummelen et al., 1996), significant effects were observed. The NOEC normalized to 10% organic matter was 1.0 $mg/kg_{dw,\ standard\ soil}$ for the growth of females. From the presented data a reliable EC10 can be derived as well. Taking account of loss of the substance in between renewal of the food, the EC10 is 1.9 $mg/kg_{dw,\ standard\ soil}$ and still slightly higher than the NOEC reported in the study, based on initial concentrations. This value has been selected (Table 73).

Table 73: Selected chronic toxicity data of benz[a]anthracene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [$mg/kg_{standard\ soil}$]***
Crustacea	*Oniscus asellus*	1.9 [a]

Notes to Table 73
[a] Most sensitive parameter (growth of females).

Although there are data for 5 species, all species are invertebrates. They can be considered as primary consumers (springtails) and decomposers. Therefore, an assessment factor of 50 should be applied in principle. However, given the fact that 5 species are tested and *Oniscus asellus* appears to be a very sensitive species, an assessment factor of 10 seems justified. A value of 0.19 $mg/kg_{dw,\ standard\ soil}$ is derived for the $MPC_{eco,\ soil}$. Of the 5 species tested, 3 showed no signs of toxicity up to concentrations that may be assumed to correspond with saturated pore water concentrations. It seems not justified to base the $SRC_{eco,\ soil}$ on one very sensitive species, because the $SRC_{eco,\ soil}$ should represent the HC50. Therefore, the $SRC_{eco,\ soil}$ is derived by equilibrium partitioning and is 91 $mg/kg_{dw,\ standard\ soil}$.

3.11 Benzo[*k*]fluoranthene

3.11.1 Substance identification and physicochemical properties

3.11.1.1 Identity

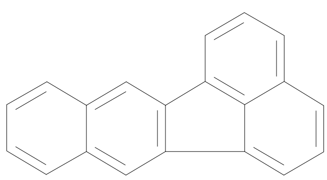

Figure 17: Structural formula of benzo[k]fluoranthene

Table 74: Identification of benzo[k]fluoranthene

Parameter	***Value***
Common/trivial/other name	Benzo[*k*]fluoranthene, 8,9-benzofluoranthene, 11,12-benzofluoranthene
Chemical name	8,9-benzofluoranthene
CAS number	207-08-9
EC number	205-916-6
SMILES code	c1ccc2cccc3c4cc5ccccc5cc4c1c23

3.11.1.2 Physicochemical properties

Table 75: Physicochemical properties of benzo[k]fluoranthene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	252.31	
Water solubility	[µg/L]	0.93	Geometric mean of 2 values by generator-column method
log K_{OW}	[-]	6.11	Slow-stirring method
log K_{OC}	[-]	5.90	QSAR
Vapour pressure	[Pa]	$1.29 \cdot 10^{-7}$	Method not clear, Antoine equation 363-430 K
Melting point	[°C]	217	
Boiling point	[°C]	480	
Henry's law constant	[Pa.m^3/mol]	0.059	Gas stripping method

3.11.2 Water

Acute toxicity data for benzo[*k*]fluoranthene are only available for *Daphnia magna*. However, in the two available studies no effects were observed. In one study the substance was analysed (Bisson et al., 2000), in the second study (Verrhiest et al., 2001) concentrations were not verified. In this study the effect of exposure to UV light was studied by placing the daphnids under UV-A (365 nm, 247 µW/cm^2) for 2 hours. This had no effect on the toxicity of benzo[*k*]fluoranthene. In both tests, benzo[*k*]fluoranthene was tested up to the solubility limit (1.0-1.1 µg/L). In a test with the marine bacterium species *Vibrio fischeri* (Loibner et al., 2004) no adverse effects were observed at concentrations up to the aqueous solubility too. Due to the low solubility of benzo[*k*]fluoranthene of about 1 µg/L, acute effects are not anticipated. Reliable chronic toxicity studies with freshwater species are available for algae, crustaceans and fish. In the 72-h study with *Pseudokirchneriella subcapitata* the EC10 for growth is larger than 1.0 µg/L (Bisson et al., 2000). For *Ceriodaphnia dubia* no toxicity was observed as well up to 1.1 µg/L and the 7-d EC10 is thus higher than this value (Bisson et al., 2000). In another test with daphnids (*Daphnia magna*) concentrations were tested up to 2.2 µg/L and no effects were observed (AquaSense, 2005). In two studies, the effects of benzo[*k*]fluoranthene in an ELS test with zebra fish (*Danio rerio*) were examined. In the first study one concentration of 0.58 µg/L was tested. At this concentration 52% mortality occurred (Hooftman and Evers-de Ruiter, 1992b). In a second study a dose-response relationship was examined (Hooftman and Evers-de Ruiter, 1992c). The mentioned concentrations here are based on measured concentrations per concentration and not on average recovery times the nominal concentration as given in the report. The LC50 estimated from the presented data with a log-logistic relationship is 0.65 µg/L. From the data for weight and length EC10s are derived of 0.31 and 0.17 µg/L. Due to the good fit of the log-logistic equation, these estimates have a low uncertainty. Two studies with marine species are available. In two 48-h studies with fertilized eggs of the echinoderm *Psammechinus miliaris* and the mollusc *Crassostrea gigas* the development of the larvae was examined (AquaSense, 2005). No effects were observed for tested concentrations up to 2.6 µg/L. In conclusion, six species were tested but only for one species effects were observed below the water solubility Table 76.

Table 76: Selected chronic toxicity data of benzo[k]fluoranthene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Pisces	*Danio rerio*	0.17 [a]

Notes to Table 76
[a] Most sensitive parameter (length).

The base-set for benzo[*k*]fluoranthene is not complete, because acute data are missing for fish. Acute toxicity was tested for algae, bacteria (*Vibrio*) and crustaceans, the latter also with inclusion of phototoxicity. Due to the high hydrophobicity of benzo[*k*]fluoranthene it is not likely that species from other taxonomic groups will show acute toxic effects.
Chronic toxicity data are available for algae, crustaceans, fish, echinoderms and molluscs. Fish are the most sensitive species. Therefore, an assessment factor of 10 could be applied to derive the $MPC_{eco,\ water}$. The lowest NOEC or EC10 is the EC10 of 0.17 µg/L for zebra fish. The $MPC_{eco,\ water}$ for freshwater is 0.017 µg/L. Because studies with two additional marine species are available, the $MPC_{eco,\ marine}$ is equal to the freshwater value. No acute toxic effects have been observed, even under influence of UV light, while phototoxicity can be considered as very sensitive acute effects. Therefore, no $MAC_{eco,\ water}$ can be derived. The value of the $SRC_{eco,\ water}$ could be taken equal to water solubility, because only 1 out of 5 species showed effects at concentrations below the solubility. The SRC thus is 0.93 µg/L.

3.11.3 Sediment

Two benthic organisms were tested for benzo[*k*]fluoranthene (Verrhiest et al., 2001). The crustacean *Hyalella azteca* was tested in a 14-d study and the midge larvae (*Chironomus riparius*) in a 10-d study. No effects on mortality and growth were observed up to concentrations of 880 $mg/kg_{dw,\ standard\ sed}$, normalized to standard sediment with 10% organic matter. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ sediment}$ is 0.79 $mg/kg_{dw,\ standard\ sed}$. The $MPC_{eco,\ marine\ sediment}$ for the marine environment is the same. The $SRC_{eco,\ sediment}$ is 44 $mg/kg_{dw,\ standard\ sed}$.

3.11.4 Soil

Toxicity tests with two species of springtails are available for benzo[*k*]fluoranthene, one with *Folsomia candida* (Bowmer et al., 1993) and *Folsomia fimetaria* (Sverdrup et al., 2002). In both studies no effects were observed on reproduction and mortality at measured concentrations up to 180 $mg/kg_{dw,\ standard\ soil}$ for *Folsomia candida* and 2100 $mg/kg_{dw,\ standard\ soil}$ for *Folsomia fimetaria*, normalized to standard soil with 10% organic matter. Pore water concentrations are possibly already saturated at concentrations below 50 mg/kg_{dw}. At the levels used in the test increasing or decreasing the concentrations has no effect anymore on the uptake of the substance from pore water. Because there is no value that can be used for terrestrial species, the MPC has to be derived by equilibrium partitioning. A value of 0.79 $mg/kg_{dw,\ standard\ soil}$ is derived for the $MPC_{eco,\ soil}$. Also the $SRC_{eco,\ soil}$ is derived by equilibrium partitioning and is 44 mg/$kg_{dw, standard soil}$. This value is based on saturated pore water concentrations.

3.12 Benzo[*b*]fluoranthene

3.12.1 Substance identification and physicochemical properties

3.12.1.1 Identity

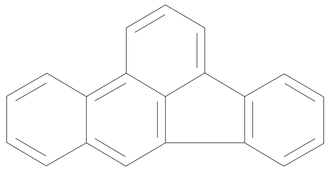

Figure 18: Structural formula of benzo[b]fluoranthene

Table 77: Identification of benzo[b]fluoranthene

Parameter	***Value***
Common/trivial/other name	Benzo[*b*]fluoranthene, 2,3-benzofluoranthene, 3,4-benzofluoranthene, benz[*e*]acephenanthrylene
Chemical name	2,3-benzofluoranthene
CAS number	205-99-2
EC number	205-911-9
SMILES code	c1c2ccccc2c3cccc4c5ccccc5c1c34

3.12.1.2 Physicochemical properties

Table 78: Physicochemical properties of benzo[b]fluoranthene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	252.31	
Water solubility	[µg/L]	1.28	Geometric mean of 2 values by generator-column method
log K_{OW}	[-]	6.124	Calculated ClogP
log K_{OC}	[-]	5.914	QSAR
Vapour pressure	[Pa]	$5 \cdot 10^{-8}$	Method not clear, Antoine equation 363-430 K
Melting point	[°C]	217	
Boiling point	[°C]	480	
Henry's law constant	[Pa.m^3/mol]	0.067	Gas stripping method

3.12.2 Water

Acute toxicity data for benzo[*b*]fluoranthene are only available for *Daphnia magna*. However, in the two available studies no effects were observed below the water solubility in the absence of UV light. In the first study the substance was analysed (Bisson et al., 2000), in the second study (Wernersson and Dave, 1997) concentrations were not verified. In this study the effect of exposure to UV light was studied by placing the daphnids under UV-A (295-365 nm; peak 340 nm; intensity 370±20 µW/cm^2) for 2 hours. Whereas benzo[*b*]fluoranthene was not toxic to daphnids in the absence of UV light, even in concentration far above the aqueous solubility, the toxicity increased after irradiation with UV light, resulting in an EC50 of 4.2 µg/L, which is still amply above the water solubility. In a test with the marine bacterium species *Vibrio fischeri* (Loibner et al., 2004) no adverse effects were observed at concentrations up to the aqueous solubility too. Due to the low solubility of benzo[*b*]fluoranthene of about 1 µg/L, acute effects are not anticipated.

Reliable chronic toxicity studies with freshwater species are available for algae and crustaceans. In the 72-h study with *Pseudokirchneriella subcapitata* the EC10 for growth is larger than 1.0 µg/L (Bisson et al., 2000). For *Ceriodaphnia dubia* no toxicity was observed as well up to 1.1 µg/L and the 7-d EC10 is thus higher than this value (Bisson et al., 2000). In conclusion, no EC50, EC10, or NOEC value is available to base the environmental risk limits upon. The base-set for benzo[*b*]fluoranthene is not complete, because acute data are missing for fish. Chronic data for fish are missing as well. This is the only trophic level that showed the adverse effects below the water solubility for benzo[*k*]fluoranthene. For this reason, the $MPC_{eco, water}$ and $MPC_{eco, marine}$ for benzo[*b*]fluoranthene were taken equal to the risk limits for benzo[*k*]fluoranthene, which has very similar properties (see section 3.11). The $SRC_{eco, water}$ for benzo[*b*]fluoranthene is derived in a similar way to benzo[*k*]fluoranthene as well by taking the solubility limit of 1.3 µg/L.

3.12.3 Sediment

The only available study with benthic organisms is a 10-d study with the marine crustacean *Rhepoxynius abronius* (Boese et al., 1998). No effects on reburial and mortality were observed up to concentrations of 105 $mg/kg_{dw, standard sed}$, normalized to standard sediment with 10% organic matter. Therefore, the MPCs are taken equal to the values for benzo[*k*]fluoranthene. The $MPC_{eco, sediment}$ is 0.79 $mg/kg_{dw, standard sed}$. The $MPC_{eco, marine sediment}$ for the marine environment is the same. The $SRC_{eco, sediment}$ is derived by equilibrium partitioning and is 62 $mg/kg_{dw, standard sed}$.

3.12.4 Soil

One toxicity test with springtails (*Folsomia fimetaria*) is available for benzo[*b*]fluoranthene (Sverdrup et al., 2002). No effects were observed on reproduction and mortality at measured concentrations up to 1300 $mg/kg_{dw, standard soil}$ for *Folsomia fimetaria*, normalized to standard soil with 10% organic matter. Pore water concentrations are possibly already saturated at concentrations slightly above 50 mg/kg_{dw}. At the levels used in the test increasing or decreasing the concentrations has no effect anymore on the uptake of the substance from pore water. Because there is no value that can be used for terrestrial species, the MPC has to be derived by equilibrium partitioning. Because the risk limits for the aquatic compartment are equal to those for benzo[*k*]fluoranthene, the $MPC_{eco, soil}$ is taken equal to the value for benzo[*k*]fluoranthene as well, which was 0.79 $mg/kg_{dw, standard soil}$ (see section 3.11). The $SRC_{eco, soil}$ is derived by equilibrium partitioning and is 62 $mg/kg_{dw, standard soil}$. This value is based on saturated pore water concentrations, which is slightly higher than the value for benzo[*k*]fluoranthene due to the higher solubility.

3.13 Benzo[*a*]pyrene

3.13.1 Substance identification and physicochemical properties

3.13.1.1 Identity

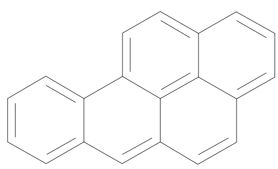

Figure 19: Structural formula of benzo[a]pyrene

Table 79: Identification of benzo[a]pyrene

Parameter	***Value***
Common/trivial/other name	Benzo[*a*]pyrene, 3,4-benzopyrene, benzo[*def*]chrysene
Chemical name	3,4-benzopyrene
CAS number	50-32-8
EC number	200-028-5
SMILES code	c12c3c4cccc3ccc1cc5ccccc5c2cc4

3.13.1.2 Physicochemical properties

Table 80. Physicochemical properties of benzo[a]pyrene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	252.31	
Water solubility	[µg/L]	1.5	Geometric mean of 6 values by the generator-column method
log K_{OW}	[-]	6.13	Slow-stirring method
log K_{OC}	[-]	5.92	QSAR
Vapour pressure	[Pa]	$1.39 \cdot 10^{-8}$	Effusion method
Melting point	[°C]	181.1	
Boiling point	[°C]	495	
Henry's law constant	[Pa.m^3/mol]	0.059	Geometric mean of 1 value by the gas stripping method and 1 value by the wetted-wall method

3.13.2 Water

Acute toxicity data for benzo[*a*]pyrene with freshwater species are available for algae, amphibians, cyanophyta, bacteria, crustaceans including *Daphnia*, insects and fish. For marine species data are available for algae, annelids, bacteria, and crustaceans. However, most data can not be considered reliable, mostly because they are performed at concentrations far above the aqueous solubility, and sometimes due to the excessive use of co-solvent. Further, in many experiments concentrations are not experimentally verified.
The lowest effect observed for algae is the EC10 for *Pseudokirchneriella subcapitata* of 0.78 µg/L (Bisson et al., 2000). This test was performed with a light intensity of 6000 to 8000 lux (~2000 µW/cm^2 with cool white fluorescent lamps). Concentrations were measured. For the same species, the EC10 and EC50 can be estimated from the data presented by Cody et al. (1984). The EC10 under cool white fluorescent light was 10 µg/L, which is above the aqueous solubility. However, under black light with intensities of 0.00032 µW/cm^2 at 670 nm, 0.0019 µW/cm^2 at 550 nm and 5.7 µW/cm^2 at 380 nm, the EC50 was 2.8 µg/L and the EC10 0.96 µg/L. Here, reported concentrations are nominal. Although the light intensities are given at single wavelengths, from the presented spectra it is estimated that the total light intensity is less than 50 µW/cm^2 in all cases. Therefore, the light intensity may play an important role in the lower EC10 from the study by Bisson et al. (2000).
The lowest acute value for immobility of *Daphnia magna* is the EC50 of 0.98 µg/L after exposure for 48 hours with a 16:8 light:dark photoperiod with visible, UV-A (320-400 nm) and UV-B (290-320 nm) with an intensities of 61, 4.4, and 0.45 µmol/m^2/s. At similar intensities without the UV-B component, the EC50 was 1.62 µg/L (Lampi et al., 2006). After exposure for 24 hours with a 16:8 light:dark photoperiod, then 2 hours exposure to UV (295-365 nm; peak 340 nm) with an intensity of 370±20 µW/cm^2 for 2 hours, followed by 1 hour of recovery in the test medium, the EC50 for immobility of *Daphnia magna* was

1.16 µg/L (Wernersson, 2003). In an earlier study with similar exposure except from the fact the recovery period was 1 hour instead of 2 hours, the EC50 was 8.6 µg/L (Wernersson and Dave, 1997). However, in these 3 studies with *Daphnia magna* the concentrations were not verified. In another study with *Daphnia magna* concentrations were verified, but the highest tested concentration was 2.7 µg/L and no toxicity was observed (Bisson et al., 2000). In a study with *Daphnia pulex* in which the concentrations were verified as well, the EC50 was 5 µg/L (Trucco et al., 1983), although this value is above the aqueous solubility of 1.5 µg/L in pure water. It can be concluded that the lowest acute toxic effects are observed in combination with exposure to UV light, although in none of these studies the concentrations were verified, which reduces the reliability.
A study with larvae of fathead minnows (*Pimephales promelas*) was performed to determine the median lethal time (Oris and Giesy Jr., 1987). 7-d old larvae were exposed to a measured concentration of 5.6 µg/L benzo[*a*]pyrene for an incubation period of 24 hour in the absence of UV radiation and thereafter exposed for 96 hours to UV light with an intensity of 20 µW/cm^2 UV-B (290-336 nm), 95 µW/cm^2 UV-A (336-400 nm). After the incubation time of 24 hours, the medium was renewed every 12 hours. The median lethal time was 40 hours, which means that more than 50% mortality occurred in the test period of 120 hours. Although also this concentration was above the water solubility, the concentration in the test medium was verified analytically and no cosolvent was used to prepare the solution.
The selected acute toxicity data are presented in Table 81.

Table 81: Selected acute toxicity data of benzo[a]pyrene to freshwater species

Taxon	***Species***	***LC50 or EC50 [µg/L]***
Crustacea	*Daphnia pulex*	5

Chronic toxicity data are available for freshwater algae, amphibians, crustaceans, plants, fish, and protozoans and marine algae, bacteria, crustaceans, echinoderms, molluscs, and fish. However, also for the chronic data, most studies must be considered unreliable due to the used concentrations that exceed the water solubility.
The 72-h EC10 for growth of *Pseudokirchneriella subcapitata* is 0.78 µg/L and the 7-d EC10 for reproduction of *Ceriodaphnia dubia* is 0.5 µg/L (Bisson et al., 2000). Concentrations were measured. Two ELS studies with *Danio rerio* were performed. No significant effects were observed for mortality, hatchability, length, and weight up to measured concentrations of 4.0 µg/L in a 42-d study (Hooftman and Evers-de Ruiter, 1992b) and no effects on malformations were observed in a 7-d study at concentrations up to 0.44 µg/L (Petersen and Kristensen, 1998).
In a 36-d ELS study with *Oncorhynchus mykiss* solutions were renewed every 7 to 10 days and water concentrations were measured every 5 days. Aqueous concentrations appeared to be rather constant. It appeared that mortality and hatching were not dose-response related in a range of measured concentrations ranging from 0.08 to 3.0 µg/L (Hannah et al., 1982). Only at 2.4 µg/L a significant difference in mortality was observed. The length of alevins was significantly reduced at all benzo[*a*]pyrene concentrations. However, a dose-response relationship was completely lacking and the effect percentage did not exceed 8% at all concentrations. At 0.21, 2.4, and 3.0 µg/L significantly more abnormalities were observed. However, at intermediate concentrations of 0.37 and 1.5 µg/L no significant effects were observed. Therefore, the NOEC for abnormalities is 1.5 µg/L. If the presented data are evaluated with a log-logistic

relationship, an EC10 of 2.9 µg/L is derived. Due to the absence of dose-response relationships for mortality, hatching, and length, this EC10 for abnormalities is considered as most critical endpoint for *Oncorhynchus mykiss*.

Table 82: Selected chronic toxicity data of benzo[a]pyrene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Pseudokirchneriella subcapitata*	0.78
Crustacea	*Ceriodaphnia dubia*	0.503
Pisces	*Oncorhynchus mykiss*	2.9 [a]

Notes to Table 82
[a] Most sensitive endpoint (malformations).

A method for evaluating pollutant genotoxicity, embryotoxicity and teratogenicity using sea urchin (*Strongylocentrotus purpuratus*) embryos was developed and tested using benzo[*a*]pyrene (Hose et al., 1983; Hose, 1985). In this 48-h study with eggs and sperm of the echinoderm *Strongylocentrotus purpuratus* no significant effects were observed on fertilisation success of eggs. After 48 hours however, the embryos exposed to a nominal concentration of 1.0 µg/L benzo[*a*]pyrene and higher showed a significantly higher percentage abnormalities of the gastrulae. Only the nominal concentration of 0.5 µg/L was not significantly different from the solvent (ethanol) control. All treatments, including the solvent control were significantly different from the sea water control. The percentage effect shows a dose-response relationship in the nominal concentrations of 0.5, 1, and 5 µg/L. At higher concentrations, i.e. above the aqueous solubility, the effect percentage remains rather constant. The concentrations were measured and initial concentrations were within 10% of the nominal values. After 48 hours all concentrations had declined to about 0.5 µg/L except from the highest concentrations of 50 µg/L, which had declined to 2 µg/L. In a 48-h study with fertilized eggs of the echinoderm *Psammechinus miliaris* the development of the larvae was examined (AquaSense, 2005). No effects were observed for tested concentrations up to 1.6 µg/L. Concentrations were verified in this study.
The shell development of embryos of the mollusc *Crassostrea gigas* was investigated in a 48-h study (Lyons et al., 2002). Under UV lacking fluorescent laboratory lighting with a photoperiod of 12:12 hours light:dark, the NOEC for abnormal shells is 1 µg/L. With a log-logistic relationship, the derived EC10 from the presented data is 1.1 µg/L. When UV irradiation with an intensity of 456.2±55 µW/cm^2 UV-A and 6.3±0.1 µW/cm^2 UV-B with a photoperiod of 12:12 hours light:dark was used, the NOEC reduced to 0.5 µg/L. The presented data show a clear dose-response relationship and the EC10 derived from these data with a log-logistic equation is 0.22 µg/L. Concentrations were not verified in this study.
In 2 48-h studies with fertilized eggs of the same species (*Crassostrea gigas*) the development of the larvae was examined (AquaSense, 2005). No effects were observed for measured concentrations up to 1.6 µg/L. However, no UV light was used in this study.
In a 7-d ELS study with the marine fish *Fundulus heteroclitus* mild deformities were observed in the benzo[*a*]pyrene treatment groups ranging from 0.25 to 10 µg/L, while these effects were not observed in the controls (Wassenberg et al., 2002). Concentrations were not verified. The percentage effect ranged from 0 to 43% but a dose-response relationship was completely missing. In the second lowest concentration of 0.5 µg/L 0% deformities were observed. Therefore, no useable endpoint can be derived from this study.

In a 6-d ELS study with the marine flatfish *Psettichtys melanostichus* the only tested concentration of 0.1 µg/L resulted in significantly reduced hatching succes (on the fifth day of the study) and in 5% of the embryos deformities were found (Hose et al., 1982). However, in the control group only 57.0% hatched on average, with a range from 21.6 to 89.6%. In the treated group the average hatching success was 28.1% with a range of 7% to 67.6%. The meaning of these results can therefore be questioned, especially because after 120 hours the percentage hatching was almost equal. The exposure concentration in this study was verified.
The only study that resulted in a useable NOEC for marine species is given in Table 83.

Table 83: Selected chronic toxicity data of benzo[a]pyrene to marine species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Echinodermata	*Strongylocentrotus purpuratus*	0.5

Acute toxicity data are available for algae, daphnids and fish. In the chronic studies the lowest reliable values (i.e. with verification of the exposure concentrations) were 0.50 µg/L for the freshwater daphnid *Ceriodaphnia dubia* and the marine echinderm *Strongylocentrotus purpuratus*. However, phototoxicity is not included in these data. The EC50 for daphnids in the presence of UV light was as low as nominal concentrations of 1 µg/L. The NOEC for the mollusc *Crassostrea gigas* was 0.5 µg/L, based on nominal concentrations, while the calculated EC10 was even as low as 0.22 µg/L. Because exposure concentrations of benzo[*a*]pyrene are not rather stable in aquatic test systems, actual concentrations might even have been lower in these systems. An assessment factor of 10 is therefore not justified in this case. Instead an assessment factor of 50 is used. Because data are available for several typical marine species, the same factor can be applied for the marine environment. The $MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$ is therefore 0.010 µg/L.
Phototoxic effects are effects that are very acute of nature. Phototoxicity has been observed for algae, daphnids, fish and molluscs. A $MAC_{eco,\ water}$ and a $MAC_{eco,\ marine}$ are therefore useful parameters. Given the fact that the lowest observed effects are phototoxicity to larvae of molluscs, which have an EC10 based on nominal concentrations that is only 22 times as high as the MPC, the $MAC_{eco,\ water}$ and the $MAC_{eco,\ marine}$ can be taken equal to their respective MPC values.
The SRC_{eco} is based on the geometric mean of the chronic data. As there are species that show effects below the lowest selected NOEC (*Crassostrea gigas*) as well as above the solubility (*Danio rerio* and *Psammechinus miliaris*), the geometric of the selected toxicity data seems a good representative of the HC50. The SRC_{eco} is thus 0.87 µg/L.

3.13.3 Sediment

No data for benthic organisms are available. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ sediment}$ and $MPC_{eco,\ marine\ sediment}$ are the same: 0.49 $mg/kg_{dw,\ standard\ sed}$. The $SRC_{eco,\ sediment}$ is 42 $mg/kg_{dw,\ standard\ sed}$.

3.13.4 Soil

Many toxicity data with terrestrial species are available for benzo[*a*]pyrene. From several studies, it appears that benzo[*a*]pyrene concentrations are stable in the used test systems (Bleeker et al., 2003; Droge et al., 2006; Van Straalen and Verweij, 1991; Van Brummelen and Stuijfzand, 1993; Van Brummelen et

al., 1996). Because nominal concentrations are retrieved in the test systems, this improves the reliability of the data in general.
Due to the low solubility of benzo[*a*]pyrene, pore water concentrations are possibly already saturated at concentrations well below 100 mg/kg_{dw}. Indeed, for several species no effects have been observed, while on the other hand a few NOECs are well above this level of 100 mg/kg_{dw}. For the earthworm *Eisenia andrei*, the mite *Hypoaspis aculeifer*, the springtails *Folsomia candida* and *Folsomia fimetaria*, the terrestial plants *Avena sativa*, *Brassica rapa*, *Sinapsis alba* and *Trifolium pratense*, and the terrestrial processes respiration and dehydrogenase no effects were observed at a concentration of 69 $mg/kg_{dw,\ standard\ soil}$ and mostly much higher. For the species and processes for which a NOEC or EC10 could be derived, the selected data are presented in Table 84.

Table 84: Selected chronic toxicity data of benzo[a]pyrene to terrestrial species and processes

Taxon	***Species***	***NOEC/EC10 [mg/kg$_{standard\ soil}$]***
Annelida	*Eisenia f. fetida*	26 [a]
Crustacea	*Oniscus asellus*	8.1 [b]
Crustacea	*Porcellio scaber*	1.6
Macrophyta	*Lolium perenne*	307
Microbial process	nitrification	1046

Notes to Table 84
[a] Most sensitive endpoint (cocoon production).
[b] Most sensitive endpoint (fresh weight).

In one study with the pot worm *Enchytraeus crypticus* a concentration of 26 $mg/kg_{dw,\ standard\ soil}$, recalculated to a soil with 10% organic matter, caused 24% reduction in reproduction. This concentration is referred to as threshold concentration (Achazi et al., 1995). This concentration is probably referring to significant effects. The concentration below this threshold concentration was 2.6 $mg/kg_{dw,\ standard\ soil}$. The reliability of the results with *Eisenia fetida* from the same study have been classified as unassignable, because two batches of seemingly similar benzo[*a*]pyrene yielded different results. The values mentioned in this study with *Eisenia fetida* showed markedly more toxicity than the values in a similar, later study from the same group (Schaub and Achazi, 1996). However, in its turn these values from the latter study with *Eisenia fetida* have been reevaluated as well, because the control for benzo[*a*]pyrene yielded much higher reproduction values (about twice as high) than the control for fluoranthene and all low concentrations for both compounds, resulting in significant effects mentioned in the study at the lowest concentrations for benzo[*a*]pyrene.
Because of the large data set for benzo[*a*]pyrene, which covers all trophic levels and includes 14 species from 4 taxonomic groups and 3 terrestial processes, a minimum assessment factor of 10 should be used to derive the $MPC_{eco,\ soil}$. This $MPC_{eco,\ soil}$ thus becomes 0.16 $mg/kg_{dw,\ standard\ soil}$. With this data set the use of a species sensitivity distribution seems justified, but the method to deal with the studies resulting in no effects is not available at this moment. Because for most species effects are not observed up to the level of the aqueous solubility in pore water, the $SRC_{eco,\ soil}$ is derived by equilibrium partitioning from the aqueous solubility and is 76 $mg/kg_{dw,\ standard\ soil}$.

3.14 Benzo[*ghi*]perylene

3.14.1 Substance identification and physicochemical properties

3.14.1.1 Identity

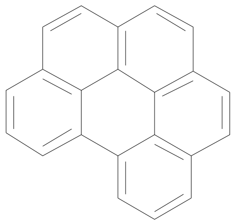

Figure 20: Structural formula of benzo[ghi]perylene

Table 85: Identification of benzo[ghi]perylene

Parameter	***Value***
Common/trivial/other name	Benzo[*ghi*]perylene, 1,12-benzoperylene, benzoperylene
Chemical name	1,12-benzoperylene
CAS number	191-24-2
EC number	205-883-8
SMILES code	c16cccc2ccc3ccc4ccc5cccc6c5c4c3c12

3.14.1.2 Physicochemical properties

Table 86: Physicochemical properties of benzo[ghi]perylene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	276.33	
Water solubility	[µg/L]	0.31	Geometric mean of 2 values by the generator-column method
log K_{OW}	[-]	6.22	Slow-stirring method
log K_{OC}	[-]	6.01	QSAR
Vapour pressure	[Pa]	$1.39 \cdot 10^{-8}$	Effusion method
Melting point	[°C]	272.5	
Boiling point	[°C]	525	
Henry's law constant	[Pa.m^3/mol]	0.034	Gas stripping method

3.14.2 Water

For algae no EC50 is presented. However, in the 72-h study with *Pseudokirchneriella subcapitata* the EC10 for growth is higher than 0.16 µg/L (Bisson et al., 2000) and hence the EC50 must also be higher than this value. The lowest acute value for immobility of *Daphnia magna* is the EC50 of 0.13 µg/L after exposure for 48 hours with a 16:8 light:dark photoperiod with visible, UV-A (320-400 nm) and UV-B (290-320 nm) with an intensities of 61, 4.4, and 0.45 µmol/m^2/s. At similar intensities without the UV-B component, the EC50 was 1.04 µg/L (Lampi et al., 2006). However, in this study with *Daphnia magna* the concentrations were not verified. Besides that, the solubility of benzo[*ghi*]perylene is amply below 1 µg/L, while the EC50 determined without UV-B illumination is above 1 µg/L. In another study with *Daphnia magna* concentrations were verified, but the highest tested concentration was 0.2 µg/L and no toxicity was observed (Bisson et al., 2000).
For fish, no standard acute toxicity data are available. A study with larvae of *Pimephales promelas* was performed to determine the median lethal time (Oris and Giesy Jr., 1987). 7-d old larvae were exposed to a measured concentration of 0.15 µg/L benzo[*ghi*]perylene for an incubation period of 24 hours in the

absence of UV radiation and thereafter exposed for 96 hours to UV light with an intensity of 20 μW/cm^2 UV-B (290-336 nm), 95 μW/cm^2 UV-A (336-400 nm). After the incubation time of 24 hours, the medium was renewed every 12 hours. After 120 hours, of which the last 96 hours were with UV radiation, less than 20% mortality of the fish larvae occurred at 0.15 μg/L.
Reliable chronic toxicity studies with freshwater species are available for algae, crustaceans and fish. The 72-h EC10 for the growth rate of *Pseudokirchneriella subcapitata* (Bisson et al., 2000) and the 42-d NOEC in an ELS test with *Danio rerio* (Hooftman and Evers-de Ruiter, 1992b) were higher than 0.16 μg/L. The EC10 in a 7-d study with *Ceriodaphnia dubia* was 0.082 μg/L. In both the test with *C. dubia* and *P. subcapitata* and the test with *D. rerio* concentrations were measured. In further tests with duckweed (Huang et al., 1997a) and marine bacteria (El-Alawi et al., 2002; Loibner et al., 2004) no adverse effects were observed, but in all these studies concentrations were not verified or experimental details about solubility in test medium are missing. The only reliable study with a value that can be used for risk assessment is therefore the EC10 for *C. dubia* (Table 87).

Table 87: Selected chronic toxicity data of benzo[ghi]perylene to freshwater species

Taxon	***Species***	***NOEC or EC10 [μg/L]***
Crustacea	*Ceriodaphnia dubia*	0.082

The determination of the lethal time for *Pimephales promelas* can be considered as an acute fish study and hence the base-set can be considered as complete, although no reliable EC50 values are available, mostly due to the fact that without UV illumination benzo[*ghi*]perylene is not toxic up to the water solubility. Chronic toxicity data are available for algae, crustaceans and fish. Therefore, an assessment factor of 10 should be applied to derive the $MPC_{eco,\ water}$. The lowest NOEC or EC10 is the EC10 of 0.082 μg/L for *Ceriodaphnia dubia*. The $MPC_{eco,\ water}$ for freshwater is 0.0082 μg/L. Because no studies with additional marine species are available, the $MPC_{eco,\ marine}$ is derived by applying an assessment factor of 100. The $MPC_{eco,\ marine}$ is 0.00082 μg/L. No acute EC50s have been selected due to the shortcomings of the studies described above. However, from these studies, it is clear that for daphnids acute toxic effects due to phototoxicity occur at nominal concentrations that lie in the same range as the chronic effects. The $MAC_{eco,\ water}$ and the $MAC_{eco,\ marine}$ can therefore be taken equal to their respective MPC values. Because of the 3 valid chronic toxicity studies, only the value for crustaceans is below the water solubility and the value for algae and fish did not result in effects up to concentrations of 0.16 μg/L, the $SRC_{eco,\ water}$ could be taken equal to this limit value to reflect the HC50.

3.14.3 Sediment

No data for benthic organisms are available. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ sediment}$ is 0.49 mg/$kg_{dw,\ standard\ sed}$. For the marine environment, this number is a factor of 10 lower. The $MPC_{eco,\ marine\ sediment}$ is 0.049 mg/$kg_{dw,\ standard\ sed}$. The $SRC_{eco,\ sediment}$ is 9.6 mg/$kg_{dw,\ standard\ sed}$.

3.14.4 Soil

Only one toxicity test with terrestrial species is available for benzo[*ghi*]perylene (Bowmer et al., 1993). In this test with the springtail *Folsomia candida* no effects were observed on reproduction and mortality up to measured concentrations of 180 mg/kg$_{dw}$ in a soil with 10% organic matter. Pore water concentrations are possibly already saturated at concentrations well below 100 mg/kg$_{dw}$. At the levels used in the test increasing or decreasing the concentrations has no effect anymore on the uptake of the substance from pore water. Because there is no value that can be used for terrestrial species, the MPC has to be derived by equilibrium partitioning. A value of 0.49 mg/kg$_{dw, standard soil}$ is derived for the MPC$_{eco, soil}$. Also the SRC$_{eco, soil}$ is derived by equilibrium partitioning and is 9.6 mg/kg$_{dw, standard soil}$.

3.15 Dibenz[*a,h*]anthracene

3.15.1 Substance identification and physicochemical properties

3.15.1.1 Identity

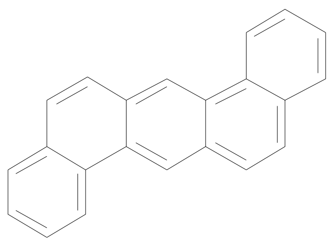

Figure 21: Structural formula of dibenz[a,h]anthracene

Table 88: Identification of dibenz[a,h]anthracene

Parameter	***Value***
Common/trivial/other name	Dibenz[*a,h*]anthracene, 1,2,5,6-dibenzanthracene
Chemical name	Dibenz[*a,h*]anthracene
CAS number	53-70-3
EC number	200-121-8
SMILES code	c12ccccc1ccc3cc4c5ccccc5ccc4cc23

3.15.1.2 Physicochemical properties

Table 89. Physicochemical properties of dibenz[a,h]anthracene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	278.34	
Water solubility	[µg/L]	0.91	Geometric mean of 3 values by the shake-flask method
log K_{OW}	[-]	6.55	Average of two values determined by the shake-flask method
log K_{OC}	[-]	6.29	QSAR
Vapour pressure	[Pa]	$3.7 \cdot 10^{-10}$	Effusion method
Melting point	[°C]	269.5	
Boiling point	[°C]	524	
Henry’s law constant	[Pa.m^3/mol]	0.035	Calculated from vapour pressure and solubility

3.15.2 Water

For algae no EC50 is presented. However, in the 72-h study with *Pseudokirchneriella subcapitata* the EC10 for growth is 0.14 µg/L (Bisson et al., 2000) and hence the EC50 must be higher than this value.
The lowest acute value for immobility of *Daphnia magna* is the EC50 of 0.55 µg/L after exposure for 48 hours with a 16:8 light:dark photoperiod with

visible, UV-A (320-400 nm) and UV-B (290-320 nm) with an intensities of 61, 4.4, and 0.45 μmol/m^2/s. At similar intensities without the UV-B component, the EC50 was 1.56 μg/L (Lampi et al., 2006). An EC50 of 1.8 μg/L was observed for *Daphnia magna* after exposure for 24 hours with a 16:8 light:dark photoperiod, then 2 hours exposure under UV irradiation (295-365 nm; peak 340 nm) with an intensity of 370±20 μW/cm^2 for 2 hours, followed by 1 hour of recovery in the test medium (Wernersson, 2003). In an earlier study with similar exposure except from the fact that the recovery period was 1 hour instead of 2 hours, the EC50 was 4.6 μg/L (Wernersson and Dave, 1997). While in the first study a co-solvent was used, solutions in the latter two studies were prepared by coating the substance on the bottom of a glass vessel. However, in none of these studies with *Daphnia magna* the concentrations were verified. Besides that, the solubility of dibenz[*a,h*]anthracene is below 1 μg/L. In another study with *Daphnia magna* concentrations were verified, but the highest tested concentration was 0.34 μg/L and no toxicity was observed (Bisson et al., 2000). For fish, no standard acute toxicity data are available. A study with larvae of *Pimephales promelas* was performed to determine the median lethal time (Oris and Giesy Jr., 1987). 7-d old larvae were exposed to a measured concentration of 0.15 μg/L dibenz[*a,h*]anthracene for an incubation period of 24 hours in the absence of UV radiation and thereafter exposed for 96 hours to UV light with an intensity of 20 μW/cm^2 UV-B (290-336 nm), 95 μW/cm^2 UV-A (336-400 nm). After the incubation time of 24 hours, the medium was renewed every 12 hours. After 120 hours, of which the last 96 hours were with UV radiation, no mortality of the fish larvae occurred at 0.15 μg/L.
Reliable chronic toxicity studies with freshwater species are available for crustaceans and algae. No effect was observed at concentrations up to 0.032 μg/L in a 7-d study with *Ceriodaphnia dubia*. The 72-h EC10 for the growth rate of *Pseudokirchneriella subcapitata* was 0.14 μg/L (Bisson et al., 2000). In both the test with *C. dubia* and *P. subcapitata* concentrations were measured. In further tests with duckweed (Huang et al., 1997a) and marine bacteria (El-Alawi et al., 2002; Loibner et al., 2004), algae (Boney and Corner, 1962) and annelids (Rossi and Neff, 1978) no adverse effects were observed, but in all these studies concentrations were not verified or experimental details about solubility in test medium are missing. The only reliable study with a value that can be used for risk assessment is therefore the EC10 for *P. subcapitata* (Table 90).

Table 90: Selected chronic toxicity data of dibenz[a,h]anthracene to freshwater species

Taxon	***Species***	***NOEC or EC10 [μg/L]***
Algae	*Pseudokirchneriella subcapitata*	0.14

The determination of the lethal time for *Pimephales promelas* can be considered as an acute fish study and hence the base-set can be considered as complete, although no reliable EC50 values are available, mostly due to the fact that without illumination with UV light no toxic effects were observed up to the water solubility. Chronic toxicity data are available for algae and crustaceans but not for fish. Because the concentration that was tested with *Pimephales promelas* at which no mortality occurred is as low as the EC10 for algae, fish might be the most sensitive species of the base-set. Further, the highest tested concentration for *Ceriodaphnia dubia* was four times lower than the EC10 for *Pseudokirchneriella subcapitata*. Therefore, an assessment factor of 100 should be applied to derive the $MPC_{eco,\ water}$. The lowest NOEC or EC10 is the EC10 of 0.14 μg/L for growth of *Pseudokirchneriella subcapitata*. The $MPC_{eco,\ water}$ for freshwater is 0.0014 μg/L. Because no studies with additional marine species are available, the $MPC_{eco, marine}$ is derived by applying an assessment factor of 1000. The $MPC_{eco, marine}$ is 0.00014 μg/L. No acute EC50s have been selected due to the shortcomings of the studies described above. However, from these studies, it is clear that for daphnids acute toxic effects due to phototoxicity occur at nominal concentrations that lie in the same range as the chronic effects for algae. However, because phototoxicity is a very sensitive acute effect, assessment factors of 100 and 1000 seem not justified for the $MAC_{eco, water}$ and the $MAC_{eco, marine}$. Instead, the $MAC_{eco, water}$ and the $MAC_{eco, marine}$ can therefore be taken equal to their respective MPC values multiplied by a factor of 10, i.e. 0.014 μg/L and 0.0014 μg/L, respectively. The value of the $SRC_{eco, water}$ could be taken equal to the only available NOEC of 0.14 μg/L, because no information is available for fish and the EC10 for daphnids could be higher than this NOEC but a factor of 4 lower as well.

3.15.3 Sediment

No data for benthic organisms are available. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco, sediment}$ is 0.18 $mg/kg_{dw, standard sed}$. For the marine environment, this number is a factor of 10 lower. The $MPC_{eco, marine sediment}$ is 0.018 $mg/kg_{dw, standard sed}$. The $SRC_{eco, sediment}$ is 18 $mg/kg_{dw, standard sed}$.

3.15.4 Soil

Only one toxicity test with terrestrial species is available for dibenz[*a,h*]anthracene (Sverdrup et al., 2002). In this test with the springtail *Folsomia fimetaria* no effects were observed on reproduction and mortality up to measured concentrations of 2870 mg/kg_{dw}, normalized to standard soil with 10% organic matter. Pore water concentrations are possibly already saturated at about 100 mg/kg_{dw}. At the levels used in the test increasing or decreasing the concentrations has no effect anymore on the uptake of the substance from pore water. Because there is no value that can be used for terrestrial species, the MPC has to be derived by equilibrium partitioning. The resulting $MPC_{eco, soil}$ is 0.18 $mg/kg_{dw, standard soil}$ is derived. Also the $SRC_{eco, soil}$ is derived by equilibrium partitioning and is 18 $mg/kg_{dw, standard soil}$.

3.16 Indeno[1,2,3-*cd*]pyrene

3.16.1 Substance identification and physicochemical properties

3.16.1.1 Identity

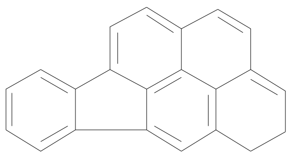

Figure 22: Structural formula of indeno[1,2,3-cd]pyrene

Table 91: Identification of indeno[1,2,3-cd]pyrene

Parameter	***Value***
Common/trivial/other name	Indeno[1,2,3-*cd*]pyrene, 2,3-*o*-phenylenepyrene
Chemical name	Indeno[1,2,3-*cd*]pyrene
CAS number	193-39-5
EC number	205-893-2
SMILES code	c1ccc2c(c1)c3ccc4ccc5cccc6cc2c3c4c56

3.16.1.2 Physicochemical properties

Table 92: Physicochemical properties of indeno[1,2,3-cd]pyrene

Parameter	***Unit***	***Value***	***Remark***
Molecular weight	[g/mol]	276.33	
Water solubility	[µg/L]	0.19	Generator-column method
log K_{OW}	[-]	6.584	Calculated ClogP
log K_{OC}	[-]	6.374	QSAR
Vapour pressure	[Pa]	$1.0 \cdot 10^{-8}$	
Melting point	[°C]	162	
Boiling point	[°C]		
Henry's law constant	[Pa.m^3/mol]	0.035	Gas stripping method

3.16.2 Water

Very few data are available for indeno[1,2,3-*cd*]pyrene. In the acute toxicity study 48-h with *Daphnia magna*, concentrations were measured (Bisson et al., 2000). No toxicity was observed but the test range was up to 357 µg/L, which is far above the solubility limit. In a study with the luminescent marine bacterium *Vibrio fischeri* no inhibition of the bioluminescence was observed up to the level of the water solubility. However, the solubility was not reported (Loibner et al., 2004). Two chronic studies are available in which the aqueous concentrations were measured (Bisson et al., 2000). These values are presented in Table 93.

Table 93: Selected chronic toxicity data of indeno[1,2,3-cd]pyrene to freshwater species

Taxon	***Species***	***NOEC or EC10 [µg/L]***
Algae	*Pseudokirchneriella subcapitata*	1.5
Crustacea	*Ceriodaphnia dubia*	0.27

The base-set is not complete for indeno[1,2,3-*cd*]pyrene. However, due to the hydrophobicity acute toxic effects are not expected to occur. With the EC10 for reproduction of *Ceriodaphnia dubia* and growth rate of *Pseudokirchneriella subcapitata* 2 sensitive endpoints are covered that are among the lowest effect concentrations for 6 other PAHs. Therefore, an assessment factor of 100 is applied to the lowest EC10, despite the fact that the base-set is not complete. The resulting $MPC_{eco,\ water}$ is 0.0027 µg/L.
No suitable chronic toxicity data are available for marine species. The assessment factor for marine water is 1000 in this case. The $MPC_{eco,\ marine}$ is 0.00027 µg/L. Because of the absence of acute toxicity, a $MAC_{eco,\ water}$ can not be derived. The $SRC_{eco,\ water}$ is equal to the geometric mean of the two chronic data and is 0.64 µg/L.

3.16.3 Sediment

No data for benthic organisms are available. Therefore, the ERLs are derived by means of equilibrium partitioning. The $MPC_{eco,\ sediment}$ is 0.38 $mg/kg_{dw,\ standard\ sed}$.

For the marine environment, this number is a factor of 10 lower. The $MPC_{eco, marine sediment}$ is 0.038 mg/$kg_{dw, standard sed}$. The $SRC_{eco, sediment}$ is 89 mg/$kg_{dw, standard sed}$.

3.16.4 Soil

Only one toxicity test with terrestrial species is available for indeno[1,2,3-*cd*]pyrene (Sverdrup et al., 2002). In this test with the springtail *Folsomia fimetaria* no effects were observed on reproduction and mortality up to measured concentrations of 3350 mg/kg_{dw}, normalized to standard soil with 10% organic matter. Pore water concentrations are possibly already saturated below 100 mg/kg_{dw}. At the levels used in the test increasing or decreasing the concentrations has no effect anymore on the uptake of the substance from pore water. Because this value can not be used, the MPC for terrestrial species has to be derived by equilibrium partitioning. For the $MPC_{eco, soil}$ a value of 0.38 mg/$kg_{dw, standard soil}$ is derived. Also the $SRC_{eco, soil}$ is derived by equilibrium partitioning and is 89 mg/$kg_{dw, standard soil}$.

4 Summary and analysis of data

4.1 Overview of derived risk limits

An overview of the derived risk limits is given in Table 94.

For comparison, the formerly derived ecotoxicological MPC values (Kalf et al., 1995) are shown in Table 95. It can be concluded that the new values for the MPC are generally lower than the formerly derived values (Kalf et al., 1995), especially for the higher PAHs. It has to be noted that for several of the higher PAHs the ecotoxicological values were derived from QSAR calculations without a further assessment factor. In the revision of the first tranche Intervention Values, new MPC values were derived on the basis of the same data as well (Verbruggen et al., 2001). For the values that were derived from QSARs (chrysene, benzo[*ghi*]perylene, and indeno[1,2,3-*cd*]pyrene) an additional assessment factor of 10 was applied. For several of the other substances a higher assessment factor was applied, in accordance with the methodology that has been followed since that time as documented in the Technical Guidance Document (European Commission, 2003) and the guidance for the Water Framework Directive (Lepper, 2005). These lower values are generally lower than the values derived in the current evaluation, which are based on more data with mostly a lower assessment factor.
For almost all PAHs the values for soil and sediment were solely based on the equilibrium partitioning method. In the current evaluation more and more reliable data for these higher PAHs were available and QSARs were not applied anymore. Many reliable studies for benthic and especially terrestrial species have been found, which made it possible to base the ERLs for soil and sediment on direct toxicity instead of equilibrium partitioning.

In Table 96, a comparison of the new SRC_{eco} values with the formerly derived ecotoxicological and human toxicological SRC values (Lijzen et al., 2001) is made. A comparison of the SRC values shows that the newly derived ecotoxicological values are generally somewhat higher than the ecotoxicological values derived in the revision of the first tranche Intervention Values (Verbruggen et al., 2001; Lijzen et al., 2001). However, the ecotoxicological values are especially for the lower PAHs much lower than the human toxicological values (Lijzen et al., 2001), while these values are in the same order of magnitude for the higher PAHs.

The derived values can also be compared with the Environmental Quality Standards that are set under the Water Framework Directive for priority substances under Directive 2008/105/EC. This comparison is shown in Table 97. Although the number of data included in the derivation is generally lower, the Environmental Quality Standards from the Water Framework Directive are mostly higher than the values derived in this report. This is remarkable for several reasons. First, in most cases the lowest assessment factors have been used in this report for the MAC_{eco} values. This means that the lowest reliable values have not been considered in the derivation of the quality standards for the Water Framework Directive. For fluoranthene, it should be noted that the $MAC_{eco,\ water}$ is at the level of the HC5 for acute data derived in this report (L(E)C50 data and no NOECs or EC10s). The extra assessment factor for the marine environment is applied in this report, because no reliable data for additional marine taxonomic groups were available for the higher PAHs. These

data were not available for the derivation of the quality standards under the WFD as well, but still the same assessment factor has been applied as for freshwater.
Further, it is remarkable that Directive 2008/105/EC clearly states that each individual EQS is applicable, which means that the toxic unit approach should not be applied, which differs from the proposed values in this report, because concentration addition should be considered to apply to the mixture of PAHs.

Table 94: Overview of the derived risk limits for each PAH individually. Concentrations in water are in µg/L, concentrations in soil and sediment in mg/kg$_{dw\ standard\ soil/sed}$ containing 10% organic matter

Compound	***MAC$_{eco,\ water}$***	***MAC$_{eco,\ marine}$***	***MPC$_{eco,\ water}$***	***MPC$_{eco,\ marine}$***	***SRC$_{eco,\ water}$***	***MPC$_{eco,\ sediment}$***	***MPC$_{eco,\ marine\ sediment}$***	***SRC$_{eco,\ sediment}$***	***MPC$_{eco,\ soil}$***	***SRC$_{eco,\ soil}$***
Naphthalene	130	130	2.0	2.0	518	0.16	0.16	42	0.69	14
Acenaphthylene	33	3.3	1.3	0.13	72	0.17	0.017	9.5	0.17	9.4
Acenaphthene	3.8	0.76	3.8	0.38	102	0.97	0.10	31	0.68	31
Fluorene	34	6.8	1.5	0.30	117	0.83	0.17	64	1.6	82
Phenanthrene	6.7	6.7	1.1	1.1	43	0.78	0.78	63	3.6	90
Anthracene	0.10	0.10	0.10	0.10	4.2	0.047	0.0047	3.2	0.34	60
Pyrene	0.023	0.023	0.023	0.023	4.2	1.67	0.84	136	1.8	53
Fluoranthene	0.12	0.12	0.12	0.12	12	4.11	4.11	96	4.8	309
Chrysene	0.070	0.0070	0.070	0.0070	1.6	1.64	0.16	38	1.6	38
Benz[*a*]anthracene	0.10	0.010	0.012	0.0012	3.1	0.35	0.04	91	0.19	91
Benzo[*k*]fluoranthene			0.017	0.017	0.93	0.79	0.79	44	0.79	44
Benzo[*b*]fluoranthene			0.017	0.017	1.3	0.79	0.79	62	0.79	62
Benzo[*a*]pyrene	0.010	0.010	0.010	0.010	0.87	0.49	0.49	42	0.16	76
Benzo[*ghi*]perylene	0.0082	0.00082	0.0082	0.00082	0.16	0.49	0.049	10	0.49	10
Dibenz[*a,h*]anthracene	0.014	0.0014	0.0014	0.00014	0.14	0.18	0.018	18	0.18	18
Indeno[1,2,3-*cd*]pyrene			0.0027	0.00027	0.64	0.38	0.038	89	0.38	89

Table 95: Comparison of the formerly derived MPCs for PAHs with the values derived in this report. Concentrations in water are in µg/L, concentrations in soil and sediment in mg/kg$_{dw\ standard\ soil/sed}$ containing 10% organic matter

MPC	***MPC$_{eco,\ water}$***	***MPC$_{eco,\ water}$***	***MPC$_{eco,\ water}$***	***MPC$_{eco,\ sediment}$***	***MPC$_{eco,\ sediment}$***	***MPC$_{eco,\ sediment}$***	***MPC$_{eco,\ soil}$***	***MPC$_{eco,\ soil}$***	***MPC$_{eco,\ soil}$***
Reference	a	b	c	a	b	c	a	b	c
Naphthalene	2.0	2.1	1.2	0.16	0.12	0.14	0.69	0.12	0.14
Acenaphthylene	1.3			0.17			0.17		
Acenaphthene	3.8			0.97			0.68		
Fluorene	1.5			0.83			1.6		
Phenanthrene	1.1	3.2	0.30	0.78	3.3	0.51	3.6	3.3	0.51
Anthracene	0.10	0.034	0.07	0.05	0.039	0.12	0.34	0.039	0.12
Pyrene	0.023			1.67			1.8		
Fluoranthene	0.12	0.12	0.30	4.11	1.0	2.6	4.8	1.0	2.6
Chrysene	0.070	0.28	0.34	1.64	8.1	10.7	1.6	8.1	10.7
Benz[*a*]anthracene	0.012	0.010	0.01	0.35	0.025	0.36	0.19	0.49	0.25
Benzo[*k*]fluoranthene	0.017	0.0036	0.04	0.79	0.38	2.4	0.79	0.38	2.4
Benzo[*b*]fluoranthene	0.017			0.79			0.79		
Benzo[*a*]pyrene	0.010	0.0050	0.05	0.49	0.052	2.7	0.16	0.19	0.26
Benzo[*ghi*]perylene	0.0082	0.0031	0.03	0.49	0.57	7.5	0.49	0.57	7.5
Dibenz[*a,h*]anthracene	0.0014			0.18			0.18		
Indeno[1,2,3-*cd*]pyrene	0.0027	0.00061	0.04	0.38	0.031	5.9	0.38	0.031	5.9

a This report.
b Verbruggen (2001).
c Kalf (1995).

Table 96: Comparison of the formerly derived SRCs for PAHs with the values derived in this report. Concentrations in water are in µg/L, concentrations in soil and sediment in mg/kg$_{dw\ standard\ soil/sed}$ containing 10% organic matter

SRC	***SRC$_{eco,\ water}$***	***SRC$_{eco,\ water}$***	***SRC$_{human,\ gw}$***	***C$_{max}$ in drinking water***	***SRC$_{eco,\ sediment}$***	***SRC$_{eco,\ sediment}$***	***SRC$_{human,\ sediment}$***	***SRC$_{eco,\ soil}$***	***SRC$_{eco,\ soil}$***	***SRC$_{human,\ soil}$***
Reference	a	b	c	d	a	b	c	a	b	c
Naphthalene	518	290	15,600	1260	42	17	120	14	17	870
Acenaphthylene	72		4010	1570	9.5		170	9.4		26,000
Acenaphthene	102		2570	15,700	31		47,000	31		>100,000
Fluorene	117		1320	1260	64		210	82		23,000
Phenanthrene	43	30	850	1260	63	31	440	90	31	23,000
Anthracene	4.2	1.4	71	1260	3	1.6	4200	60	1.6	25,500
Pyrene	4.2		106	15,700	136		60,000	53		>100,000
Fluoranthene	11	30	201	1570	96	260	1600	309	260	30,300
Chrysene	1.6	1.2	1.8	1570	38	35	6000	38	35	32,000
Benz[*a*]anthracene	3.1	1.0	12	157	91	49	290	91	2.5	3000
Benzo[*k*]fluoranthene	0.93	0.36	0.48	157	44	38	560	44	38	3200
Benzo[*b*]fluoranthene	1.3		17	157	62		100	62		2800
Benzo[*a*]pyrene	0.87	0.72	0.84	16	42	28	17	76	7.0	280
Benzo[*ghi*]perylene	0.16	0.18	0.19	942	10	33	3600	10	33	19,200
Dibenz[*a,h*]anthracene	0.14		0.83	16	18		27	18		70
Indeno[1,2,3-*cd*]pyrene	0.64	0.036	0.26	157	89	1.9	580	89	1.9	3200

a This report.
b Formerly derived ecotoxicological values(Verbruggen et al., 2001).
c Risk value used for deriving serious soil and groundwater contamination (Lijzen et al., 2001).
d Direct consumption of groundwater as drinkingwater for the derivation of the overall SRC$_{gw}$, recalculated values are slightly different from earlier reported values (Lijzen et al., 2001).

Table 97: Comparison of the Environmental Quality Standards for PAHs under the Water Framework Directive (2008/105/EC) with the values derived in this report. Concentrations in water are in µg/L

ERL	***$MAC_{eco, water}$***	***$MAC_{eco, water}$***	***$MAC_{eco, marine}$***	***$MAC_{eco, marine}$***	***$MPC_{eco, water}$***	***$MPC_{eco, water}$***	***$MPC_{eco, marine}$***	***$MPC_{eco, marine}$***
Reference	a	b	a	b	a	b	a	b
Naphthalene	130	n.a.	130	n.a.	2.0	2.4	2.0	1.2
Acenaphthylene	33		3.3		1.3		0.13	
Acenaphthene	3.8		0.76		3.8		0.38	
Fluorene	34		6.8		1.5		0.30	
Phenanthrene	6.7		6.7		1.1		1.1	
Anthracene	0.10	0.4	0.10	0.4	0.10	0.1	0.10	0.1
Pyrene	0.023		0.023		0.023		0.023	
Fluoranthene	0.12	1	0.12	1	0.12	0.1	0.12	0.1
Chrysene	0.070		0.0070		0.070		0.0070	
Benz[*a*]anthracene	0.10		0.010		0.012		0.0012	
Benzo[*k*]fluoranthene					0.017	Σ0.03	0.017	Σ0.03
Benzo[*b*]fluoranthene					0.017	Σ0.03	0.017	Σ0.03
Benzo[*a*]pyrene		0.1		0.1	0.010	0.05	0.010	0.05
Benzo[*ghi*]perylene	0.0082		0.00082		0.0082	Σ0.002	0.00082	Σ0.002
Dibenz[*a,h*]anthracene	0.014		0.0014		0.0014		0.00014	
Indeno[1,2,3-*cd*]pyrene					0.0027	Σ0.002	0.00027	Σ0.002

a This report.
b WFD (2008/105/EC).

4.2 Environmental risk limits on the basis of internal lipid residues

The derived risk limits appear to be rather different from each other. However, a closer look at the data shows that the difference is largely explained by the differences in hydrophobicity if the risk limits for water are considered, while the risk limits for soil and sediment are more or less constant at least for the $SRC_{eco,\ soil}$ and $SRC_{eco,\ sediment}$. This is more prominent, when instead of the risk limits the individual selected data are considered. In Figure 23 all selected acute toxicity data for both freshwater and marine species are presented as a function of the log K_{ow} of each PAH. Although there is a trend with log K_{ow} it appears that the most phototoxic PAHs (anthracene, pyrene, and fluoranthene in the middle of the figure) lead to very low values in comparison with the other PAHs.
A clearer picture is created if the chronic toxicity data are considered. These data are presented in Figure 24. It appears that the toxicity, expressed as a band width of species sensitivity, increases with increasing hydrophobicity. This reflects the increasing bioconcentration of PAHs with increasing hydrophobicity, at least in invertebrates and young fish that do mostly not metabolize PAHs to a significant content.
When soil and sediment are considered, not only bioaccumulation into terrestrial and benthic organisms exposed via the pore water phase is hydrophobicity dependent, but the sorption to organic matter in the soil and sediment as well. This results in more or less constant toxicity with increasing hydrophobicity. Indeed this is observed. No clear relationship of the toxicity with hydrophobicity is found for both terrestrial species (Figure 25) and benthic species (Figure 26).

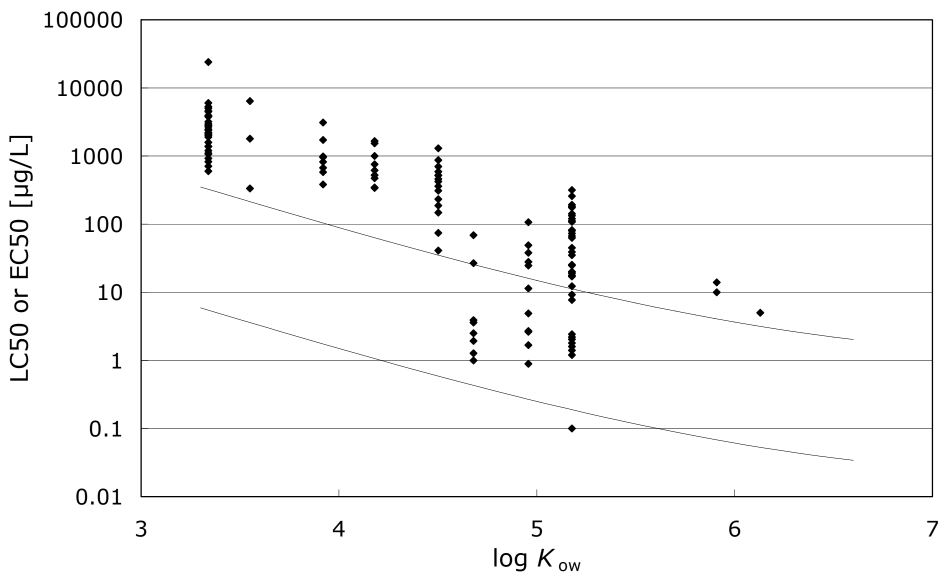

Figure 23: Acute toxicity of PAHs to freshwater and marine aquatic species as a function of hydrophobicity

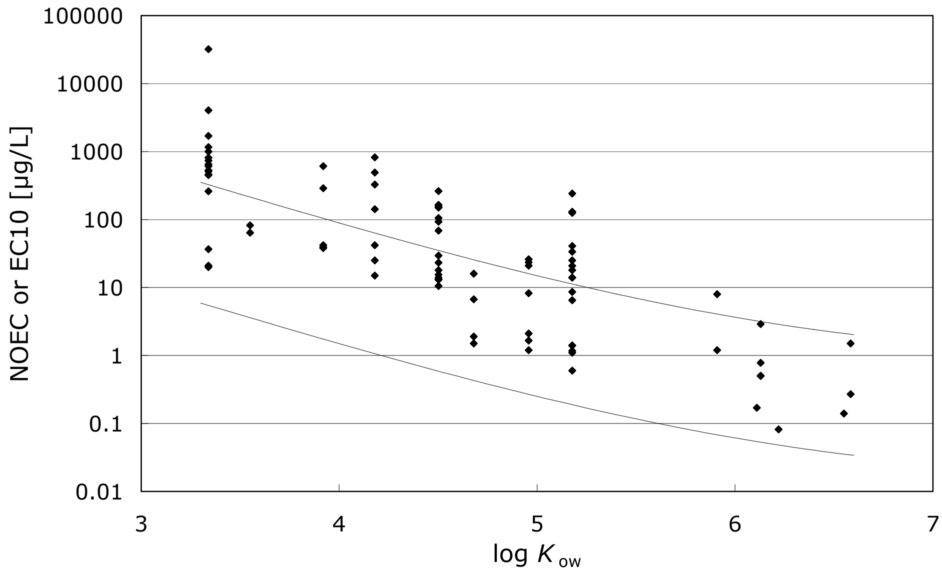

Figure 24: Chronic toxicity of PAHs to freshwater and marine aquatic species as a function of hydrophobicity

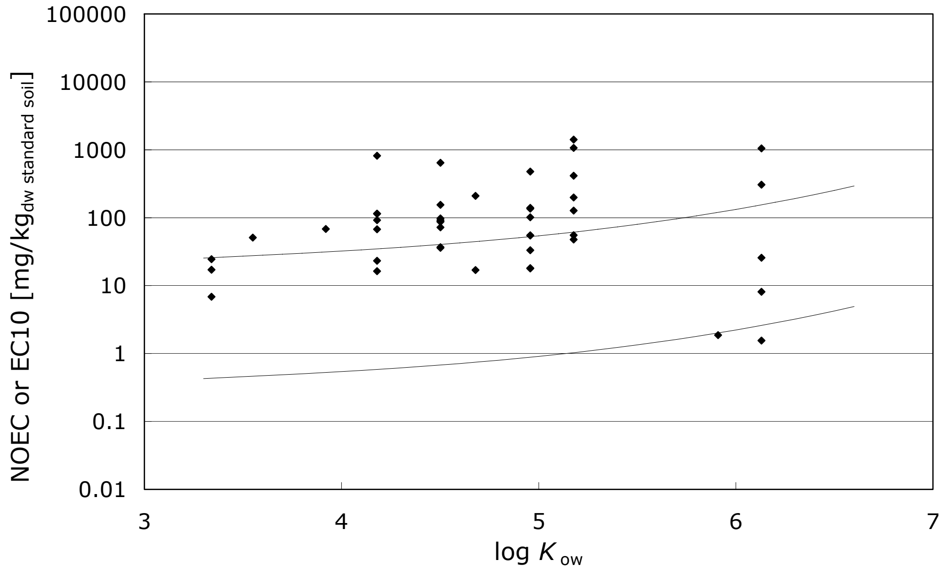

Figure 25: Chronic toxicity of PAHs to terrestrial species as a function of hydrophobicity

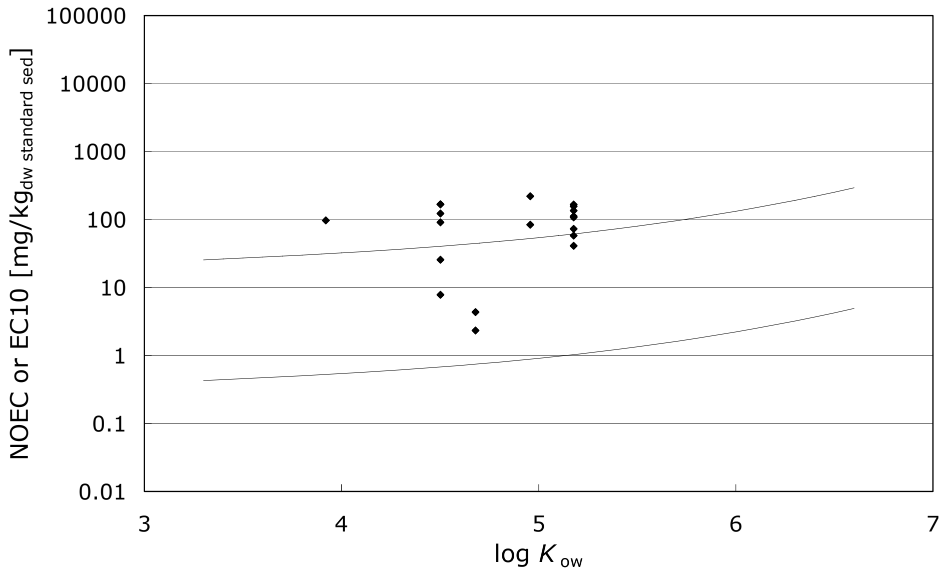

Figure 26: Chronic toxicity of PAHs to benthic species as a function of hydrophobicity

Because of this evidence of the mainly equilibrium partitioning driven toxicity of PAHs, it could be considered to follow a similar approach for PAHs as has been developed for total petroleum hydrocarbons (TPH) (Verbruggen et al., 2008). Several assumptions are evaluated again for PAHs, because they form the basis for successfully applying the internal body burden approach.
The first assumption is that toxic effects are directly related to the internal residue of the substance. If the parent substance is extensively metabolized in the organisms, this assumption could be erroneous.
Photoinduced toxicity is a mode of toxic action that is not caused by the parent compound but by a photoactivated reaction product. However, for phototoxicity it has been shown that this process is dependent on the amount of the parent substance that has been accumulated by the organisms. The difference with metabolism is that metabolism is caused by metabolic processes within the body of the organisms themselves, while for photoactivation the process takes place in the organisms but is induced by ultraviolet radiation applied from outside the body.
Especially for vertebrates it has been shown that metabolized PAHs are mutagenic and carcinogenic and thus causing toxicity. In such a case, not the residue of the parent substance in the organism but the throughput of the parent substance to the toxic metabolite would be of importance.
The selected toxicity data are from studies with either invertebrates, which mostly lack the capability to metabolize PAHs, or with early life stages of fish and amphibians. For early life stages of fish, it appeared that metabolism is very limited (Petersen and Kristensen, 1998). Because most ecotoxicity studies are performed with early life stages, which lack the metabolic capacity of older organisms, it is assumed that metabolism generally plays only a minor role in the selected toxicity data.
Nevertheless, for the amphipod *Hyalella azteca* it was shown that PAHs were substantially metabolized, especially naphthalene (Lee et al., 2002b). Moreover, toxicity could not simply be attributed to the accumulated amount of PAH in the amphipods (as would be so for narcosis), because lethal concentrations still decreased in time, when the bioaccumulation process had already reached an equilibrium. To describe time-dependent toxicity more complex models than the

critical body residue approach for narcotic substances were developed. Examples of these models are the damage assessment model (DAM) from Lee et al. (2002a) or the threshold damage model (TDM) from Ashauer et al. (2007). These models take account of both toxicokinetics (uptake and depuration) and toxicodynamics (damage and repair). However, damage is related to the accumulated amount, and the parameters to describe the toxicodynamics are relatively constant for the selected PAHs (Lee et al., 2002a). As a result, the incipient (i.e. chronic) effect concentrations are still linearly related to the accumulated amount of the substance.

Further, it can be reasoned (Lee and Landrum, 2006; Ashauer et al., 2007) that the concept of damage addition is equivalent to concentration addition, if it is assumed that in the toxicokinetics and toxicodynamics no interaction occurs between the compounds. Therefore, the concept of concentration addition still applies and the toxic unit approach can be used. This is an important observation, because the mode of toxic action could be different and independent action would be assumed to apply instead of concentration addition.

A second assumption is that the accumulation behaviour from the aqueous phase to both organic matter of soil and sediment as well as to biological membranes that are considered the target for narcosis, is hydrophobicity dependent. For sorption to organic matter this has been evaluated before (European Commission, 2008; Verbruggen et al., 2008). For bioconcentration into lipids this is generally true if the relationship between bioconcentration and hydrophobicity is not confounded by metabolism. Despite the metabolism of naphthalene in *Hyalella azteca*, it appeared that the bioconcentration factor of the parent compound was not necessarily lower compared to that what was expected based on the hydrophobicity of the substance. Moreover, there still is a perfect relationship between the LC50 based on external water concentrations and the log K_{ow}, which implies that toxicity is mainly hydrophobicity dependent (Lee et al., 2002b). It appears that there is a good correlation between bioconcentration and hydrophobicity for e.g. *Daphnia magna* (Newsted and Giesy, 1987) and fish early life stages (zebrafish larvae) (Petersen and Kristensen, 1998). In both cases the slope of this equation is slightly less than unity (0.87 and 0.92, respectively), similar to what was assumed for the derivation of the environmental risk limits for total petroleum hydrocarbons (Verbruggen et al., 2008). The values used within this reference were based on partitioning to artificial membranes (Verbruggen et al., 2000) as well as on estimations from QSAR modeling (Di Toro et al., 2000).

Consequently, the used methodology as well as the equations from the derivation of the ERLs for total petroleum hydrocarbons (Verbruggen et al., 2008) can be adopted to derive environmental risk limits for the PAHs. For this goal, all individual chronic toxicity data were recalculated to internal lipid residues. Residues were expressed on a molar basis. For aquatic toxicity, internal residues were calculated directly by multiplying with the membrane water partition coefficient. For soil and sediment, data were first transferred to pore water concentrations by dividing by the partition coefficient, after which the internal residues were derived in the same way. If for one species data were available for several PAHs, the geometric mean of the internal residues was used.

The membrane water partition coefficients were estimated from a polynomial fit (Verbruggen et al., 2008). Earlier work for TPH used a straight line up to a log K_{ow} of 5.5, based on a QSAR approach (Di Toro et al., 2000), for which recently a slightly revised equation (log K_{m}=0.936*log K_{ow}) was presented (McGrath and Di Toro, 2009). However, the assumption that the intercept in this equation is 0, is not necessarily true. For artificial membrane-water partition coefficients, that underlie the polynomial fit, an almost equal slope of 0.92±0.05, but a different intercept of 0.33±0.14 was found (Verbruggen et al., 2000). It appears that the experimental values for critical body burdens, after application of chemical class corrections (Di Toro et al., 2000), correspond much better with the derived critical target lipid body burdens (CTLBBs) if this intercept is taken into account. For this reason, only the polynomial fit on the experimentally determined membrane-water partition coefficients was used. However, differences in the final results are very small.

Next to the method described above, a similar exercise as was performed by Di Toro et al. (2000) can be made with the selected chronic toxicity data. In this case, the chronic toxicity data are expressed as concentrations in water as well, similar to the methodology described above. The concentrations are then plotted on a molar basis as a function of log K_{ow}. A linear regression analysis is made in which the intercept is calculated for each species individually, but the slope of the regression is shared over all species.

Reliable chronic toxicity data (no observed effect residue – NOER or 10% effective residue – ER10) were available for 34 aquatic species, containing 3 algae, 2 amphibians, 1 tunicate, 8 crustaceans, 4 echinoderms, 3 insects, 1 aquatic plant, 1 mollusc, and 10 fish species. For benthic species there were reliable chronic toxicity data for 10 species, containing 2 freshwater and 1 marine annelid, 1 freshwater and 4 marine crustaceans, and 2 freshwater insects. The freshwater species were both tested in water only exposure and a water-sediment system. The internal residue for these species was based on both types of tests by calculating the pore water concentration from the sediment concentrations. For terrestrial species, reliable chronic toxicity data were available for 13 species, containing 5 annelids, 2 crustaceans, 3 insects, and 3 terrestrial plants. In total the data set for freshwater, marine water, freshwater sediment, marine sediment, and soil contains 54 species (Table 98). The results of both methods (i.e. Verbruggen et al., 2008; Di Toro et al., 2000) are discussed below. The methods result in a set of 54 internal residues for different species. Although the spread in data for the different PAHs can be considerable, this is assumed to be random variation. Based on the calculations with membrane-water partition coefficients, the internal residues for *Pseudokrichneriella subcapitata*, for example, range from 0.29 to 61 mmol/kg_{lipid}. Fluorene has the highest internal residue, but is not necessarily an outlier if it is assumed that the data are log-normal distributed (which underlies the use of the geometric mean instead of the average for multiple data). Nevertheless, the NOERs for the rest of the 11 PAHs for which data are available range from 0.29 for anthracene to 3.7 mmol/kg_{lipid} for fluoranthene. For *Ceriodaphnia dubia* a similar situation is observed. The lowest value is 0.12 mmol/kg_{lipid} for benzo[*ghi*]perylene and the highest value 7.5 mmol/kg_{lipid} for naphthalene. The NOERs for the rest of the 10 PAHs range from 0.51 mmol/kg_{lipid} for fluoranthene to 1.9 mmol/kg_{lipid} for acenaphthene. For *Hyalella azteca* the lowest value observed of 0.48 mmol/kg_{lipid} can be explained by the specific phototoxicity of fluoranthene in combination with the experimental lighting conditions applied in the water-only test. It should be noted that the same species and compound tested in a water-sediment system resulted in a calculated NOER of 5.8 mmol/kg_{lipid}. However, for many species the spread in NOER is less than a factor of 10. Therefore, taking the geometric mean of the internal residues seems to be justified, as no apparent differences were observed. In Table 98 the log of the NOER data is presented for all species, including the average, standard deviation, minimum, maximum, and the number of data.

With the method of Di Toro et al. (2000), a regression is made of all chronic toxicity data on a molar basis as a function of log K_{ow}, including the terrestrial and benthic toxicity data that were first expressed as pore water concentration The general slope of the data is -1.024±0.06112 (95% confidence intervals -1.146 to -0.9027). With only the aquatic toxicity data a similar result is obtained (-1.030±0.08100 with 95% confidence intervals -1.193 to -0.8676). This slope is considerably steeper than the original value of -0.945 from the target lipid model (Di Toro et al., 2000) or the updated version of -0.936±0.015 (McGrath and Di Toro, 2009).
The bioaccumulation studies with daphnids and fish early life-stages show a slope that is much more similar to this universal slope of 0.936 for narcosis than to the value of 1.024 obtained by the latter method, which is similar but considers only chronic toxicity of PAHs instead of acute values.
Therefore, further analysis has been performed with the values obtained from the membrane-water partitioning coefficients based on experimental values for K_m, which show a similar slope as the universal slope for narcosis and the BCF values for PAHs in daphnids and fish early-life stages. By applying the steeper shared slope of 1.024 risk limits for smaller PAHs would be higher, while those for 5- to 6-ring PAHs would be lower.
The dataset meets the criteria for goodness of fit at all significance levels for the Anderson-Darling, Kolmogorov-Smirnov, and Cramer von Mises tests, calculated with the computer program ETX (Van Vlaardingen et al., 2004). It appears that there is no significant difference in the both the variance (F-test) and the mean (t-test) between any of the compartments or subsets (e.g. water vs. sediment, water vs. soil, sediment vs. soil, or fresh vs. marine). This is another argument to combine all data into one species sensitivity distribution. The species sensitivity distribution is shown in Figure 27. The HC5 of this distribution is 0.39 mmol/L_{lipid} (90% CI: 0.22-0.63 mmol/L_{lipid}), and the HC50 is 4.7 mmol/L_{lipid} (90% CI: 3.3-6.6 mmol/L_{lipid}).
These values for the HC5 and HC50 are very comparable to the values earlier derived for TPH based on the results of toxicity tests with 6 benthic species in sediment freshly spiked with 2 types of oil (Verbruggen et al., 2008). For TPH, an HC5 of 0.41 mmol/L_{lipid} (90% CI: 0.01-1.88 mmol/L_{lipid}) and HC50 of 8.7 mmol/L_{lipid} (90% CI: 2.1–36.5 mmol/L_{lipid}) were derived. The values for PAHs are only slightly lower than the values for TPH. This is similar to what was observed for acute toxicity of PAHs compared to other substances that are assumed to act by narcosis. The effect concentrations of PAHs were estimated to be 0.546 times lower than the general values for baseline toxicity (Di Toro et al., 2000). With application of this factor, the values for PAHs derived from the HC5 and HC50 of TPH would become 0.22 and 4.7 mmol/L_{lipid}. Together with the rather steep slope of the species sensitivity distribution (i.e. relatively low interspecies variability), the main mode of toxic action seems to be narcosis.

Table 98: Overview of selected data for chronic toxicity of PAHs based on internal residues. If for one species several PAHs were tested, statistics of the distribution are presented

			***Method of Verbruggen et al (2008)* log NOER**				***Method of Di Toro (2000)* log NOER**		
Taxon	**Test compartment**	**Species**	Average	Standard deviation	Minimum	Maximum	Average	Standard deviation	Number of PAHs
algae	freshwater	*Pseudokirchneriella subcapitata*	0.22	0.65	-0.54	1.61	0.66	0.34	11
algae	freshwater	*Scenedesmus vacuolatus*	0.96	0.34	0.49	1.25	1.28	0.35	6
algae	marine water	*Champia parvula*	1.07				1.22	0.52	1
amphibian	freshwater	*Ambystoma maculatum*	1.74				2.10	0.57	1
amphibian	freshwater	*Rana pipiens*	1.04				1.40	0.57	1
annelida	freshwater sediment	*Lumbriculus variegates*	-0.05	0.75	-0.58	0.31	0.19	0.44	2
annelida	freshwater sediment	*Stylaria lacustris*	0.73	0.31	0.51	0.85	1.31	0.57	2
annelida	marine sediment	*Limnodrilus hoffmeisteri*	1.29	0.00	1.29	1.16	1.56	0.45	2
annelida	soil	*Eisenia Andrei*	1.37				1.63	0.56	1
annelida	soil	*Eisenia f. fetida*	0.26	0.52	-0.11	0.46	0.73	0.47	2
annelida	soil	*Eisenia veneta*	1.21	0.22	1.03	1.42	1.48	0.37	4
annelida	soil	*Enchytraeus crypticus*	0.86	0.28	0.50	0.95	1.11	0.35	5
annelida	soil	*Lumbricus rubellus*	0.69				1.00	0.57	1
crustacean	freshwater	*Ceriodaphnia dubia*	0.00	0.47	-0.90	0.73	0.40	0.33	10
crustacean	freshwater	*Daphnia magna*	-0.05	0.35	-0.43	0.22	0.21	0.37	4
crustacean	freshwater	*Daphnia pulex*	0.25				0.48	0.55	
crustacean	freshwater	*Diporeia spp.*	0.45				0.81	0.57	1
crustacean	freshwater and	*Hyalella azteca*	0.94	0.60	-0.32	1.21	1.20	0.33	7

Taxon	Test compartment	Species	Method of Verbruggen et al (2008) log NOER Average	Standard deviation	Minimum	Maximum	Method of Di Toro (2000) log NOER Average	Standard deviation	Number of PAHs
	sediment								
crustacean	marine sediment	*Corophium spinicorne*	0.93				1.29	0.57	1
crustacean	marine sediment	*Coullana spec.*	1.10				1.46	0.57	1
crustacean	marine sediment	*Rhepoxynius abronius*	1.06	0.14	0.87	0.99	1.32	0.37	4
crustacean	marine sediment	*Schizopera knabeni*	0.24	0.39	-0.04	0.42	0.53	0.45	2
crustacean	marine water	*Acartia tonsa*	0.63	0.83	-0.32	1.15	0.93	0.41	3
crustacean	marine water	*Cancer magister*	-0.52				-0.36	0.52	1
crustacean	marine water	*Mysidopsis bahia*	-0.58				-0.22	0.57	1
crustacean	marine water	*Paracartia grani*	0.89				1.04	0.52	1
crustacean	soil	*Oniscus asellus*	-0.41	0.82	-1.11	0.32	0.09	0.43	3
crustacean	soil	*Porcellio scaber*	-1.32				-0.62	0.61	1
echinodermata	marine water	*Arbacia punctulata*	1.35				1.58	0.55	1
echinodermata	marine water	*Paracentrotus lividus*	1.10	0.28	0.84	1.38	1.34	0.35	5
echinodermata	marine water	*Strongylocentrotus droebachiensis*	1.03				1.18	0.52	1
echinodermata	marine water	*Strongylocentrotus purpuratus*	-0.13				0.58	0.61	1
insecta	freshwater	*Paratanytarsus parthenogeneticus*	0.25				0.42	0.54	1
insecta	freshwater and sediment	*Chironomus riparius*	0.71	0.69	-0.31	1.02	0.97	0.37	4
insecta	freshwater and sediment	*Chironomus tentans*	0.72	0.08	0.66	0.69	1.08	0.46	2
insecta	soil	*Folsomia candida*	0.31	0.28	0.10	0.47	0.54	0.38	3
insecta	soil	*Folsomia fimetaria*	0.70	0.30	0.28	0.91	0.93	0.31	8

Taxon	Test compartment	Species	*Method of Verbruggen et al (2008)* log NOER Average	Standard deviation	Minimum	Maximum	*Method of Di Toro (2000)* log NOER Average	Standard deviation	Number of PAHs
insecta	soil	*Protaphorura armata*	0.20				0.51	0.57	1
macrophyta	freshwater	*Lemna gibba*	2.21	0.65	1.75	2.52	2.47	0.43	2
macrophyta	soil	*Lolium perenne*	1.71	0.49	0.97	1.86	2.08	0.39	4
macrophyta	soil	*Sinapsis alba*	1.31	0.50	0.95	1.95	1.59	0.37	4
macrophyta	soil	*Trifolium pratense*	0.97	0.21	0.69	1.10	1.24	0.37	4
mollusca	marine water	*Mytilus galloprovincialis*	0.98	0.62	0.38	1.62	1.24	0.36	4
pisces	freshwater	*Danio rerio*	0.19	0.75	-0.61	0.80	0.62	0.42	3
pisces	freshwater	*Lepomis macrochirus*	0.49				0.68	0.54	
pisces	freshwater	*Micropterus salmoides*	-0.06	0.30	-0.28	-0.01	0.13	0.42	2
pisces	freshwater	*Oncorhynchus kisutch*	0.82				0.98	0.52	1
pisces	freshwater	*Oncorhynchus mykiss*	0.20	0.64	-0.54	0.64	0.56	0.40	3
pisces	freshwater	*Oryzias latipes*	1.10				1.33	0.55	1
pisces	freshwater	*Pimephales promelas*	0.46	0.61	-0.22	0.94	0.69	0.35	4
pisces	marine water	*Cyprinodon variegatus*	1.44				1.61	0.54	1
pisces	marine water	*Gadus morhua*	1.16				1.31	0.52	1
pisces	marine water	*Oncorhynchus gorbuscha*	0.58				0.73	0.52	1
tunicata	marine water	*Ciona intestinalis*	1.51	0.54	0.95	1.92	1.75	0.38	3

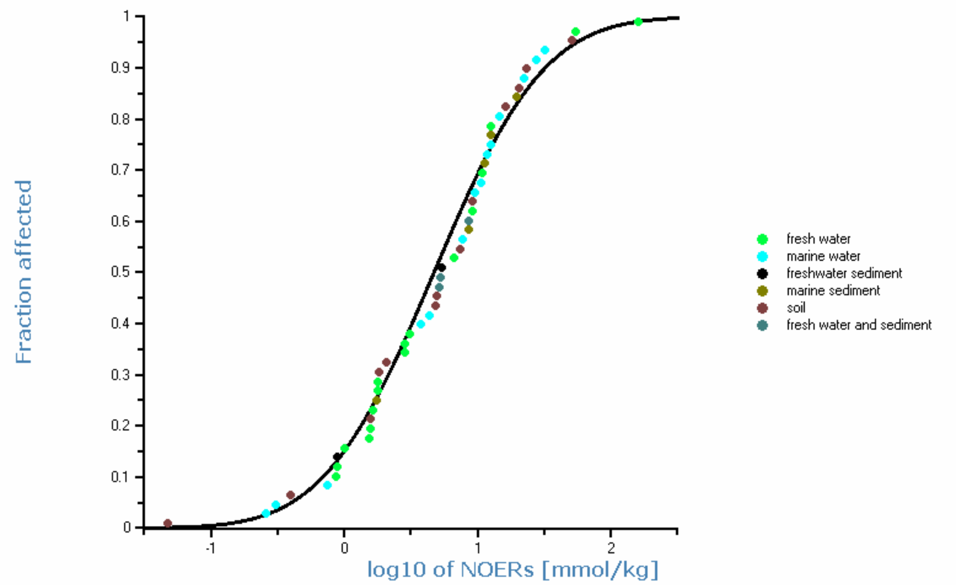

Figure 27: Species sensitivity distribution of all species in different compartments based on internal residues of individual PAHs

The values of the HC5 and HC50 can be recalculated to concentrations for the individual PAHs in water, sediment, and soil. These values are remarkably higher than the values derived with the deterministic approach (assessment factors). When applying the SSD method to derive risk limits, an assessment factor of 1 to 5 should be applied to the HC5 to derive the MPC in accordance with the European methodology (Van Vlaardingen and Verbruggen, 2007). For TPH this factor has been set to 1, mainly because the mixtures are supposed to act by narcosis and a rather thorough validity check of the method has been performed. However, the PAHs have several modes of toxic action. For some of the PAHs phototoxicity is leading to very low acute effect concentrations. Examples are the acute toxicity of anthracene to algae (Gala and Giesy, 1992), daphnids (Allred and Giesy, 1985), insects (Bleeker et al., 2003), and marine amphipods (Pelletier et al., 1997), pyrene to marine amphipods (Pelletier et al., 1997) and fluoranthene to juvenile flatfish (Spehar et al., 1999). Recalculated to internal lipid residues, these L(E)C50s are all equal to or lower than the HC5. Among the most sensitive species are many crustaceans. Two of them are the terrestrial isopods exposed to benz[*a*]anthracene and benzo[*a*]pyrene in food (Van Brummelen and Stuijfzand, 1993; Van Brummelen et al., 1996; Van Straalen and Verweij, 1991). Another two are the marine crustaceans Dungeness crab exposed to naphthalene (Caldwell et al., 1977) and the amphipod *Mysidopsis bahia* exposed to fluoranthene (Spehar et al., 1999). These four species are at or below the HC5. Also the freshwater daphnids (*Daphnia magna* and *Ceriodaphnia dubia*) belong to the most sensitive species. It is therefore considered necessary to apply a maximum value of 5 to the HC5 to be protective for the most sensitive species (crustaceans) and the most sensitive acute toxic effects (phototoxicity, where crustaceans, but also insects and early life stages of molluscs and fish are at risk). The resulting values of this exercise are shown in Table 99. The levels of the MPC_{eco} and SRC_{eco} are also shown in Figure 23 to 26 by means of the lower and higher lines, respectively. It can be seen that the lines follow the data rather well, taking note of the observation made above on phototoxicity and sensitive groups of species. Additionally, it should be noted that for several of the higher PAHs the SRC_{eco} is at the level of the solubility in water, which means that effect concentrations above this line will not be observed.

In conclusion it can be stated that this exercise is a reconfirmation, at least for these substances, that the equilibrium partitioning method is a useful method in setting quality standards. The large number of data used here shows that the variability is mostly due to individual studies, but that on average there is no difference between the different compartments. Because the variability due to inhomogenous datasets has been reduced and no different and sometimes high assessment factors have been used, the risk limits for PAHs derived in this way are considered to be more coherent with each other. Because toxicity is driven by equilibrium partitioning, monitoring of these PAHs could be focused on measuring free water concentrations, e.g. in pore water, with solid phase extraction techniques. An advantage of such a measurement would be that reduced bioavailability in soil or sediment, for example due to the presence of black carbon, is taken into account.

Table 99: Comparison of the risk limits based on internal residues calculated from membrane water partition coefficients and the SSD approach and the risk limits derived derived for each PAH individually with the deterministic approach. Concentrations in water are in µg/L, concentrations in soil and sediment in mg/kg$_{dw\ standard\ soil/sed}$ containing 10% organic matter

Risk limit	***MPC$_{eco,}$ water***	***MPC$_{eco,}$ water***	***SRC$_{eco,}$ water***	***SRC$_{eco,}$ water***	***MPC$_{eco,}$ soil and sediment***	***MPC$_{eco,}$ sediment***	***MPC$_{eco,}$ soil***	***SRC$_{eco,}$ soil and sediment***	***SRC$_{eco,}$ sediment***	***SRC$_{eco,}$ soil***
Method	**HC5/5**	**AF** [a]	**HC50**	**geom** [a]	**HC5/5**	**AF**	**AF**	**HC50**	**geom**	**geom.**
Data	**All PAHs**	**Single PAH**	**All PAHs**	**Single PAH**	**All PAHs**	**Single PAH**	**Single PAH**	**All PAHs**	**Single PAH**	**Single PAH**
Naphthalene	5.4	2.0	324	518	0.43	0.16	0.69	26	42	14
Acenaphthylene	4.0	1.3	236	72	0.51	0.17	0.17	30	9.5	9.4
Acenaphthene	1.7	3.8	104	102	0.53	0.97	0.68	31	31	31
Fluorene	1.1	1.5	63	117	0.58	0.83	1.6	35	64	82
Phenanthrene	0.58	1.1	35	43	0.67	0.78	3.6	40	63	90
Anthracene	0.41	0.10	24	4.2	0.71	0.05	0.34	42	3	60
Pyrene	0.27	0.023	16	4.2	0.89	1.67	1.8	53	136	53
Fluoranthene	0.18	0.11	11	11	0.99	4.11	4.8	59	96	309
Chrysene	0.074	0.070	4.4	1.6	1.7	1.64	1.6	103	38	38
Benz[*a*]anthracene	0.064	0.012	3.8	3.1	1.9	0.35	0.19	112	91	91
Benzo[*k*]fluoranthene	0.054	0.017	3.2	0.93	2.5	0.79	0.79	151	44	44
Benzo[*b*]fluoranthene	0.053	0.017	3.2	1.3	2.6	0.79	0.79	153	62	62
Benzo[*a*]pyrene	0.053	0.010	3.2	0.87	2.6	0.49	0.16	154	42	76
Benzo[*ghi*]perylene	0.052	0.0082	3.1	0.16	3.1	0.49	0.49	186	10	10
Dibenz[*a,h*]anthracene	0.036	0.0014	2.2	0.14	4.7	0.18	0.18	279	18	18
Indeno[1,2,3-*cd*]pyrene	0.035	0.0027	2.1	0.64	4.9	0.38	0.38	289	89	89

Note: [a] except for fluoranthene, where the SSD approach was applied for water

References

Abernethy S, Bobra AM, Shiu WY, Wells PG, Mackay D. 1986. Acute lethal toxicity of hydrocarbons and chlorinated hydrocarbons to two planktonic crustaceans: The key role of organism-water partitioning. Aquat Toxicol 8: 163-174.

Achazi RK, Chroszcz G, Düker C, Henneken M, Rothe B, Schaub K, Steudel I. 1995. The effect of fluoranthene (Fla), benzo(a)pyrene (BaP) and cadmium (Cd) upon survival rate and life cycle parameter of two terrestrial annelids in laboratory test systems. Newslett Enchytraeidae 4: 7-14.

Adema DMM, Henzen L. 1990. De invloed van 50 prioritaire stoffen op de groei van *Lactuca sativa* (sla). Zeist, The Netherlands: TNO (MT-TNO). TNO report R90/101.

Ahrens MJ, Nieuwenhuis R, Hickey CW. 2002. Sensitivity of juvemile *Macomona liliana* (bivalva) to UV-photoactivated fluoranthene toxicity. Environ Toxicol 17: 567-577.

Aksmann A, Tukaj Z. 2004. The effect of anthracene and phenanthrene on the growth, photosynthesis, and SOD activity of the green alga *Scenedesmus armatus* depends on the PAR irradiance and CO_2 level. Arch Environ Contam Toxicol 47: 177-184.

Allred PM, Giesy JP. 1985. Solar radiation-induced toxicity of anthracene to *Daphnia pulex*. Environ Toxicol Chem 4: 219-226.

Altenburger R, Walter H, Grote M. 2004. What contributes to the combined effect of a complex mixture? Environ Sci Technol 38: 6353-6362.

Anderson JW, Neff JM, Cox BA, Tatem HE, Hightower GM. 1974. The effects of oil on estuarine animals: Toxicity, uptake and depuration, respiration. In: Vernberg FJ, Vernberg WB, eds. Pollution and physiology of marine organisms. New York: Academic Press. pp. 285-310.

Ankley GT, Erickson RJ, Phipps GL, Mattson VR, Kosian PA, Sheedy BR, Cox JS. 1995. Effects of light intensity on the phototoxicity of fluoranthene to a benthic macroinvertebrate. Environ Sci Technol 29: 2828-2833.

AquaSense. 2005. Toxicity tests with priority substances in the Water Framework Directive. Amsterdam, The Netherlands: AquaSense. Report number 2034.

Arfsten DP, Davenport R, Schaeffer DJ. 1994. UV-A coexposure enhances the toxicity of aromatic hydrocarbons, munitions, and metals to *Photobacterium phosphoreum*. Biomed Environ Sci 7: 101-108.

Ashauer R, Boxall ABA, Brown CD. 2007. Modeling combined effects of pulsed exposure to carbaryl and chlorpyrifos on *Gammarus Pulex*. Environ Sci Technol 41: 5535-5541.

Atienzar FA, Conradi M, Evenden AJ, Jha AN, Depledge MH. 1999. Qualitative assessment of genotoxicity using random amplified polymorphic DNA: Comparison of genomic template stability with key fitness parameters in *Daphnia magna* exposed to benzo[*a*]pyrene. Environ Toxicol Chem 18: 2275-2282.

Baars A, Theelen R, Janssen P, Hesse J, Van Apeldoorn M, Meijerink M, Verdam L, Zeilmaker M. 2001. Re-evaluation of human-toxicological maximum permissible risk levels. Bilthoven, The Netherlands: National Institute of Public Health and the Environment. RIVM report 711701025.

Baek K-H, Kim H-S, Oh H-M, Yoon B-D, Kim J, Lee I-S. 2004. Effects of crude oil, oil components, and bioremediation on plant growth. Journal of Environmental Science and Health, Part A: Toxic Hazardous Substances and Environmental Engineering A39: 2465-2472.

Bamdad M, Reader S, Grolière CA, Bohatier J, Denizeau F. 1997. Uptake and efflux of polycyclic aromatic hydrocarbons by *Tetrahymena pyriformis*: Evidence for a resistance mechanism. Cytometry 28: 170-175 .

Barata C, Baird DJ. 2000. Determining the ecotoxicological mode of action of chemicals from measurements made on individuals: results from instar-based tests with *Daphnia magna* Straus. Aquat Toxicol 48: 195-209.

Barata C, Baird DJ, Miñarro A, Soares AMVM. 2000. Do genotype responses always converge from lethal to nonlethal toxicant exposure levels? Hypothesis tested using clones of *Daphnia magna* Straus. Environ Toxicol Chem 19: 2314-2322.

Barata C, Calbet A, Saiz E, Ortiz L, Bayona JM. 2005. Predicting single and mixture toxicity of petrogenic polycyclic aromatic hydrocarbons to the copepod *Oithona davisae*. Environ Toxicol Chem 24: 2992-2999.

Bastian MV, Toetz DW. 1982. Effect of eight polynuclear hydrocarbons on growth of *Anabaena flos-aquae*. Bull Environ Contam Toxicol 29: 531-538.

Bastian MV, Toetz DW. 1985. Effect of polynuclear hydrocarbons on algal nitrogen fixation (acetylene reduction). Bull Environ Contam Toxicol 35: 258-265.

Belfroid A, Sikkenk M, Seinen W, Van Gestel K, Hermens J. 1994. The toxicokinetic behavior of chlorobenzenes in earthworm (*Eisenia andrei*) experiments in soil. Environ Toxicol Chem 13: 93-99.

Bellas J, Thor P. 2007. Effects of selected PAHs on reproduction and survival of the calanoid copepod *Acartia tonsa*. Ecotoxicology 16: 465-474.

Bellas J, Saco-Álvarez L, Nieto Ó, Beiras R. 2008. Ecotoxicological evaluation of polycyclic aromatic hydrocarbons using marine invertebrate embryo-larval bioassays. Mar Pollut Bull 57: 493-502.

Berdugo V, Harris RP, O'Hara SC. 1977. The effect of petroleum hydrocarbons on reproduction of an estuarine planktonic copepod in laboratory cultures. Mar Pollut Bull 8: 138-143.

Bisson M, Dujardin R, Flammarion P, Garric J, Babut M, Lamy M-H, Porcher J-M, Thybaud É, Vindimian É. 2000. Complément au SEQ-Eau: méthode de détermination des seuils de qualité pour les substances génotoxiques. Verneuil-en-Halatte, France: Institut National de l'Environnement Industriel et des Risques (INERIS), Agence de l'eau Rhin-Meuse.

Black JA, Birge WJ, Westerman AG, Francis PC. 1983. Comparative aquatic toxicology of aromatic hydrocarbons. Fundam Appl Toxicol 3: 353-358.

Bleeker EAJ, Wiegman S, Droge STJ, Kraak MHS, Van Gestel CAM. 2003. Towards an improvement of the risk assessment of polycyclic (hetero)aromatic hydrocarbons. Amsterdam, The Netherlands: Aquatic Ecology and Ecotoxicology, Faculty of Science, University of Amsterdam and Animal Ecology, Institute of Ecological Science, Faculty of Earth and Life Sciences, Vrije Universiteit Amsterdam. Report 2003-01 (UvA)/Report 2003-04 (VU).

Bleeker EAJ, Verbruggen EMJ. 2009. Bioaccumulation of polycyclic aromatic hydrocarbons in aquatic organisms. Bilthoven, The Netherlands: National Institute of Public Health and the Environment. RIVM report 601779002/2009.

Blinova I. 2004. Use of freshwater algae and duckweeds for phytotoxicity testing. Environ Toxicol 19: 425-428.

Blum DJW, Speece RE. 1991. A database of chemical toxicity to environmental bacteria and its use in interspecies comparisons and correlations. Research Journal WPCF 63: 198-207.

Bobra AM, Shiu WY, Mackay D. 1983. Acute toxicity of fresh and weathered crude oils to *Daphnia magna*. Chemosphere 12: 1137-1149.

Boese BL, Lamberson JO, Swartz RC, Ozretich RJ. 1997. Photoinduced toxicity of fluoranthene to seven marine benthic crustaceans. Arch Environ Contam Toxicol 32: 389-393.

Boese BL, Lamberson JO, Swartz RC, Ozretich R, Cole F. 1998. Photoinduced toxicity of PAHs and alkylated PAHs to a marine infaunal amphipod (*Rhepoxynius abronius*). Arch Environ Contam Toxicol 34: 235-240.

Boese BL, Ozretich RJ, Lamberson JO, Swartz RC, Cole FA, Pelletier J, Jones J. 1999. Toxicity and phototoxicity of mixtures of highly lipophilic PAH compounds in marine sediment: Can the ΣPAH model be extrapolated? Arch Environ Contam Toxicol 36: 270-280.

Boney AD, Corner EDS. 1962. On the effects of some carcinogenic hydrocarbons on the growth of sporelings of marine red algae. J Mar Biol Assoc UK 42: 579-585.

Boney AD. 1974. Aromatic hydrocarbons and the growth of marine algae. Mar Pollut Bull 5: 185-186.

Bonnet JL, Guiraud P, Dusser M, Kadri M, Laffosse J, Steiman R, Bohatier J. 2005. Assessment of anthracene toxicity toward environmental eukaryotic microorganisms: *Tetrahymena pyriformis* and selected micromycetes. Ecotoxicol Environ Saf 60: 87-100.

Borovsky D, Linley JR, Kagan J. 1987. Polycyclic aromatic compounds as phototoxic mosquito larvicides. J Am Mosq Control Assoc 3: 246-250.

Bowmer CT, Roza P, Henzen L, Degeling C. 1993. The development of chronic toxicological tests for PAH contaminated soils using the earthworm *Eisenia fetida* and the springtail *Folsomia candida*. Delft, the Netherlands: TNO Environmental and Energy Research, TNO Institute of Environmental Sciences. TNO-report IMW-R 92/387.

Bowmer CT. 1994. Paris Commission sediment reworker ring-test, 1993. Technical report. Delft, the Netherlands: TNO Environmental and Energy Research, TNO Institute of Environmental Sciences. TNO-report IMW-R 93/317.

Broderius SJ, Kahl MD, Hoglund MD. 1995. Use of joint toxic response to define the primary mode of toxic action for diverse industrial organic chemicals. Environ Toxicol Chem 14: 1591-1605.

Brown PJ, Long SM, Spurgeon DJ, Svendsen C, Hankard PK. 2004. Toxicological and biochemical responses of the earthworm *Lumbricus rubellus* to pyrene, a non-carcinogenic polycyclic aromatic hydrocarbon. Chemosphere 57: 1675-1681.

Buccafusco RJ, Ells SJ, LeBlanc GA. 1981. Acute toxicity of priority pollutants to bluegill sunfish (*Lepomis macrochirus*). Bull Environ Contam Toxicol 26: 446-452.

Burýšková B, Hilscherová K, Bláha L, Maršálek B, Holoubek I. 2006. Toxicity and modulations of biomarkers in *Xenopus laevis* embryos exposed to polycyclic aromatic hydrocarbons and their *N*-heterocyclic derivatives. Environ Toxicol 21: 590-598.

Cairns MA, Nebeker AV. 1982. Toxicity of acenaphthene and isophorone to early life stages of fathead minnows. Arch Environ Contam Toxicol 11: 703-707.

Calbet A, Saiz E, Barata C. 2007. Lethal and sublethal effects of naphthalene and 1,2-dimethylnaphthalene on the marine copepod *Paracartia grani*. Mar Biol 151: 195-204.

Caldwell RS, Caldarone EM, Mallon MH. 1977. Effects of a seawater-soluble fraction of Cook Inlet crude oil and its major aromatic components on larval stages of the Dungeness crab, *Cancer magister* Dana. In: Wolfe DA, ed. Fate and effects of petroleum hydrocarbons in marine ecosystems and organisms. New York: Pergamon Press. pp. 210-220.

Chikae M, Hatano Y, Ikeda R, Morita Y, Hasan Q, Tamiya E. 2004. Effect of bis(2-ethylhexyl) phthalate and benzo[a]pyrene on the embryos of the Japanese medaka (*Oryzias latipes*). Environmental Toxicology and Pharmacology 16: 141-145.

Chung KW, Fulton MH, Scott GI. 2007a. Use of the juvenile clam, *Mercenaria mercenaria*, as a sensitive indicator of aqueous and sediment toxicity. Ecotoxicol Environ Saf 67: 333-340.

Chung MK, Hu R, Wong MH, Cheung KC. 2007. Comparative toxicity of hydrophobic contaminants to microalgae and higher plants. Ecotoxicology 16: 393-402.

Cody TE, Radike MJ, Warshawsky D. 1984. The phototoxicity of benzo[*a*]pyrene in the green alga *Selenastrum capricornutum*. Environ Res 35: 122-132.

Cole FA, Boese BL, Swartz RC, Lamberson JO, DeWitt TH. 2000. Effects of storage on the toxicity of sediments spiked with fluoranthene to the amphipod, *Rhepoxynius abronius*. Environ Toxicol Chem 19: 744-748.

Correa M, Coler R. 1983. Enhanced oxygen uptake rates in dragonfly nymphs (*Somatochlora cingulata*) as an indication of stress from naphthalene. Bull Environ Contam Toxicol 30: 269-276.

Crider JY, Wilhm J, Harmon HJ. 1982. Effects of naphthalene on the hemoglobin concentration and oxygen uptkae of *Daphnia magna*. Bull Environ Contam Toxicol 28: 52-57.

Crouau Y, Chenon P, Gisclard C. 1999. The use of *Folsomia candida* (Collembola, Isotomidae) for the bioassay of xenobiotic substances and soil pollutants. Appl Soil Ecol 12: 103-111.

Dange AD, Masurekar VB. 1982. Naphthalene-induced changes in carbohydrate metabolism in *Sarotherodon mossambicus* Peters (Pisces: Cichlidae). Hydrobiologia 94: 163-172.

Dangé A. 1986. Metabolic effects of naphthalene, toluene or phenol intoxication in the cichlid fish tilapia, *Oreochromis mossambicus*: Changes in aminotransferase activities. Environ Pollut Ser A 42: 311-323.

Darville RG, Wilhm JL. 1984. The effect of naphthalene on oxygen consumption and hemoglobin concentration in *Chironomus attenuatus* and on oxygen consumption and life cycle of *Tanytarsus dissimilis*. Environ Toxicol Chem 3: 135-141.

DeGraeve GM, Elder RG, Woods DC, Bergman HL. 1982. Effect of naphthalene and benzene on fathead minnows and rainbow trout. Arch Environ Contam Toxicol 11: 487-490.

Deshmukh NV, Deshmukh VD, Masurekar VB. 1985. Naphthalene toxicity to the speckled prawn, *Metapenaeus monoceros* (FAB): Seasonal variation. Geobios 12: 263-265.

DeWitt TH, Ozretich RJ, Swartz RC, Lamberson JO, Schults DW, Ditsworth GR, Jones JKP, Hoselton L, Smith LM. 1992. The influence of organic matter quality on the toxicity and partitioning of sediment-associated fluoranthene. Environ Toxicol Chem 11: 197-208.

Diamond SA, Oris JT, Guttman SI. 1995. Adaptation to fluoranthene exposure in a laboratory population of fathead minnows. Environ Toxicol Chem 14: 1393-1400.

DiMichele L, Taylor MH. 1978. Histopathological and physiological responses of *Fundulus heteroclitus* to naphthalene exposure. J Fish Res Board Can 35: 1060-1066.

Di Toro DM, McGrath JA, Hansen DJ. 2000. Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. I. Water and tissue. Environ Toxicol Chem 19: 1951-1970.

Djomo JE, Dauta A, Ferrier V, Narbonne JF, Monkiedje A, Njine T, Garrigues P. 2004. Toxic effects of some major polyaromatic hydrocarbons found in crude oil aquatic sediments on *Scenedesmus subspicatus*. Water Res 38: 1817-1821.

Donkin P, Widdows J, Evans SV, Worrall CM, Carr M. 1989. Qunatitative structure-activity relationships for the effects of hydrophobic organic chemicals on rate of feeding by mussels (*Mytilus edulis*). Aquat Toxicol 14: 277-294.

Donkin P, Widdows J, Evans SV, Brinsley MD. 1991. QSARs for the sublethal responses of marine mussels (*Mytilus edilus*). Sci Total Environ 109/110: 461-476.

Droge STJ, León Paumen M, Bleeker EAJ, Kraak MHS, Van Gestel CAM. 2006. Chronic toxicity of polycyclic aromatic compounds to the springtail *Folsomia candida* and the enchytraeid *Enchytraeus crypticus*. Environ Toxicol Chem 25: 2423-2431.

Eason CT, Svendsen C, O'Halloran K, Weeks JM. 1999. An assessment of the lysomal neutral red retention test and immune function assay in earthworms (*Eisenia andrei*) following exposure to chlorpyrifos, benzo-a-pyrene (BaP), and contaminated soil. Pedobiologia 43: 641-645.

Eastmond DA, Booth GM, Lee ML. 1984. Toxicity, accumulation, and elimination of polycyclic aromatic sulfur heterocycles in *Daphnia magna*. Arch Environ Contam Toxicol 13: 105-111.

Edmisten GE, Bantle JA. 1982. Use of *Xenopus laevis* larvae in 96-hour, flow-through toxicity tests with naphthalene. Bull Environ Contam Toxicol 29: 392-399.

Edsall CC. 1991. Acute toxicities to larval rainbow trout of representative compounds detected in Great Lakes fish. Bull Environ Contam Toxicol 46: 173-178.

El-Alawi YS, Dixon DG, Greenberg BM. 2001. Effects of a pre-incubation period on the photoinduced toxicity of polycyclic aromatic hydrocarbons to the luminescent bacterium *Vibrio fischeri*. Environ Toxicol 16: 277-286.

El-Alawi YS, Huang X-D, Dixon DG, Greenberg BM. 2002. Quantitative structure-activity relationship for the photoinduced toxicity of polycyclic aromatic hydrcarbons to the luminescent bacteria *Vibrio fischeri*. Environ Toxicol Chem 21: 2225-2232.

El-Fouly MM. 1980. Effect of low concentrations of 3,4-benzpyrene on growth and N-fractions of seedlings. Landwirt Forsch 33: 108-117.

Emery Jr. VL, Dillon TM. 1996. Chronic toxicity of phenanthrene to the marine polychaete worm, *Nereis* (*Neanthes*) *arenaceodentata*. Bull Environ Contam Toxicol 56: 265-270.

Eschenbach A, Gehlen P, Bierl R. 1991. Untersuchungen zum Einfluß von Fluoranthen und Benzo(a)pyren auf Bodenmikroorganismen und zum mikrobiellen Abbau dieser Substanzen. Mitt Dtsch Bodenkundl Ges 63: 91-94.

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

European Commission. 2008. European Union Risk Assessment Report: Coal tar pitch, high temperature CAS No: 65996-93-2 EINECS No: 266-028-2. Luxembourg: Office for Official Publications of the European CommunitiesJoint Research Centre, Institute for Health and Consumer Protection, European Chemicals Bureau (ECB). Draft report, final version R323.

Evans AD, Nipper M. 2008. The influence of biomass on the toxicity of hydrophobic organic contaminants. Arch Environ Contam Toxicol 54: 219-225.

Falk-Petersen I-B, Sæthre LJ, Lönnig S. 1982. Toxic effects of naphthalene and methylnaphthalenes on marine plankton organisms. Sarsia 67: 171-178.

Feldmannová M, Hilscherová K, Maršálek B, Bláha L. 2006. Effects of N-heterocyclic polyaromatic hydrocarbons on survival, reproduction, and biochemical parameters in *Daphnia magna*. Environ Toxicol 21: 425-431.

Fernandez M, L'Haridon J. 1992. Influence of lighting conditions on toxicity and genotoxicity of various PAH in the newt in vivo. Mutat Res 298: 31-41.

Fernandez M, L'Haridon J. 1994. Effects of light on the cytotoxicity and genotoxicity of benzo(a)pyrene and an oil refinery effluent in the newt. Environ Molec Mutagen 24: 124-136.

Finger SE, Little EF, Henry MG, Fairchild JF, Boyle TP. 1985. Comparison of laboratory and field assessment of fluorene - Part I: Effects of fluorene on the survival, growth, reproduction, and behavior of aquatic organisms in laboratory tests. In: Boyle TP, ed. Validation and predictability of laboratory methods for assessing the fate and effects of contaminants in aquatic ecosystems. ASTM STP 865. Philedelphia, PA: American Society for Testing and Materials. pp. 120-133.

Foran JA, Holst LL, Giesy JP. 1991. Effects of photoenhanced toxicity of anthracene on ecological and genetic fitness of *Daphnia magna*: A reappraisal. Environ Toxicol Chem 10: 425-427.

Forget-Leray J, Landriau I, Minier C, Leboulenger F. 2005. Impact of endocrine toxicants on survival, development, and reproduction of the estuarine copepod *Eurytemora affinis* (Poppe). Ecotoxicol Environ Saf 60: 288-294.

Foster GD, Tullis RE. 1984. A quantitative structure-activity relationship between partition coefficients and the acute toxicity of naphthalene derivatives in *Artemia salina* nauplii. Aquat Toxicol 5: 245-254.

Frumin GT, Chuiko GM, Pavlov DF, Menzykova OV. 1992. New rapid method to evaluate the median effect concentrations of xenobiotics in hydrobionts. Bull Environ Contam Toxicol 49: 361-367.

Gala WR, Giesy JP. 1992. Photo-induced toxicity of anthracene to the green alga, *Selenastrum capricornutum*. Arch Environ Contam Toxicol 23: 316-323.

Gala WR, Giesy JP. 1994. Flow cytometric determination of the photoinduced toxicity of anthracene to the green alga *Selenastrum capricornutum*. Environ Toxicol Chem 13: 831-840.

Gaur JP. 1988. Toxicity of some oil constituents to *Selenastrum capricornutum*. Acta Hydrochim Hydrobiol 16: 617-620.

Geiger DL, Northcott CE, Call DJ, Brooke LT eds. 1985. Acute Toxicities of Organic Chemicals to Fathead Minnows (*Pimephales Promelas*). Superior, WI, USA: Center for Lake Superior Environmental Studies, University of Wisconsin-Superior.

Geiger JG, Buikema Jr. AL. 1981. Oxygen consumption and filtering rate of *Daphnia pulex* after exposure to water-soluble fractions of naphthalene, phenanthrene, No. 2 fuel oil, and coal-tar creosote. Bull Environ Contam Toxicol 27: 783-789.

Geiger JG, Buikema Jr. AL. 1982. Hydrocarbons depress growth and reproduction of *Daphnia pulex* (Cladocera). Can J Fish Aquat Sci 39: 830-836.

Gharrett JA, Rice SD. 1987. Influence of simulated tidal cycles on aromatic hydrocarbon uptake and elimination by the shore crab *Hemigrapsus nudus*. Mar Biol 95: 365-370.

Giddings JM. 1979. Acute toxicity to *Selenastrum capricornutum* of aromatic compounds from coal conversion. Bull Environ Contam Toxicol 23: 360-364 .

Goddard KA, Schultz RJ, Stegeman JJ. 1987. Uptake, toxicity, and distribution of benzo[*a*]pyrene and monooxygenase induction in the topminnows *Poeciliopsis monacha* and *Poeciliopsis lucida*. Drug Metab Dispos 15: 449-455.

Gust KA, Fleeger JW. 2006. Exposure to cadmium-phenanthrene mixtures elicits complex toxic responses in the freshwater tubificid oligochaete, *Ilyodrilus templetoni*. Arch Environ Contam Toxicol 51: 54-60.

Gust KA. 2006. Joint toxicity of cadmium and phenanthrene in the freshwater amphipod *Hyalella azteca*. Arch Environ Contam Toxicol 50: 7-13.

Hall AT, Oris JT. 1991. Anthracene reduces reproductive potential and is maternally transferred during long-term exposure in fathead minnows. Aquat Toxicol 19: 249-264.

Halling-Sørensen B, Nyholm N, Baun A. 1996. Algal toxicity test with volatile and hazardous compounds in air-tight test flasks with CO_2 enriched headspace. Chemosphere 32: 1513-1526.

Hannah JB, Hose JE, Landolt ML, Miller BS, Felton SP, Iwaoka WT. 1982. Benzo(a)pyrene-induced morphologic and developmental abnormalities in rainbow trout. Arch Environ Contam Toxicol 11: 727-734.

Hatch AC, Burton Jr. GA. 1998. Effects of photoinduced toxicity of fluoranthene on amphibian embryos and larvae. Environ Toxicol Chem 17: 1777-1785.

Hatch AC, Burton Jr. GA. 1999. Photo-induced toxicity of PAHs to *Hyalella azteca* and *Chironomus tentans*: Effects of mixtures and behavior. Environ Pollut 106: 157-167.

Hawkins SA, Billiard SM, Tabash SP, Brown RS, Hodson PV. 2002. Altering cytochrome P4501A activity affects polycyclic aromatic hydrocarbon ,etabolism and toxicity in rainbow trout (*Oncorhynchus mykiss*). Environ Toxicol Chem 21: 1845-1853.

Heitmuller PT, Hollister TA, Parrish PR. 1981. Acute toxicity of 54 industrial chemicals to sheepshead minnows (*Cyprinodon variegatus*). Bull Environ Contam Toxicol 27: 596-604.

Heldal M, Norland S, Lien T, Knutsen G, Tjessem K, Aarberg A. 1984 . Toxic responses of the green alga *Dunaliella bioculata* (Chlorophycea, Volvocales) to selected oxidised hydrocarbons. Environ Pollut Ser A 34: 119-132.

Herbert IN, Svendsen C, Hankard PK, Spurgeon DJ. 2004. Comparison of instantaneous rate of population increase and critical-effect estimates in *Folsomia candida* exposed to four toxicants. Ecotoxicol Environ Saf 57: 175-183.

Holcombe GW, Phipps GL, Fiandt JT. 1983. Toxicity of selected priority pollutants to various aquatic organisms. Ecotoxicol Environ Saf 7: 400-409.

Holcombe GW, Phipps GL, Knuth ML, Felhaber T. 1984. The acute toxicity of selected substituted phenols, benzenes and benzenoic acid esters to fathead minnows *Pimephales promelas*. Environ Pollut Ser A 35: 367-381.

Holst LL, Giesy JP. 1989. Chronic effects of the photoenhanced toxicity of anthracene on *Daphnia magna* reproduction. Environ Toxicol Chem 8: 933-942.

Hooftman RN. 1991. Ecotoxicological testing of polycyclic aromatic hydrocarbons. Delft, the Netherlands: TNO Environmental and Energy Research, TNO Institute of Environmental Sciences. TNO-report IMW-P91-026.

Hooftman RN, Evers-de Ruiter A. 1992a. The toxicity and uptake of fluoranthene in *Brachydanio rerio* in an early life stage test (draft OECD guideline). Delft, the Netherlands: TNO Environmental and Energy Research, TNO Institute of Environmental Sciences. TNO-report IMW-R 92/207.

Hooftman RN, Evers-de Ruiter A. 1992b. Early life stage tests with *Brachydanio rerio* and several polycyclic aromatic hydrocarbons using an intermittent flow-through system (draft OECD guideline). Delft, the Netherlands: TNO Environmental and Energy Research, TNO Institute of Environmental Sciences. TNO-report IMW-R 92/210.

Hooftman RN, Evers-de Ruiter A. 1992c. The toxicity and uptake of benzo(k)fluoranthene using *Brachydanio rerio* in an early life stage test (draft OECD guideline). Delft, the Netherlands: TNO Environmental and Energy Research, TNO Institute of Environmental Sciences. TNO-report IMW-R 92/218.

Hooftman RN, Evers-de Ruiter A. 1992d. Investigations into the aquatic toxicity of phenanthrene (cover-report for reproduction tests with the waterflea *Daphnia magna* and an Early Life Stage (ELS) test with the zebra fish *Brachydanio rerio*. Delft, the Netherlands: TNO Environmental and Energy Research, TNO Institute of Environmental Sciences. TNO-report R 92/290.

Hook SE, Lee RF. 2004. Interactive effects of UV, benzo[*a*]pyrene, and cadmium on DNA damage repair in embryos of the grass shrimp *Paleomonetes pugio*. Mar Environ Res 58: 735-739.

Hose JE, Hannah JB, DiJulio D, Landolt ML, Miller BS, Iwaoka WT, Felton SP. 1982. Effects of benzo(a)pyrene on early development of flatfish. Arch Environ Contam Toxicol 11: 167-171.

Hose JE, Puffer HW, Oshida PS, Bay SM. 1983. Developmental and cytogenic abnormalities induced in the purple sea urchin by environmental levels of benzo(a)pyrene. Arch Environ Contam Toxicol 12: 319-325.

Hose JE. 1985. Potential uses of sea urchin embryos for identifying toxic chemicals: Description of a bioassay incorporating cytologic, cytogenetic and embryologic endpoints. J Appl Toxicol 5: 245-254.

Huang X-D, Dixon DG, Greenberg BM. 1993. Impacts of UV radiation and photomodification on the toxicity of PAHs to the higher plant *Lemna gibba* (duckweed). Environ Toxicol Chem 12: 1067-1077.

Huang X-D, Dixon DG, Greenberg BM. 1995. Increased polycyclic aromatic hydrocarbon toxicity following their photomodification in natural sunlight: Impacts on the duckweed *Lemna gibba* L. G-3. Ecotoxicol Environ Saf 32: 194-200.

Huang X-D, Krylov SN, Ren L, McConkey BJ, Dixon DG, Greenberg BM. 1997a. Mechanistic quantitative structure-activity relationship model for the photoinduced toxicity of polycyclic aromatic hydrocarbons: II. An empirical model for the toxicity of 16 polycyclic aromatic hydrocarbons to the duckweed *Lemna gibba* L. G-3. Environ Toxicol Chem 16: 2296-2303.

Huang X-D, McConkey BJ, Babu TS, Greenberg BM. 1997b. Mechanisms of photoinduced toxicity of photomodified anthracene to plants: Inhibition of photosynthesis in the aquatic higher plant *Lemna gibba* (duckweed). Environ Toxicol Chem 16: 1707-1715.

Hulzebos EM, Adema DMM, Dirven-Van Breemen EM, Henzen L, Van Dis WA, Herbold HA, Hoekstra JA, Baerselman R, Van Gestel CAM. 1993. Phytotoxicity studies with *Lactuca sativa* in soil and nutrient solution. Environ Toxicol Chem 12: 1079-1094.

Hulzebos EM. unpublished data. Phytotoxicity studies with *Lactuca sativa* in soil and nutrient solution: IV. Miscellaneous compounds.

Hund-Rinke K, Simon M. 2005. Terrestrial ecotoxicity of eight chemicals in a systematic approach. J Soils Sediments 5: 59-65.

Hutchinson TC, Hellebust JA, Tam D, Mackay D, Mascarenhas RA, Shiu WY. 1980. The correlation of the toxicity to algae of hydrocarbons and halogenated hydrocarbons with their physico-chemical properties. In: Afghan BK, Mackay D, Hydrocarbons and halogenated hydrocarbons in the aquatic environment. New York, NY, USA: Plenum Press. pp. 577-586.

Ishio S, Chen JC, Kawasaki Y, Ohba N. 1977. Cell division of *Gyrodinium* sp. and mitotic delay induced by causal substances of algal tumor and carcinogens. Bulletin of the Japanese Society of Scientific Fisheries 43: 507-516.

Jager T. 1998. Mechanistic approach for estimating bioconcentration of organic chemicals in earthworms (oligochaeta). Environ Toxicol Chem 17: 2080-2090.

Jamroz T, Ledakowicz S, Miller JS, Sencio B. 2003. Microbiological evaluation of toxicity of three polycyclic aromatic hydrocarbons and their decomposition products formed by advanced oxidation processes. Environ Toxicol 18: 187-191.

Jee J-H, Kim S-G, Kang J-C. 2004. Effects of phenanthrene on growth and basic physiological functions of the olive flounder, *Paralichthys olivaceus*. J Exp Mar Biol Ecol 304: 123-136.

Jensen J, Sverdrup LE. 2002. Joint toxicity of linear alkylbenzene sulfonate and pyrene on *Folsomia fimetaria*. Ecotoxicol Environ Saf 52: 75-81.

Johnson BT, Long ER. 1998. Rapid toxicity assessment of sediment from estuarine ecosystems: A new tandem *in vitro* testing approach. Environ Toxicol Chem 17: 1099-1106.

Joshi PC, Misra RB. 1986. Evaluation of chemically-induced phototoxicity to aquatic organism using Paramecium as a model. Biochem Biophys Res Commun 139: 79-84.

Kagan J, Kagan PA, Buhse Jr. HE. 1984. Light-dependent toxicity of α-terthienyl and anthracene toward late embryonic stages of *Rana pipiens*. J Chem Ecol 10: 1115-1122.

Kagan J, Kagan ED, Kagan IA, Kagan PA, Quigley S. 1985. The phototoxicity of non-carcinogenic polycyclic aromatic hydrocarbons in aquatic organisms. Chemosphere 14: 1829-1834.

Kagan J, Kagan ED. 1986. The toxicity of benzo[a]pyrene and pyrene in the mosquito *Aedes aegypti*, in the dark and in the presence of ultraviolet light. Chemosphere 15: 243-251.

Kagan J, Kagan ED, Kagan IA, Kagan PA. 1987. Do polycyclic aromatic hydrocarbons, acting as photosensitizers, participate in the toxic effects of acid rain? In: Zika RG, Cooper WJ, eds. Photochemistry of environmental aquatic systems. ACS Symposium Series 327. Washington, DC: American Chemical Society. pp. 191-204.

Kaiser KLE, Palabrica VS. 1991. *Photobacterium phosphoreum* toxicity data index. Water Poll Res J Can 26: 361-431.

Kalf DF, Crommentuijn GH, Posthumus R, Van de Plassche EJ. 1995. Integrated Environmental Quality Objectives for Polycyclic Aromatic Hydrocarbons (PAHs). Bilthoven, The Netherlands: National Institute of Public Health and the Environment. RIVM report 679101018.

Kane Driscoll S, Harkey GA, Landrum PF. 1997a. Accumulation and toxicokinetics of fluoranthene in sediment bioassays with freshwater amphipods. Environ Toxicol Chem 16: 742-753.

Kane Driscoll S, Landrum PF, Tigue E. 1997b. Accumulation and toxicokinetics of fluoranthene in water-only exposures with freshwater amphipods. Environ Toxicol Chem 16: 754-761.

Kane Driscoll S, Landrum PF. 1997. A comparison of equilibrium partitioning and critical body residue approaches for predicting toxicity of sediment-associated fluoranthene to freshwater amphipods. Environ Toxicol Chem 16: 2179-2186.

Karickhoff SW, Brown DS, Scott TA. 1979. Sorption of hydrophobic pollutants on natural sediments. Water Res 13: 241-248.

Kauss PB, Hutchinson TC. 1975. The effects of water-soluble petroleum components on the growth of *Chlorella vulgaris* Beijerinck. Environ Pollut 9: 157-174.

Kirchmann H, Åström H, Jönsäll G. 1991. Organic pollutants in sewage sludge 1. Effect of toluene, naphthalene, 2-methylnaphthalene, 4-n-nonylphenol and di-2-ethylhexyl phthalate on soil biological processes and their deomposition in soil. Swed J Agric Res 21: 107-113.

Korn S, Moles A, Rice SD. 1979. Effects of temperature on the median tolerance limit of pink salmon and shrimp exposed to toluene, naphthalene, and Cook Inlet crude oil. Bull Environ Contam Toxicol 21: 521-525.

Kukkonen J, Landrum PF. 1994. Toxicokinetics and toxicity of sediment-associated pyrene to *Lumbriculus variegatus* (oligochaeta). Environ Toxicol Chem 13: 1457-1468.

Lampi MA, Gurska J, McDonald KIC, Xie F, Huang X-D, Dixon DG, Greenberg BM. 2006. Effect of irradiance spectra on the photoinduced toxicity of three polycyclic aromatic hydrocarbons. Environ Toxicol Chem 25: 1079-1087.

Lamy-Enrici M-H, Dondeyne A, Thybaud E. 2003. Influence of the organic matter on the bioavailability of phenanthrene for benthic organisms. Aquat Ecosys Health Manag 6: 391-396.

Landrum PF, Giesy JP, Oris JT, Allred PM. 1987. Photoinduced toxicity of polycyclic aromatic hydrocarbons to aquatic organisms. In: Vandermeulen JH, Hrudey SE, eds. Oil in freshwater: chemistry, biology, countermeasure technology. New York: Pergamon Press. pp. 304-318.

Landrum PF, Lotufo GR, Gossiaux DC, Gedeon ML, Lee J-H. 2003. Bioaccumulation and critical body residue of PAHs in the amphipod, *Diporeia* spp.: Additional evidence to support toxicity additivity for PAH mixtures. Chemosphere 51: 481-489.

Laughlin Jr. RB, Neff JM. 1979. Interactive effects of salinity, temperature and polycyclic aromatic hydrocarbons on the survival and development rate of larvae of the mud crab *Rhithropanopeus harrisii*. Mar Biol 53: 281-291.

LeBlanc GA. 1980. Acute toxicity of priority pollutants to water flea (*Daphnia magna*). Bull Environ Contam Toxicol 24: 684-691.

Lee WY, Nicol JAC. 1978a. The effect of naphthalene on survival and activity of the amphipod *Parhyale*. Bull Environ Contam Toxicol 20: 233-240.

Lee WY, Nicol JAC. 1978b. Individual and combined toxicity of some petroleum aromatics to the marine amphipod *Elasmpus pectenicrus*. Mar Biol 48: 215-222.

Lee J-H, Landrum PF, Field LJ, Koh C-H. 2001. Application of a Σpolycyclic aromatic hydrocarbon model and a logistic regression model to sediment toxicity data based on a species-specific, water-only LC50 toxic unit for *Hyalella azteca*. Environ Toxicol Chem 20: 2102-2113.

Lee J-H, Landrum PF, Koh C-H. 2002a. Prediction of time-dependent PAH toxicity in *Hyalelle azteca* using a damage assessment model. Environ Sci Technol 36: 3131-3138.

Lee J-H, Landrum PF, Koh C-H. 2002b. Toxicokinetics and time-dependent PAH toxicity in the amphipod *Hyalella azteca*. Environ Sci Technol 36: 3124-3130.

Lee J-H, Landrum PF. 2006. Development of a multi-component damage assessment model (MDAM) for time-dependent mixture toxicity with toxicokinetic interactions. Environ Sci Technol 40: 1341-1349.

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

Leyval C, Binet P. 1998. Effect of polyaromatic hydrocarbons in soil on arbuscular mycorrhizal plants. J Environ Qual 27: 402-407.

Lijzen JPA, Baars AJ, Otte PF, Rikken M, Swartjes FA, Verbruggen EMJ, Van Wezel AP. 2001. Technical evaluation of the Intervention Values for Soil/sediment and Groundwater. Human and ecotoxicological risk assessment and derivation of risk limits for soil, aquatic sediment and groundwater. Bilthoven, The Netherlands: National Institute of Public Health and the Environment. RIVM report 711701023.

Loibner AP, Szolar OHJ, Braun R, Hirmann D. 2004. Toxicity testing of 16 priority polycyclic aromatic hydrocarbons using Lumistox®. Environ Toxicol Chem 23: 557-564.

Lotufo GR, Fleeger JW. 1996. Toxicity of sediment-associated pyrene and phenanthrene to *Limnodrilus hoffmeisteri* (oligochaeta: tubificidae). Environ Toxicol Chem 15: 1508-1516.

Lotufo GR. 1997. Toxicity of sediment-associated PAHs to an estuarine copepod: Effects on survival, feeding, reproduction and behavior. Mar Environ Res 44: 149-166.

Lotufo GR. 1998. Lethal and sublethal toxicity of sediment-associated fluoranthene to benthic copepods: application of the critical-body-residue approach. Aquat Toxicol 44: 17-30.

Lyons BP, Pascoe CK, McFadzen IRB. 2002. Phototoxicity of pyrene and benzo[*a*]pyrene to embryo-larval stages of the pacific oyster *Crassostrea gigas*. Mar Environ Res 54: 627-631.

Léon Paumen M, Borgman E, Kraak MHS, Van Gestel CAM, Admiraal W. 2008. Life cycle responses of the midge *Chironomus riparius* to polycyclic aromatic compound exposure. Environ Pollut 152: 225-232.

Léon Paumen M, Stol P, Ter Laak TL, Kraak MHS, Van Gestel CAM, Admiraal W. 2008. Chronic exposure of the oligochaete *Lumbriculus variegatus* to polycyclic aromatic compounds (PACs): Bioavailability and effects on reproduction. Environ Sci Technol 42: 3434-3440.

Mackay D, Shiu WY, Ma K-C, Lee SC. 2006. Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals [computer program]. Second edition. CD-ROM. Boca Raton, FL, USA: CRC Press Taylor & Francis Group.

Maliszewska-Kordybach B, Klimkowicz-Pawlas A, Smreczak B, Janusauskaite D. 2007. Ecotoxic effect of phenanthrene on nitrifying bacteria in soils of different properties. J Environ Qual 36: 1635-1645.

Mallakin A, McConkey BJ, Miao G, McKibben B, Snieckus V, Dixon DG, Greenberg BM. 1999. Impacts of structural photomodification on the toxicity of environmental contaminants: Anthracene photooxidation products. Ecotoxicol Environ Saf 43: 204-212.

Mallakin A, Babu TS, Dixon DG, Greenberg BM. 2002. Sites of toxicity of specific photooxidation products of anthracene to higher plants: Inhibition of photosynthetic activity and electron transport in *Lemna gibba* L. G-3 (duckweed). Environ Toxicol 17: 462-471.

Mayer Jr. FL, Ellersieck MR. 1986. Manual of acute toxicity: Interpretation and data base for 410 chemicals and 66 species of freshwater animals. Washington, DC, USA: United States Department of the interior fish and wildlife service. Resource Publication 160.

McCloskey JT, Oris JT. 1991. Effect of water temperature and dissolved oxygen concentration on the photo-induced toxicity of anthracene to juvenile bluegill sunfish (*Lepomis macrochirus*). Aquat Toxicol 21: 145-156.

McConkey BJ, Duxbury CL, Dixon DG, Greenberg BM. 1997. Toxicity of PAH photooxidation product to the bacteria *Photobacterium phosphoreum* and the duckweed *Lemna gibba*: Effects of phenanthrene and its primary photoproduct, phenanthrenequinone. Environ Toxicol Chem 16: 892-899.

McGrath JA, Di Toro DM. 2009. Validation of the target lipid model for toxicity assessment of residual petroleum constituents: monocyclic and polycyclic aromatic hydrocarbons. Environ Toxicol Chem 28: 1130-1148.

Meier PG, Choi K, Sweet LI. 2000. Acute and chronic life cycle toxicity of acenaphthene and 2,4,6,-trichlorophenol to the midge *Paratanytarsus parthenogeneticus* (Diptera: Chironomidae). Aquat Toxicol 51: 31-44.

Milleman RE, Birge WJ, Black JA, Cushman RM, Daniels KL, Franco PJ, Giddings JM, McCarthy JF, Stewart AJ. 1984. Comparative acute toxicity to aquatic organisms of components of coal-derived synthetic fuels. Trans Am Fisher Soc 113: 74-85.

Mitchell RL, Burchett MD, Pulkownik A, McCluskey L. 1988. Effects of environmentally hazardous chemicals on the emergence and early growth of selected Australian plants. Plant Soil 112: 195-199.

Moles A. 1980. Sensitivity of parasitized Coho salmon fry to crude oil, toluene and naphthalene. Trans Am Fisher Soc 109: 293-297.

Moles A, Bates S, Rice SD, Korn S. 1981. Reduced growth in Coho salmon fry exposed to two petroleum components, toluene and naphthalene, in fresh water. Trans Am Fisher Soc 110: 430-436.

Moles A, Rice SD. 1983. Effects of crude oil and naphthalene on growth, caloric content, and fat content of pink salmon juveniles in seawater. Trans Am Fisher Soc 112: 205-211.

Monson PD, Call DJ, Cox DA, Liber K, Ankley GT. 1999. Photoinduced toxicity of fluoranthene to northern leopard frogs (*Rana pipiens*). Environ Toxicol Chem 18: 308-312.

Moreau CJ, Klerks PL, Haas CN. 1999. Interaction between phenanthrene and zinc in their toxicity to the sheepshead minnow (*Cyprinodon variegatus*). Arch Environ Contam Toxicol 37: 251-257.

Muńoz MJ, Tarazona JV. 1993. Synergistic effect of two- and four-component combinations of the polycyclic hydrocarbons: Phenanthrene, anthracene, naphthalene and acenaphtene on *Daphnia magna*. Bull Environ Contam Toxicol 50: 363-368.

Nałęcz-Jawecki G, Sawicki J. 1999. Spirotox - A new tool for testing the toxicity of volatile compounds. Chemosphere 38: 3211-3218.

Neuhauser EF, Loehr RC, Malecki MR, Milligan DL, Durkin PR. 1985. The toxicity of selected organic chemicals to the earthworm *Eisenia fetida*. J Environ Qual 14: 383-388.

Neuhauser EF, Durkin PR, Malecki MR, Anatra M. 1986a. Comparative toxicity of ten organic chemicals to four earthworm species. Comp Biochem Physiol, C: Comp Pharmacol Toxicol 83C: 197-200.

Neuhauser EF, Loehr RC, Malecki MR. 1986b. Contact and artificial soil tests using earthworms to evaluate the impact of wastes in soil. In: Petros Jr. JK, Lacy WJ, Conway RA, eds. Hazardous and Industiral Solid Waste Testing: Fourth Symposium. ASTM STP 886. Philedelphia, PA: American Society for Testing and Materials. pp. 192-203.

Neuhauser EF, Callahan CA. 1990. Growth and reproduction of the earthworm *Eisenia fetida* exposed to sublethal concentrations of organic chemicals. Soil Biol Biochem 22: 175-179.

Newsted JL, Giesy JP. 1987. Predictive models for photoinduced acute toxicity of polycyclic aromatic hydrocarbons to *Daphnia magna*, Strauss (Cladocera, crustacea). Environ Toxicol Chem 6: 445-461.

Nikkilä A, Penttinen S, Kukkonen JVK. 1999. UV-B induced acute toxicity of pyrene to the waterflea *Daphnia magna* in natural freshwaters. Ecotoxicol Environ Saf 44: 271-279.

Okay OS, Karacik B. 2007. Photoinduced toxicity of selected PAHs to the marine microalga *Phaeodactylum tricornutum*. J Environ Sci Health, Part A 42: 707-714.

Okay OS, Karacik B. 2008. Bioconcentration and phototoxicity of selected PAHs to marine mussel *Mytilus galloprovincialis*. J Environ Sci Health, Part A 43: 1234-1242.

Olmstead AW, LeBlanc GA. 2005. Joint action of polycyclic aromatic hydrocarbons: Predictive modeling of sublethal toxicity. Aquat Toxicol 75: 253-262.

Oris JT, Giesy JP, Allred PM, Grant DF, Landrum PF. 1984. Photoinduced toxicity of anthracene in aquatic organisms: An environmental perspective. In: Veziroğlu TN, ed. The biosphere: Problems and solutions. Amsterdam, The Netherlands: Elsevier Science Publishers B.V. pp. 639-658.

Oris JT, Giesy Jr. JP. 1985. The photoenhanced toxicity of anthracene to juvenile sunfish (*Lepomis* spp.). Aquat Toxicol 6: 133-146.

Oris JT, Giesy Jr. JP. 1986. Photoinduced toxicity of anthracene to juvenile bluegill sunfish (*Lepomis macrochirus* rafinesque): Photoperiod effects and predictive hazard evaluation. Environ Toxicol Chem 5: 761-768.

Oris JT, Giesy Jr. JP. 1987. The photo-induced toxicity of polycyclic aromatic hydrocarbons to larvae of the fathead minnow (*Pimephales promelas*). Chemosphere 16: 1395-1404.

Oris JT, Winner RW, Moore MV. 1991. A four-day survival and reproduction test for *Ceriodaphnia dubia*. Environ Toxicol Chem 10: 217-224.

Ostrander GK, Landolt ML, Kocan RM. 1988. The ontogeny of coho salmon (*Oncorhynchus kisutch*) behavior following embryonic exposure to benzo[*a*]pyrene. Aquat Toxicol 13: 325-346.

Ott FS, Harris RP, O'Hara SCM. 1978. Acute and sublethal toxicity of naphthalene and three methylated derivatives to the estuarine copepod, *Eurytemora affinis*. Mar Environ Res 1: 49-58.

Parkhurst BR, Bradshaw AS, Forte JL, Wright GP. 1981. The chronic toxicity to *Daphnia magna* of acridine, a representative azaarene present in synthetic fossil fuel products and wastewaters. Environ Pollut Ser A 24: 21-30.

Passino DRM, Smith SB. 1987. Acute bioassays and hazard evaluation of representative contaminants detected in Great Lakes fish. Environ Toxicol Chem 6: 901-907.

Passino-Reader DR, Berlin WH, Hickey JP. 1995. Chronic bioassays of rainbow trout fry with compounds representative of contaminants in Great Lakes fish. J Great Lakes Res 21: 373-383.

Peachey RL, Crosby DG. 1996. Phototoxicity in tropical reef animals. Mar Environ Res 42: 359-362.

Peachey RBJ. 2005. The synergism between hydrocarbon pollutants and UV radiation: a potential link between coastal pollution and larval mortality. J Exp Mar Biol Ecol 315: 103-114.

Pelletier MC, Burgess RM, Ho KT, Kuhn A, McKinney RA , Ryba SA. 1997. Phototoxicity of individual polycyclic aromatic hydrocarbons and petroleum to marine invertebrate larvae and juveniles. Environ Toxicol Chem 16: 2190-2199.

Petersen GI, Kristensen P. 1998. Bioaccumulation of lipophilic substances in fish early life stages. Environ Toxicol Chem 17: 1385-1395.

Pillai MC, Vines CA, Wikramanayake AH, Cherr GN. 2003. Polycyclic aromatic hydrocarbons disrupt axial development in sea urchin embryos through a β-catenin dependent pathway. Toxicology 186: 93-108.

Propst TL, Fort DJ, Stover EL, Schrock B, Bantle JA. 1997. Evaluation of the developmental toxicity of benzo[ɑ]pyrene and 2-acetylaminofluorene using *Xenopus*: Modes of biotransformation. Drug Chem Toxicol 20: 45-61.

Randall TL, Knopp PV. 1980. Detoxification of specific organic substances by wet oxydation. J Wat Pollut Control Fed 52: 2117-2130.

Ren L, Huang X-D, McConkey BJ, Dixon DG, Greenberg BM. 1994. Photoinduced toxicity of three polycyclic aromatic hydrocarbons (fluoranthene, pyrene, and naphthalene) to the duckweed *Lemna gibba* L. G-3. Ecotoxicol Environ Saf 28: 160-171.

Renoux AY, Millette D, Tyagi RD, Samson R. 1999. Detoxification of fluorene, phenanthrene, carbazole and *p*-cresol in columns of aquifer sand as studied by the Microtox® assay. Water Res 33: 2045-2052.

Rhodes S, Farwell A, Hewitt LM, MacKinnon M, Dixon DG. 2005. The effect of dimethylated and alkylated polycyclic aromatic hydrocarbons on the embryonic development of the Japanese medaka. Ecotoxicol Environ Saf 60: 247-258.

Rice SD, Thomas RE. 1989. Effect of pre-treatment exposures of toluene or naphthalene on the tolerance of pink salmon (*Oncorhynchus gorbuscha*) and kelp shrimp (*Eualis suckleyi*). Comp Biochem Physiol, C: Comp Pharmacol Toxicol 94C: 289-293.

Rogerson A, Shiu WY, Huang GL, Mackay D, Berger J. 1983. Determination and interpretation of hydrocarbon toxicity to ciliate protozoa. Aquat Toxicol 3: 215-228.

Römbke J, Bauer C, Marschner A. 1994. Verhalten und Wirkungen von sechs Umweltchemikalien in terrestrischen Labortests. Ecoinforma 6: 269-282.

Römbke J, Bauer C, Brodesser J, Brodsky J, Danneberg G, Heimann D, Renner I, Schallnaß H-J. 1995. Grundlagen für die Beurteilung des ökotoxikologischen Gefährdungspotentials von Altstoffen im Medium Boden - Entwicklung einer Teststrategie. Berlin, Germany: German Federal Environmental Agency (Umweltbundesamt). UBA-Texte 53/95.

Rossi SS, Neff JM. 1978. Toxicity of polynuclear aromatic hydrocarbons to the polychaete *Neanthes arenaceodentata*. Mar Pollut Bull 9: 220-223.

Sabourin TD. 1982. Respiratory and circulatory responses of the blue crab to naphthalene and the effect of acclimation salinity. Aquat Toxicol 2: 301-318.

Sæthre LJ, Falk-Petersen I-B, Sydnes LK, Lønnig S, Naley AM. 1984. Toxicity and chemical reactivity of naphthalene and methylnaphthalenes. Aquat Toxicol 5: 291-306.

Sanborn HR, Malins DC. 1977. Toxicity and metabolism of naphthalene: A study with marine larval invertebrates. Proc Soc Exp Biol Med 154: 151-155 .

Sanz-Lazaro C, Marin A, Borredat M. 2008. Toxicity studies of polynuclear aromatic hydrocarbons (PAHs) on European amphipods. Toxicol Mech Methods 18: 323-327.

Savino JF, Tanabe LL. 1989. Sublethal effects of phenanthrene, nicotine, and pinane on *Daphnia pulex*. Bull Environ Contam Toxicol 42: 778-784.

Schaub K, Achazi RK. 1996. Die akute und subakute Toxizität von Rieselfeldböden und polyzyklischen aromatischen Kohlenwasserstoffen (PAK) im Regenwurmtest. In: Kratz W., ed. Riesenfelder in Berlin und Brandenburg. Landschaftsentwicklung & Umweltforschung 101. Technische Universität Berlin. pp. 181-187.

Schemer H, Linden KG. 2007. Aqueous photodegradation and toxicity of the polycyclic aromatic hydrocarbons fluorene, dibenzofuran, and dibenzothiophene. Water Res 41: 853-861.

Schoeny R, Cody T, Warshawsky D, Radike M. 1988. Metabolism of mutagenic polycyclic aromatic hydrocarbons by photosynthetic algal species. Mutat Res 197: 289-302.

Schuler LJ, Landrum PF, Lydy MJ. 2004. Time-dependent toxicity of fluoranthene to freshwater invertebrates and the role of biotransformation on lethal body residues. Environ Sci Technol 38: 6247-6255.

Šepič E, Bricelj M, Leskovšek H. 2003. Toxicity of fluoranthene and its biodegradation metabolites to aquatic organisms. Chemosphere 52: 1125-1133.

Sjursen H, Sverdrup LE, Krogh PH. 2001. Effects of polycyclic aromatic compounds on the drought tolerance of *Folsomia fimetaria* (Collembola, isotomidae). Environ Toxicol Chem 20: 2899-2902.

Sjursen H, Holmstrup M. 2004. Cold and drought stress in combination with pyrene exposure: studies with *Protaphorura armata* (Collembola: Onychiuridae). Ecotoxicol Environ Saf 57: 145-152.

Smith RL, Hargreaves BR. 1983. A simple toxicity apparatus for continuous flow with small volumes: Demonstration with mysids and naphthalene. Bull Environ Contam Toxicol 30: 406-412.

Smith SB, Savino JF, Blouin MA. 1988. Acute toxicity to *Daphnia pulex* of six classes of chemical compounds potentially hazardous to Great Lakes aquatic biota. J Great Lakes Res 14: 394-404.

Son A-J, Shin K-H, Lee J-U, Kim K-W. 2003. Chemical and ecotoxicity assessment of PAH-contaminated soils remediated by enhanced soil flushing. Environ Eng Sci 20: 197-206.

Sørensen TS, Holmstrup M. 2005. A comparative analysis of the toxicity of eight common soil contaminants and their effects on drought tolerance in the collembolan *Folsomia candida*. Ecotoxicol Environ Saf 60: 132-139.

Southerland HA, Lewitus AJ. 2004. Physiological responses of estuarine phytoplankton to ultraviolet light-induced fluoranthene toxicity. J Exp Mar Biol Ecol 298: 303-322.

Spehar RL, Poucher S, Brooke LT, Hansen DJ, Champlin D, Cox DA. 1999. Comparative toxicity of fluoranthene to freshwater and saltwater species under fluorescent light. Arch Environ Contam Toxicol 37: 496-502.

Stewart KM, Thompson RS. 1995. Fluoranthene as a model toxicant in sediment studies with *Chironomus riparius*. J Aquat Ecosystem Health 4: 231-238.

Suedel BC, Rodgers Jr. JH, Clifford PA. 1993. Bioavailability of fluoranthene in freshwater sediment toxicity tests. Environ Toxicol Chem 12: 155-165.

Suedel BC, Rodgers Jr. JH. 1996. Toxicity of fluoranthene to *Daphnia magna*, *Hyalella azteca*, *Chironomus tentans*, and *Stylaria lacustris* in water-only and whole sediment exposures. Bull Environ Contam Toxicol 57: 132-138.

Sverdrup LE, Kelley AE, Krogh PH, Nielsen T, Jensen J, Scott-Fordsmand JJ, Stenersen J. 2001. Effects of eight polycyclic aromatic compounds on the survival and reproduction of the springtail *Folsomia fimetaria* L. (Collembola, isotomidae). Environ Toxicol Chem 20: 1332-1338.

Sverdrup LE 2001. Toxicity of Tar Constituents in Terrestrial Ecosystems: Effects of Eight Polycyclic Aromatic Compounds on Terrestrial Plants, Soil Invertebrates and Micro-Organisms. University of Oslo, Oslo, Norway.

Sverdrup LE, Nielsen T, Krogh PH. 2002. Soil ecotoxicity of polycyclic aromatic hydrocarbons in relation to soil sorption, lipophilicity, and water solubility. Environ Sci Technol 36: 2429-2435.

Sverdrup LE, Krogh PH, Nielsen T, Stenersen J. 2002a. Relative sensitivity of three terrestrial invertebrate tests to polycyclic aromatic compounds. Environ Toxicol Chem 21: 1927-1933.

Sverdrup LE, Jensen J, Kelley AE, Krogh PH, Stenersen J. 2002b. Effects of eight polycyclic aromatic compounds on the survival and reproduction of *Enchytraeus crypticus* (Oligochaeta, clitellata). Environ Toxicol Chem 21: 109-114.

Sverdrup LE, Jensen J, Krogh PH, Stenersen J . 2002c. Studies on the effect of soil aging on the toxicity of pyrene and phenanthrene to a soil-dwelling springtail. Environ Toxicol Chem 21: 489-492.

Sverdrup LE, Ekelund F, Krogh PH, Nielsen T, Johnson K. 2002d. Soil microbial toxicity of eight polycyclic aromatic compounds: Effects on nitrification, the genetic diversity of bacteria, and the total number of protozoans. Environ Toxicol Chem 21: 1644-1650.

Sverdrup LE, Krogh PH, Nielsen T, Kjær C, Stenersen J. 2003. Toxicity of eight polycyclic aromatic compounds to red clover (*Trifolium pratense*), ryegrass (*Lolium perenne*), and mustard (*Sinapsis alba*). Chemosphere 53: 993-1003.

Sverdrup LE, De Vaufleury A, Hartnik T, Hagen SB, Loibner AP, Jensen J. 2006. Effects and uptake of polycyclic aromatic compounds in snails (*Helix aspersa*). Environ Toxicol Chem 25: 1941-1945.

Sverdrup LE, Hagen SB, Krogh PH, Van Gestel CAM. 2007. Benzo(a)pyrene shows low toxicity to three species of terrestrial plants, two soil invertebrates, and soil-nitrifying bacteria. Ecotoxicol Environ Saf 66: 362-368.

Swartz RC, Kemp PF, Schults DW, Lamberson JO. 1988. Effects of mixtures of sediment contaminants on the marine infaunal amphipod, *Rhepoxynius abronius*. Environ Toxicol Chem 7: 1013-1020.

Swartz RC, Schults DW, Dewitt TH, Ditsworth GR, Lamberson JO. 1990. Toxicity of fluoranthene in sediment to marine amphipods: A test of the equilibrium partitioning approach to sediment quality criteria. Environ Toxicol Chem 9: 1071-1080.

Swartz RC, Ferraro SP, Lamberson JO, Cole FA, Ozretich RJ, Boese BL, Schults DW, Behrenfeld M, Ankley GT. 1997 . Photoactivation and toxicity of mixtures of polycyclic aromatic hydrocarbon compounds in marine sediment. Environ Toxicol Chem 16: 2151-2157.

Tatem HE, Anderson JW. 1973. The toxicity of four oils to *Palaemonetes pugio* (Holthuis) in relation to uptake and retention of specific petroleum hydrocarbons. Am Zool 13: 1307-1308.

Tatem HE, Cox BA, Anderson JW. 1978. The toxicity of oils and petroleum hydrocarbons to estuarine crustaceans. Estuar Coastal Mar Sci 6: 365-373.

Thomas RE, Rice SD. 1979. The effect of exposure temperature on oxygen consumption and opercular breathing rates of pink salmon fry exposed to toluene, naphthalene, and water-soluble fractions of Cook Inlet crude oil and No. 2 fuel oil. In: Vernberg WB, Calabrese A, Thurberg FP, Vernberg FJ, eds. Marine Pollution: Functional Responses. New York: Academic Press, Inc. pp. 39-52.

Thursby GB, Steele RL, Kane ME. 1985. Effect of organic chemicals on growth and reproduction in the marine red alga *Champia parvula*. Environ Toxicol Chem 4: 797-805.

Trucco RG, Engelhardt FR, Stacey B. 1983. Toxicity, accumulation and clearance of aromatic hydrocarbons in *Daphnia pulex*. Environ Pollut Ser A 31: 191-202.

Unger MA, Newman MC, Vadas GG. 2007. Predicting survival of grass shrimp (*Palaemonetes pugio*) during ethylnaphthalene, dimethylnaphthalene, phenanthrene exposures differing in concentration and duration. Environ Toxicol Chem 26: 528-534.

Unger MA, Newman MC, Vadas GG. 2008. Predicting survival of grass shrimp (*Palaemonetes pugio*) exposed to naphthalene, fluorene, and dibenzothiophene. Environ Toxicol Chem 27: 1802-1808.

Van Brummelen TC, Stuijfzand SC. 1993. Effects of benzo[*a*]pyrene on survival, growth and energy reserves in the terrestrial isopods *Oniscus asellus* and *Porcellio scaber*. Sci Total Environ Supplement: 921-930.

Van Brummelen TC, Van Gestel CAM, Verweij RA. 1996. Long-term toxicity of five polycyclic aromatic hydrocarbons for the terrestrial isopods *Oniscus asellus* and *Porcellio scaber*. Environ Toxicol Chem 15: 1199-1210.

Van Straalen NM, Verweij RA. 1991. Effects of benzo(a)pyrene on food assimilation and growth efficiency in *Porcellio scaber* (Isopoda). Bull Environ Contam Toxicol 46: 134-140.

Van Vlaardingen P, Traas TP, Wintersen AM, Aldenberg T. 2004. ETX 2.0. A program to calculate hazardous concentrations and fraction affected, based on normally distributed toxicity data. Bilthoven, The Netherlands: National Institute for Public Health and the Environment. RIVM report 601501028/2004.

Van Vlaardingen PLA, Verbruggen EMJ. 2007. Guidance for the derivation of environmental risk limits within the framework of 'International and national environmental quality standards for substances in the Netherlands' (INS). Revision 2007. Bilthoven, The Netherlands: National Institute for Public Health and the Environment. RIVM report 601782001.

Verbruggen EMJ, Vaes WHJ, Parkerton TF, Hermens JLM. 2000. Polyacrylate-coated SPME fibers as a tool to simulate body residues and target concentrations of complex organic mixtures for estimation of baseline toxicity. Environ Sci Technol 34: 324-331.

Verbruggen EMJ, Posthumus R, Van Wezel AP. 2001. Ecotoxicological Serious Risk Concentrations for soil, sediment and (ground)water: updated proposals for first series of compounds. Bilthoven, The Netherlands: National Institute of Public Health and the Environment. RIVM report 711701020.

Verbruggen EMJ, Beek M, Pijnenburg J, Traas TP. 2008. Ecotoxicological environmental risk limits for total petroleum hydrocarbons on the basis of internal lipid concentrations. Environ Toxicol Chem 27: 2436-2448.

Verrhiest G, Clément B, Blake G. 2001. Single and combined effects of sediment-associated PAHs on three species of freshwater macroinvertebrates. Ecotoxicology 10: 363-372.

Walker SE, Taylor DH, Oris JT. 1998. Behavioral and histopathological effects of fluoranthene on bullfrog larvae (*Rana catesbeiana*). Environ Toxicol Chem 17: 1998.

Walter H, Consolaro F, Gramatica P, Scholze M, Altenburger R. 2002. Mixture toxicity of priority pollutants at no observed effect concentrations (NOECs). Ecotoxicology 11: 299-310.

Ward GS, Parrish PR, Rigby RA. 1981. Early life stage toxicity test with a saltwater fish: Effects of eight chemicals on survival, growth, and development of sheepshead minnows (*Cyprinodon variegatus*). J Toxicol Environ Health 8: 225-240.

Wassenberg DM, Swails EE, Di Guilio RT. 2002. Effects of single and combined exposures to benzo(a)pyrene and 3,3'4,4'5-pentachlorobiphenyl on EROD activity and development in *Fundulus heteroclitus*. Mar Environ Res 54: 279-283.

Weinstein JE, Polk KD. 2001. Phototoxicity of anthracene and pyrene to glochidia of the freshwater mussel *Utterbackia imbecilis*. Environ Toxicol Chem 20: 2021-2028.

Weinstein JE. 2001. Characterization of the acute toxicity of photoactivated fluoranthene to glochidia of the freshwater mussel, *Utterbackia imbecillis*. Environ Toxicol Chem 20: 412-419.

Weinstein JE, Sanger DM, Holland FA. 2003. Bioaccumulation and toxicity of fluoranthene in the estuarine oligochaete *Monopylephorus rubroniveus*. Ecotoxicol Environ Saf 55: 278-286.

Weinstein JE, Sanger DM. 2003. Comparative tolerance of two estuarine annelids to fluoranthene under normoxic and moderately hypoxic conditions. Mar Environ Res 56: 637-648 .

Werner I, Nagel R. 1997. Stress proteins HSP60 and HSP70 in three species of amphipods exposed to cadmium, diazinon, dieldrin and fluoranthene. Environ Toxicol Chem 16: 2393-2403.

Wernersson A-S, Dave G. 1997. Phototoxicity identification by solid phase extraction and photoinduced toxicity to *Daphnia magna*. Arch Environ Contam Toxicol 32: 268-273.

Wernersson A-S. 2003. Predicting petroleum phototoxicity. Ecotoxicol Environ Saf 54: 355-365.

Wilcoxen SE, Meier PG, Landrum PF. 2003. The toxicity of fluoranthene to *Hyalella azteca* in sediment and water-only exposures under varying light spectra. Ecotoxicol Environ Saf 54: 105-117.

Winkler DL, Duncan KL, Hose JE, Puffer HW. 1983. Effects of benzo(a)pyrene on the early development of California grunion, *Leuresthes tenuis* (Pisces, Atherinidae). Fishery Bulletin 81: 473-481.

Xie F, Koziar SA, Lampi MA, Dixon DG, Norwood WP, Borgmann U, Huang X-D, Greenberg BM. 2006. Assessment of the toxicity of mixtures of copper, 9,10-phenanthrenequinone, and phenanthrene to *Daphnia magna*: Evidence for a reactive oxygen mechanism. Environ Toxicol Chem 25: 613-622.

Yoshioka Y, Nagase H, Ose Y, Sato T. 1986. Evaluation of the test method "Activated sludge, respiration inhibition test" proposed by the OECD. Ecotoxicol Environ Saf 12: 206-212.

Yoshioka Y, Ose Y. 1993. A quantitative structure-activity relationship study and ecotoxicological risk quotient for the protection from chemical pollution. Environ Toxicol Water Qual 8: 87-101.

Appendix. Detailed ecotoxicity data

Table 100: Legend to the tables in the Appendix

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 101: Acute toxicity of naphthalene (CASnr. 91-20-3) for freshwater organisms

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Chlamydomonas angulosa	5*10^4 cells/ml	N	S		am	6.5	19		3 h	EC50	photosynthesis/assimilation 14C	9600	3	25, 106, 231	Hutchinson et al., 1980
Chlorella vulgaris	20*10^4 cells/ml	N	S		am	6.5	19		3 h	EC50	photosynthesis/assimilation 14C	19000	3	25, 106, 231	Hutchinson et al., 1980
Chlorella vulgaris	3-10*10^4 cells/ml	N	S		am		20±2		24 h	EC50	cell number	33000	3	25, 142, 231	Kauss & Hutchinson, 1975
Nitzschia palea		Y	S		am	7.6			4 h	EC50	photosynthesis/assimilation 14C	2820	2	266	Milleman et al., 1984
Pseudokirchneriella subcapitata		N							14 d	EC50	standing crop	25000	3		Gaur 1988
Pseudokirchneriella subcapitata	10^5 cells/ml	N	S	rg	am		24		4 h	EC50	photosynthesis/assimilation 14C	11000	3	92, 231, 268	Giddings 1979
Pseudokirchneriella subcapitata	10^5 cells/ml	N	S	rg	am		24		4 h	EC10	photosynthesis/assimilation 14C	3100	3	92, 231, 268	Giddings 1979
Pseudokirchneriella subcapitata		Y	S		am	7.6			4 h	EC50	photosynthesis/assimilation 14C	2960	2	266	Milleman et al., 1984
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am		25±1	27.2	7 d	EC50	growth, area under the curve	68210	3	203	Djomo et al., 2004
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC50	cell number	3800	2	242, 266	Walter et al 2002

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Amphibia															
Xenopus laevis	larvae, 3 w	Y	CF	reagent g.	dtw	7.0-7.1	28		96 h	LC50	mortality	2100	2/3	25, 266	Edmisten & Bantle, 1982
Xenopus laevis	larvae, 3 w	Y	CF	reagent g.	dtw	7.0-7.1	28		96 h	LC10	mortality	1300	2/3	25, 102, 266	Edmisten & Bantle, 1982
Bacteria															
Nitrosomonas sp.		N	Sc			6.5-8			24 h	EC50	ammonia use	29000	4		Blum and Speece 1991
Crustacea															
Daphnia magna		Y	S		tw	8.0-8.6	22-26		48 h	LC50	mortality	4100	2/3	80	Crider et al., 1982
Daphnia magna	1.5 mm, 4-6 d	N	Sc	≥97%	am	6.0-7.0	23±2		48 h	LC50	mortality	17000	3	231	Bobra et al., 1983
Daphnia magna	< 24 h	N	Sc	≥97%	rw		20±1		48 h	EC50	immobility	2194	3	34	Muñoz & Tarazona, 1993
Daphnia magna	adult, mixed age	N	S		nw	7.6±0.2	19±1.5	134±16	48 h	EC50	immobility	22600	3	80	Eastmond et al., 1984
Daphnia magna	24 h	Y	Sc		nw	7.8	19.5-20.5	140	48 h	EC50	immobility	2160	2	25, 266	Milleman et al., 1984
Daphnia magna	4-6 d	N	Sc	≥97%	am	6.0-7.0	23±2		48 h	LC50	mortality	4700	3	5, 231	Abernethy et al., 1986
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	1664	2	5	Bisson et al., 2000
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	>1024	3	105, 163	Wernersson 2003
Daphnia magna	< 24 h	N	Sc	≥80%	rw	7.4-9.4	22±1	173	48 h	LC50	mortality	8600	3		LeBlanc 1980
Daphnia magna	< 24 h	N	Sc	≥80%	rw	7.4-9.4	22±1	173	48 h	NOEC	mortality	600	3		LeBlanc 1980
Daphnia magna									48 h	LC50	mortality	24100	4		Parkhurst et al., 1981
Daphnia pulex	< 24 h	N	S	≥96%	rw		20	160-180	48 h	EC50	immobility	4663	3		Smith et al., 1988
Daphnia pulex	< 24 h	N	S	≥96%	rw		20	160-180	48 h	EC10	immobility	1900	3		Smith et al., 1988
Daphnia pulex	1.9-2.1 mm	Y	Sc		nw	7.5	15±2		96 h	LC50	mortality	1000	2	36	Trucco et al., 1983
Daphnia pulex	neonates	N	S	ACS grade	dtw	7.2 (6.8-7.5)	20±1	43 (43-48)	48 h	LC50	mortality	3400	3	35, 80	Geiger & Buikema, 1981, 1982
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3	4	165-250	5 d	EC50	immobility	1587	2		Landrum et al., 2003

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Gammarus minus	adult	Y	Sc		nw		21-24		48 h	LC50	mortality	3930	2	266	Milleman et al., 1984
Cyanophyta															
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	<2100	2	210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	EC50	nitrogen fixation	24000	2	92, 210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	EC10	nitrogen fixation	9500	2	92, 210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	2100	2	210, 211	Bastian & Toetz, 1985
Insecta															
Chironomus attenuatus	4th instar	N	S		tw	7.9-8.3	19-22		24 h	LC50	mortality	13100	3	80, 239	Darville & Wilhm, 1984
Chironomus attenuatus	4th instar	N	S		tw	7.9-8.3	19-22		24 h	LC50	mortality	13000	3	80, 239	Darville & Wilhm, 1984
Chironomus riparius	1st instar, <24 h	Y	S	>99%	DSW				96 h	LC50	mortality	600	2	82	Bleeker et al., 2003
Chironomus riparius	1st instar, <24 h	Y	S	>99%	DSW				96 h	LC50	mortality	650	2	83	Bleeker et al., 2003
Chironomus tentans	4th instar	Y	Sc		nw	7.8	23-26	140	48 h	EC50	immobility	2810	2	5, 266	Milleman et al., 1984
Somatochlora cingulata		N			nw				96 h	LC50	mortality	1000-2500	4		Correa & Coler, 1983
Tanytarsus dissimilis	4th instar	N	S		tw	7.9-8.3			48 h	LC50	mortality	20700	3	80, 238, 239	Darville & Wilhm, 1984
Tanytarsus dissimilis	4th instar	N	S		tw	7.9-8.3			48 h	LC50	mortality	12600	3	80, 238, 239	Darville & Wilhm, 1984
Macrophyta															
Lemna gibba		Y	R		am				8 d	EC50	growth rate	1600	3	102, 108, 109	Ren et al., 1994
Mollusca															
Physa gyrina	7.5 mm, 0.057 g	Y	Sc		nw	7.8	19.5-20.5	140	48 h	LC50	mortality	5020	2	266	Milleman et al., 1984
Pisces															
Abramis brama	young of year	N	S	technical	nw	7.8-8.1	17-21		24 h	LC50	mortality	10000	3		Frumin et al., 1992
Abramis brama	young of year	N	S	technical	nw	7.8-8.1	17-21		24 h	LC50	mortality	10000	3	92	Frumin et al., 1992
Abramis brama	young of year	N	S	technical	nw	7.8-8.1	17-21		24 h	LC10	mortality	5900	3	92	Frumin et al., 1992
Oncorhynchus kisutch	fry, 1 g	Y	CF		nw		~7.6		96 h	LC50	mortality	2100	2		Moles et al., 1981
Oncorhynchus kisutch	fry, 0.3 g, 7 d	Y	CF		nw				96 h	LC50	mortality	3220	2		Moles, 1980
Oncorhynchus mykiss	3.9 g, 93 mm	Y	CF		nw	7.9-8.0	15±2	535-596	96 h	LC50	mortality	1600	2	80	DeGraeve et al., 1982

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Oncorhynchus mykiss	fry (Arlee), 13-21 d	N	S	≥95%	nw		12±1.0	160-190	96 h	LC50	mortality	1800	3		Edsall, 1991
Oncorhynchus mykiss	fry (Erwin), 13-21 d	N	S	≥95%	nw		12±1.0	160-190	96 h	LC50	mortality	6100	3		Edsall, 1991
Oncorhynchus mykiss	fry (Redband), 13-21 d	N	S	≥95%	nw		12±1.0	160-190	96 h	LC50	mortality	2600	3		Edsall, 1991
Oncorhynchus mykiss	fry (Shasta), 13-21 d	N	S	≥95%	nw		12±1.0	160-190	96 h	LC50	mortality	4400	3		Edsall, 1991
Oncorhynchus mykiss	fry (Whyteville), 13-21 d	N	S	≥95%	nw		12±1.0	160-190	96 h	LC50	mortality	5500	3		Edsall, 1991
Oreochromis mossambicus		N	R						96 h	LC50	mortality	7900	4		Dangé, 1986
Oreochromis mossambicus	4-5 mo	N	S	technical	nw	7.8-8.1	22-24		24 h	LC50	mortality	22000	3		Frumin et al., 1992
Oreochromis mossambicus	4-5 mo	N	S	technical	nw	7.8-8.1	22-24		24 h	LC50	mortality	22000	3	92	Frumin et al., 1992
Oreochromis mossambicus	4-5 mo	N	S	technical	nw	7.8-8.1	22-24		24 h	LC50	mortality	20000	3	92	Frumin et al., 1992
Pimephales promelas	0.116 g, 34 d	Y	CF	98%		7.38±0.11	24.5±0.38	43.9± 0.58	96 h	LC50	mortality	6140	4*		Geiger et al., 1985
Pimephales promelas	34 d	Y	CF	98%		7.4	25	44	96 h	LC50	mortality	6140	4*		Broderius et al., 1995
Pimephales promelas	31-35 d	Y	CF	98%	nw	6.9-7.7	24.6±1.4	44.9 (42.4-46.6)	96 h	LC50	mortality	6080	2	241	Holcombe et al., 1984
Pimephales promelas	1-2 mo, 0.27 g, 28 mm	Y	Sc		nw	7.8	20±0.5	140	96 h	LC50	mortality	1990	2	266	Milleman et al., 1984
Pimephales promelas	0.9 g, 46 mm	Y	CF		nw	7.9-8.0	15±2	535-596	96 h	LC50	mortality	7900	2	80	DeGraeve et al., 1982
Protozoa															
Spirostomum ambiguum		N	Sc	analyt	am	7.4 ± 0.2	25	2.8	48 h	EC50	deformations	36400	3	5	Nałęcz-Jawecki & Sawicki, 1999
Spirostomum ambiguum		N	Sc	analyt	am	7.4 ± 0.2	25	2.8	48 h	LC50	mortality	40100	3	5	Nałęcz-Jawecki & Sawicki, 1999

Table 102: Chronic toxicity of naphthalene (CASnr. 91-20-3) for freshwater organisms

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Chlorella vulgaris	3-10*10^4 cells/ml	N	S		am		20±2		24 h	EC10	cell number	3900	3	25, 102, 142, 231	Kauss & Hutchinson, 1975
Pseudokirchneriella subcapitata	5*10^3 cells/ml	Y	S		am		23		96 h	NOEC	growth rate	≥1800	3	275, 278, 285	AquaSense 2004
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	>4270	2	167	Bisson et al., 2000
Pseudokirchneriella subcapitata		N							14 d	EC10	standing crop	13000	3		Gaur 1988
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am		25±1	27.2	7 d	EC10	growth, area under the curve	7270	3	203	Djomo et al., 2004
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	NOEC	cell number	1200	2	242, 266	Walter et al 2002
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC10	cell number	1700	2	242, 266	Walter et al 2002
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	514	2	168	Bisson et al., 2000
Daphnia magna	< 24 h	N	R	>99%	am		20		7 d	EC50	growth	4610	3		Olmstead & Leblanc 2005
Daphnia magna	< 24 h	N	R	>99%	am		20		7 d	EC10	growth	1100	3		Olmstead & Leblanc 2005
Daphnia pulex	< 24 h	Y	R	-	tw	6.9-7.5		41-50	lifetime	NOEC	reproduction, growth	≥600	3	19, 20, 21, 35	Geiger & Buikema, 1982
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3	4	165-250	10 d	EC50	immobility	1141	2		Landrum et al., 2003
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3	4	165-250	10 d	LC50	mortality	1757	2		Landrum et al., 2003
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3	4	165-250	28 d	LC50	mortality	1266	2		Landrum et al., 2003
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	10 d	LC50	mortality	2720	2		Lee et al., 2001
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	14 d	LC50	mortality	2130	2		Lee et al., 2001
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	1632	2		Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	1762	2	92	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	NOEC	mortality	1161	2		Lee et al., 2002
Cyanophyta															
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	NOEC	standing crop	≥25000	3	143	Bastian & Toetz, 1982

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Insecta															
Tanytarsus dissimilis	eggs	Y	CF		tw	7.7-8.0	17.7-22.7	132-190	life-cycle, ± 30 d	NOEC	egg hatching, adult emergence	<500	2	80, 238	Darville & Wilhm, 1984
Macrophyta															
Lemna gibba		Y	R		am				8 d	EC10	growth rate	32000	2	10, 102	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC10	growth rate	280	3	102, 108, 109	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC10	growth rate	1000	3	10, 102, 108	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC1-3	growth rate	2000	2	110	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC0-13	chlorophyll content	2000	2	110	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC2-21	growth rate	2000	2	111	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC2-42	chlorophyll content	2000	2	111	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC4-7	growth rate	2000	2	112	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC3-13	chlorophyll content	2000	2	112	Ren et al., 1994
Pisces															
Danio rerio	larvae	Y	R	>99%		7.86±0.5	27±1		96 h	NOEC	malformations	≥388	2	136, 237	Petersen & Kristensen 1998
Micropterus salmoides	eggs 2-4 d post spawning	Y	CF		am	7.4-8.1	20.2-23.2	86.8-116.3	7 d incl. 4 post-hatch	LC50	mortality	510	2		Black et al., 1983
Micropterus salmoides	eggs 2-4 d post spawning	Y	CF		am	7.4-8.1	20.2-23.2	86.8-116.3	7 d incl. 4 post-hatch	LC10	mortality	37	2	91	Black et al., 1983

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Micropterus salmoides	eggs 2-4 d post spawning	Y	CF		am	7.41-8.1	20.2-23.2	86.8-116.3	7 d incl. 4 post-hatch	LC50	mortality	680	2	266	Milleman et al., 1984
Oncorhynchus kisutch	fry, 1 g	Y	CF		nw		7.6-10.4		40 d	NOEC	weight/length (increase)	370	2		Moles et al., 1981
Oncorhynchus kisutch	fry, 1 g	Y	CF		nw		7.6-10.4		40 d	EC50	weight (wet and dry; increase)	770	2	102	Moles et al., 1981
Oncorhynchus kisutch	fry, 1 g	Y	CF		nw		7.6-10.4		40 d	EC10	weight (wet and dry; increase)	520	2	102	Moles et al., 1981
Oncorhynchus kisutch	fry, 1 g	Y	CF		nw		7.6-10.4		40 d	EC50	length (increase)	840	2	102	Moles et al., 1981
Oncorhynchus kisutch	fry, 1 g	Y	CF		nw		7.6-10.4		40 d	EC10	length (increase)	460	2	102	Moles et al., 1981
Oncorhynchus mykiss	eggs 20 min post fertilization	Y	CF		rw	7.4-8.1	13.3-14.2	86.8-116.3	27 d incl. 4 post-hatch	LC50	mortality	110	2		Black et al., 1983
Oncorhynchus mykiss	eggs 20 min post fertilization	Y	CF		rw	7.4-8.1	13.3-14.2	86.8-116.3	27 d incl. 4 post-hatch	LC10	mortality	20	2	92	Black et al., 1983
Oncorhynchus mykiss	eggs 20 min post fertilization	Y	CF		rw	7.41-8.10	13.3-14.2	86.8-116.3	27 d incl. 4 post-hatch	LC50	mortality	120	2	266	Milleman et al., 1984
Pimephales promelas	embryo/larvae	Y	CF		nw	7.9-8.0	25±1	535-596	30 d	NOEC	length, weight	450	2	8, 80	DeGraeve et al., 1982
Pimephales promelas	embryo/larvae	Y	CF		nw	7.9-8.0	25±1	535-596	30 d	NOEC	hatchability	450	2	7, 8, 80	DeGraeve et al., 1982
Pimephales promelas	embryo/larvae	Y	CF		nw	7.9-8.0	25±1	535-596	30 d	EC10	hatchability	2900	2	8, 80, 102	DeGraeve et al., 1982
Pimephales promelas	embryo/larvae	Y	CF		nw	7.9-8.0	25±1	535-596	30 d	NOEC	mortality	1800	2	8, 80	DeGraeve et al., 1982
Sarotherodon mossambicus	18 ± 3 g	N	R		tw	7.6±0.3	27±3	235±16	12 w	NOEC	growth (wet weight)	2300	3	9	Dange & Masurekar, 1982
Protozoa															
Colpidium colpoda		Y	S	≥98%	am		22±1		18 h	NOEC	mortality	≥29000	3	202	Rogerson et al., 1983
Tetrahymena elliotti		Y	Sc	≥98%	am		22±1		24 h	NOEC	mortality	≥29000	3	202	Rogerson et al., 1983

Table 103: Acute toxicity of naphthalene (CASnr. 91-20-3) for marine organisms

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Champia parvula	female	N	Rc		am		22-24	30	14 d	EC50	growth	2200	2	62, 102	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	14 d	EC50	growth	1900	2	62, 102, 239	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	14 d	EC50	growth	1000	2	62, 102, 239	Thursby et al., 1985
Annelida															
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	3800	3	50	Rossi & Neff, 1978
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	1069	2	52	Rossi & Neff, 1978
Bacteria															
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	1970	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	2620	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	2360	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	3020	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	900	3		Johnson & Long, 1998
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	2360	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	2330	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	720	2	4, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	700	2	4, 6	El-Alawi et al., 2001
Vibrio fischeri							15		5 min	EC50	bioluminescence	1800	4		Kaiser & Palabrica, 1991
Vibrio fischeri				99%			15		5 min	EC50	bioluminescence	809	4		Kaiser & Palabrica, 1991
Vibrio fischeri				99%			15		15 min	EC50	bioluminescence	907	4		Kaiser & Palabrica, 1991
Vibrio fischeri				99%			15		30 min	EC50	bioluminescence	929	4		Kaiser & Palabrica, 1991
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC50	bioluminescence	1890	2	115	Loibner et al., 2004
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	390	2	115	Loibner et al., 2004
Crustacea															
Artemia salina	nauplii	N	Sc	≥97%			20±1	30	24 h	LC50	mortality	11000	3	5, 231	Abernethy et al., 1986

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Artemia salina	nauplii, 2nd stage	Y	S	≥98%	am	8.5-8.7	19	32	24 h	EC50	immobility	3190	2	53	Foster & Tullis, 1984
Cancer magister	1st instar zoeae	Y	R	p.a.	nw		13	30	96 h	LC50	mortality	>2000	2	49, 269	Caldwell et al., 1977
Cancer magister	newly hatched zoea	Y	F		nw	7.5	10±1		36 h	LC100	mortality	8-12	4	270	Sanborn & Malins, 1977
Calanus finmarchicus	adult	Y	Sc	>97%	nw		5	33	96 h	LC50	mortality	2400	2	54, 92	Falk-Petersen et al., 1982
Calanus finmarchicus	adult	Y	Sc	>97%	nw		5	33	96 h	LC10	mortality	2200	2	54, 92	Falk-Petersen et al., 1982
Callinectes sapidus	adult, 50-227 g	Y	CF	p.a.	am		22-23	10	48 h	LC50	mortality	2900	2	51	Sabourin, 1982
Callinectes sapidus	adult, 50-227 g	Y	CF	p.a.	am		22-23	20	48 h	LC50	mortality	2100	2	51	Sabourin, 1982
Callinectes sapidus	adult, 50-227 g	Y	CF	p.a.	am		22-23	30	48 h	LC50	mortality	2000	2	51	Sabourin, 1982
Elasmopus pectenicrus	adult	N	Rc		nw		23±1.7	30	96 h	LC50	mortality	2680	2/3		Lee & Nicol, 1978b
Eualis suckleyi	1 g	Y	CF		nw		6.0-6.9		96 h	LC50	mortality	1390	2		Rice & Thomas, 1989
Eurytemora affinis	adult female	Y	Sc		nw		15		24 h	NOEC	mortality	>1000	2		Berdugo et al., 1977
Eurytemora affinis	adult female	Y	Sc		nw		15		24 h	NOEC	feeding rate	<1000	2		Berdugo et al., 1977
Eurytemora affinis	adult female	Y	Sc		nw		15		24 h	EC10	feeding rate	~930	2	92	Berdugo et al., 1977
Eurytemora affinis	adult female	Y	Sc		nw		15		24 h	NOEC	egg production	<1000	2		Berdugo et al., 1977
Eurytemora affinis	adult	Y	Sc	≥99%	nw		15	20	24 h	LC50	mortality	3800	2	271	Ott et al., 1978
Hemigrapsus nudus		N	CF		nw		9.6-10.1	28-29	8 d	LC50	mortality	1100	2	55, 216	Gharrett & Rice, 1987
Hemigrapsus nudus		N	CF		nw		9.6-10.1	28-29	8 d	LC50	mortality	2100	2	128, 252, 216	Gharrett & Rice, 1987
Hemigrapsus nudus		N	CF		nw		9.6-10.1	28-29	8 d	LC50	mortality	2800	2	129, 216	Gharrett & Rice, 1987
Hemigrapsus nudus		N	CF		nw		9.6-10.1	28-29	8 d	LC50	locomotory dysfunction	800	2	55, 252, 216	Gharrett & Rice, 1987
Hemigrapsus nudus		N	CF		nw		9.6-10.1	28-29	8 d	LC50	locomotory dysfunction	2000	2	128, 252, 216	Gharrett & Rice, 1987
Hemigrapsus nudus		N	CF		nw		9.6-10.1	28-29	8 d	LC50	locomotory dysfunction	2800	2	129, 252, 216	Gharrett & Rice, 1987
Metapenaeus monocerus	juvenile, intermoult stage	N	R		nw	7.5	21	17.5	96 h	LC50	mortality	5700	3		Deshmukh et al., 1985
Metapenaeus monocerus	juvenile, intermoult stage	N	R		nw	7.5	25	17.5	96 h	LC50	mortality	5500	3		Deshmukh et al., 1985
Metapenaeus monocerus	juvenile, intermoult stage	N	R		nw	7.5	30	17.5	96 h	LC50	mortality	4200	3		Deshmukh et al., 1985
Neomysis americana		Y	CF		am		15		96 h	LC50	mortality	1280	2	56	Smith & Hargreaves, 1983

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Neomysis americana		Y	CF		am		25		96 h	LC50	mortality	850	2	56	Smith & Hargreaves, 1983
Neomysis americana		Y	R		am		15		96 h	LC50	mortality	1420	2	56	Hargreaves et al., in press cited in Smith & Hargreaves, 1983
Neomysis americana		Y	R		am		25		96 h	LC50	mortality	800	2	56	Hargreaves et al., in press cited in Smith & Hargreaves, 1983
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC50	mortality	7190	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC10	mortality	3100	2	102	Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC50	immobility	4480	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC10	immobility	2500	2	102	Barata et al., 2005
Palaemonetes pugio			S		nw				24 h	LC50	mortality	2600	4		Anderson et al., 1974
Palaemonetes pugio									48 h	LC50	mortality	2350	4		Tatem & Anderson., 1973
Palaemonetes pugio	adult	N	S	high purity	am	8.1±0.1	21±1	15	96 h	LC50	mortality	2350	3		Tatem et al., 1978
Palaemonetes pugio		Y	R	99%	nw	7.76-7.95	19.6-21.8	18.8-21.2	48 h	LC50	mortality	2111	2	274	Unger et al. 2008
Pandalus goniurus	0.8 g, 6 cm	Y	S		nw		4	26-28	96 h	LC50	mortality	2160	3	147	Korn et al., 1979
Pandalus goniurus	0.8 g, 6 cm	Y	S		nw		8	26-28	96 h	LC50	mortality	1020	3	148	Korn et al., 1979
Pandalus goniurus	0.8 g, 6 cm	Y	S		nw		12	26-28	96 h	LC50	mortality	971	3	149	Korn et al., 1979
Pandalus platyceros	larvae stage I and IV	Y	F		nw	7.5	10±1		36 h	LC100	mortality	8-12	4	270	Sanborn & Malins, 1977
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	LC50	mortality	2535	2	25, 266	Calbet et al. 2007
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	LC50	mortality	2500	2	25, 102, 266	Calbet et al. 2007

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	LC10	mortality	1600	2	25, 102, 266	Calbet et al. 2007
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	EC50	narcosis	2467	2	25, 266	Calbet et al. 2007
Parhyale hawaiensis	adult	N	S		rw		22	30	24 h	LC50	mortality	15000	3	92	Lee & Nicol, 1978a
Parhyale hawaiensis	adult	N	S		rw		22	30	24 h	LC10	mortality	12000	3	92	Lee & Nicol, 1978a
Parhyale hawaiensis	adult	N	Sc		rw		22	30	24 h	LC50	mortality	6000	2	92	Lee & Nicol, 1978a
Parhyale hawaiensis	adult	N	Sc		rw		22	30	24 h	LC10	mortality	3700	2	92	Lee & Nicol, 1978a
Penaeus aztecus			S		nw				24 h	LC50	mortality	2500	4		Anderson et al., 1974
Penaeus aztecus	juvenile, 0.3 g	N	S	high purity	am	8.1±0.1	21±1	20	96 h	LC50	mortality	2500	3		Tatem et al., 1978
Mollusca															
Mytilus edulis	40-50 mm shell length	Y	R	≥98%	nw		15	33	48 h	EC50	feeding filtration	922	2		Donkin et al., 1989, 1991
Pisces															
Cyprinodon variegatus			S		nw				24 h	LC50	mortality	2400	4		Anderson et al., 1974
Fundulus heteroclitus	8.2±2 cm	Y	R		nw	7.6±0.2	20±1	15	96 h	LC50	mortality	5300	2	58	DiMichele & Taylor, 1978
Oncorhynchus gorbuscha	325 mg, 32 mm	Y	CF		nw		8	28	96 h	LC50	mortality	1200	2		Moles & Rice, 1983
Oncorhynchus gorbuscha	fry, 0.35 g, 3.5 cm	Y	S		nw		4	26-28	96 h	LC50	mortality	1370	3	147	Korn et al., 1979
Oncorhynchus gorbuscha	fry, 0.35 g, 3.5 cm	Y	S		nw		8	26-28	96 h	LC50	mortality	1840	3	148	Korn et al., 1979
Oncorhynchus gorbuscha	fry, 0.35 g, 3.5 cm	Y	S		nw		12	26-28	96 h	LC50	mortality	1240	3	149	Korn et al., 1979
Oncorhynchus gorbuscha	fry	Y	CF		nw		10.2-11.6		48 h	LC50	mortality	961	2		Rice & Thomas, 1989
Oncorhynchus gorbuscha	fry, 4.5-5.5 cm	Y	S		nw		12	27	24 h	LC50	mortality	920	3		Thomas & Rice, 1979

Table 104: Chronic toxicity of naphthalene (CASnr. 91-20-3) for marine organisms

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Champia parvula	female	N	Rc		am		22-24	30	14 d	NOEC	growth, reproduction (number of cystocarps)	1300	2	62	Thursby et al., 1985
Champia parvula	female	N	Rc		am		22-24	30	14 d	EC10	growth	850	2	62, 102	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	14 d	NOEC	growth	1300	2	62, 239	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	14 d	EC10	growth	1400	2	62, 102, 239	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	14 d	NOEC	growth	<695	2	62, 239	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	14 d	EC10	growth	470	2	62, 102, 239	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	11 d	NOEC	reproduction (number of tetrasporangia)	695	2	62	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	11 d	EC50	reproduction (number of tetrasporangia)	1300	2	62, 102	Thursby et al., 1985
Champia parvula	tetrasporophyte	N	Rc		am		22-24	30	11 d	EC10	reproduction (number of tetrasporangia)	900	2	62, 102	Thursby et al., 1985
Bacteria															
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC50	bioluminescence	99850	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC50	bioluminescence	98950	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	growth	99790	3	24, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	growth	99900	3	24, 6	El-Alawi et al., 2001
Crustacea															
Cancer magister	zoeae, Alaska	Y	CF	p.a.	nw		13 (10.5-14.2)	29-34	40 d	NOEC	larval developm.	21	2	49	Caldwell et al., 1977
Cancer magister	zoeae, Oregon	Y	CF	p.a.	nw		13 (10.5-14.2)	29-34	60 d	NOEC	larval developm.	≥170	2	49	Caldwell et al., 1977

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Cancer magister	zoeae, Alaska	Y	CF	p.a.	nw		13 (10.5-14.2)	29-34	40 d	NOEC	mortality, growth	≥130	2	49	Caldwell et al., 1977
Cancer magister	zoeae, Oregon	Y	CF	p.a.	nw		13 (10.5-14.2)	29-34	60 d	NOEC	mortality, growth	≥170	2	49	Caldwell et al., 1977
Eurytemora affinis	adult female	Y	R		nw		15		10 d	NOEC	feeding rate, egg production	≥50	2	57	Berdugo et al., 1977
Eurytemora affinis	adult	Y	Rc	≥99%	nw		15	20	lifetime, 15 d	NOEC	lifetime, number of eggs, brood size	<14	2	136	Ott et al., 1978
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	EC50	feeding rate	1264	2	25, 266	Calbet et al. 2007
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	EC50	feeding rate	1300	2	25, 102, 266	Calbet et al. 2007
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	EC10	feeding rate	780	2	25, 102, 266	Calbet et al. 2007
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	EC50	egg production	2096	2	25, 266	Calbet et al. 2007
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	EC50	egg production	1500	2	25, 102, 266	Calbet et al. 2007
Paracartia grani	adult female, 920 µm prosome length	Y	S	>96%	nw		20		48 h	EC10	egg production	530	2	25, 102, 266	Calbet et al. 2007
Paracartia grani	eggs	Y	R	>96%	nw		20		48 h	NOEC	egg hatching	>1300, < 6400	2	25, 136, 266	Calbet et al. 2007
Paracartia grani	920 µm prosome length	Y	R	>96%	nw		20		96 h	NOEC	feeding rate, egg production, hatching	≥130	2	25, 136, 266	Calbet et al. 2007

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Rhithropanopeus harrissi	zoeae	N	R		am		20, 25, 30	5, 15, 25	zoeal development until molting to megalops	NOEC	mortality	≥500	3	25	Laughlin & Neff, 1979
Echinodermata															
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	4781	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	649	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	950	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	4358	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	741	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	950	2	272, 273	Bellas et al. 2008
Psammechinus miliaris	fertilized eggs, 2-8 cells, <4 h	Y	Sc		nw		20	32	48 h	NOEC	larval development	≥355	2	80, 277	AquaSense 2004
Strongylocentrotus droebachiensis	eggs, ELS	Y	S	>97%	nw		5	33	96 h	LC50	mortality	1000	2	54, 92, 127	Falk-Petersen et al., 1982
Strongylocentrotus droebachiensis	eggs, ELS	Y	S	>97%	nw		5	33	96 h	LC10	mortality	940	2	54, 92, 127	Falk-Petersen et al., 1982
Strongylocentrotus droebachiensis	eggs, ELS	Y	S	>97%	nw		5	33	96 h	LC50	mortality	590	2	92, 153	Saethre et al., 1984

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Strongylocentrotus droebachiensis	eggs, ELS	Y	S	>97%	nw		5	33	96 h	LC10	mortality	580	2	92, 153	Saethre et al., 1984
Mollusca															
Crassostrea gigas	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	NOEC	larval development	≥480	3	80, 275, 276	AquaSense 2004
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	6626	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	4037	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	2051	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	9920	2	272, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	8241	2	272, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	8459	2	272, 273	Bellas et al. 2008
Pisces															
Gadus morhua	eggs, ELS	Y	S	>97%	nw		5	33	96 h	LC50	mortality	1200	2	54, 92, 127	Falk-Petersen et al., 1982
Gadus morhua	eggs, ELS	Y	S	>97%	nw		5	33	96 h	LC10	mortality	1000	2	54, 92, 127	Falk-Petersen et al., 1982
Gadus morhua	eggs, ELS	Y	S	>97%	nw		5	33	96 h	LC10	mortality	>700	2	92, 153	Saethre et ., 1984
Oncorhynchus gorbuscha	325 mg, 32 mm	Y	CF		nw		8	28	40 d	NOEC	wet weight (increase)	120	2		Moles & Rice, 1983
Oncorhynchus gorbuscha	325 mg, 32 mm	Y	CF		nw		8	28	40 d	EC50	wet weight (increase)	700	2	92	Moles & Rice, 1983
Oncorhynchus gorbuscha	325 mg, 32 mm	Y	CF		nw		8	28	40 d	EC10	wet weight (increase)	260	2	92	Moles & Rice, 1983
Oncorhynchus gorbuscha	325 mg, 32 mm	Y	CF		nw		8	28	40 d	NOEC	length (increase)	560	2		Moles & Rice, 1983
Oncorhynchus gorbuscha	325 mg, 32 mm	Y	CF		nw		8	28	40 d	EC50	length (increase)	950	2	92	Moles & Rice, 1983

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Oncorhynchus gorbuscha	325 mg, 32 mm	Y	CF		nw		8	28	40 d	EC10	length (increase)	390	2	92	Moles & Rice, 1983
Tunicata															
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC50	larval development	1948	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC10	larval development	610	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	LOEC	larval development	3281	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC50	larval development	4281	2	272, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC10	larval development	3025	2	272, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	LOEC	larval development	13125	2	272, 273	Bellas et al. 2008

Table 105: Toxicity of naphthalene (CASnr. 91-20-3) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Algae																
Chlorococcum hypnosporum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	422.96		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	84		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>1000		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	196		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	473.88		3	25, 27, 28, 59	Chung et al. 2007

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Chlorococcum hypnosporum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	64.23		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum meneghini		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	464.22		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	141.63		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>1000		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	>1000		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	529.78		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	25.79		2	25, 27, 59	Chung et al. 2007
Selenastrum capricornutum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	724.77		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	70		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>1000		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	41.8		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	419.27		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	99	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	7.26		3	25, 27, 28, 59	Chung et al. 2007
Annelida																
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	86	220	3	21, 57, 67, 85, 86	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	86	220	3	21, 57, 67, 85, 86	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	28	72	3	21, 57, 67, 85	Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	20	52	2	22, 57, 67, 85, 86	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	20	52	2	22, 57, 67, 85, 86	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	6.7	17	2	22, 57, 67, 85	Bleeker et al., 2003

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg_{dw}]	Value standard soil [mg/kg_{dw}]	Ri	Notes	Reference
Insecta																
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	24	62	3	21, 57, 67, 85, 86	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	24	62	3	21, 57, 67, 85, 86	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	11	29	3	21, 57, 67, 85	Bleeker et al., 2003
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	5.8	15	2	22, 57, 67, 85, 86	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	5.8	15	2	22, 57, 67, 85, 86	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	2.7	6.9	2	22, 57, 67, 85	Bleeker et al., 2003
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	167	614	3	12, 15, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	164	603	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	85	311	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	20	74	3	12, 15, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	53	194	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	22	81	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	56	204	2	12, 15, 22, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	52	193	2	12, 15, 22, 47, 78	Sverdrup et al., 2002

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	25	92	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	6.7	24	2	12, 15, 22, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	16	60	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	7.3	27	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Macrophyta																
Lactuca sativa		Y	≥95	loam	7.5 (7.1-7.6)	21±4	1.4	11.8	7 d	EC50	shoot growth	100	714	3	7, 52, 69	Hulzebos et al., 1993
Lactuca sativa		Y	≥95	loam	7.5 (7.1-7.6)	21±4	1.4	11.8	6 d	NOEC	shoot growth	32	229	3	7, 52	Adema & Henzen, 1990
Lactuca sativa		Y	≥95	loam	7.5 (7.1-7.6)	21±4	1.4	11.8	6 d	EC10	shoot growth	47	336	3	7, 47, 52	Adema & Henzen, 1990
Lactuca sativa		Y	≥95	loam	7.5 (7.1-7.6)	21±4	1.4	11.8	14 d	EC50	shoot growth	>100	>714	3	7, 52, 69	Hulzebos et al., 1993
Lactuca sativa		Y	≥95	loam	7.5 (7.1-7.6)	21±4	1.4	11.8	14 d	NOEC	shoot growth	≥100	≥714	3	7, 52	Adema & Henzen, 1990
Lolium perenne	seeds	N	99	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC50	germination	>1000		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	99	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC10	germination	>1000		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	99	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC50	root length	>1000		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	99	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC10	root length	155		2	10, 27, 59	Chung et al. 2007
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	shoot growth	>1000	>11111	4	10, 40, 47	Baek et al 2004
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	shoot growth	100	1111	4	10, 40, 41, 47	Baek et al 2004
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	root growth	1700	18889	4	10, 40, 47	Baek et al 2004

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	root growth	>1000	>11111	4	10, 40, 41, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	shoot growth	2500	27778	4	10, 40, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	shoot growth	100	1111	4	10, 40, 41, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	root growth	1900	21111	4	10, 40, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	root growth	100	1111	4	10, 40, 41, 47	Baek et al 2004
Microbial processes																
respiration, nitrogen mineralization, nitrification		Y		silt loam	7.3	25	3.0	13	7 d (80 d)	NOEC		≥21	≥70	3	8, 19, 21	Kirchman et al., 1991
respiration, nitrogen mineralization, nitrification		Y		silt loam	7.3	25	3.0	13	7 d	NOEC		≥7.1	≥24	2	8, 19, 22	Kirchman et al., 1991

Table 106: Toxicity of naphthalene (CASnr. 91-20-3) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Crustacea																
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	LC50	mortality	770	1756	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	EC50	reburial	751	1712	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	LC50	mortality	761	1735	2	23, 24, 46, 52, 59	Boese et al., 1998

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	EC50	reburial	737	1680	2	23, 24, 46, 52, 59	Boese et al., 1998

Table 107: Acute toxicity of acenaphthylene (CASnr: 208-96-8) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	1800	2	5	Bisson et al., 2000
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	>1024	3	105, 163	Wernersson 2003
Pisces															
Oryzias latipes			R						48 h	LC50	mortality	11000	4		Yoshioka et al., 1986
Oryzias latipes			R		dtw	7.2	20±1	40	96 h	LC50	mortality	6400	2/3		Yoshioka & Ose, 1993
Protozoa															
Tetrhymena pyriformis			S		am		30		24 h	EC50	growth	6300	3	251	Yoshioka et al., 1986

Table 108: Chronic toxicity of acenaphthylene (CASnr: 208-96-8) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	82	2	167	Bisson et al., 2000

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	64	2	168	Bisson et al., 2000

Table 109: Acute toxicity of acenaphthylene (CASnr: 208-96-8) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am	7.2±0.1	20±1		15 min	EC50	bioluminescence	800	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		15 min	EC50	bioluminescence	770	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		15 min	EC50	bioluminescence	330	2	4, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		15 min	EC50	bioluminescence	340	2	4, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	340	3		Johnson & Long, 1998
Vibrio fischeri				98%			15		5 min	EC50	bioluminescence	225	4		Kaiser & Palabrica, 1991
Vibrio fischeri				98%			15		15 min	EC50	bioluminescence	241	4		Kaiser & Palabrica, 1991
Vibrio fischeri				98%			15		30 min	EC50	bioluminescence	283	4		Kaiser & Palabrica, 1991
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC50	bioluminescence	860	2	115	Loibner et al., 2004
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	180	2	115	Loibner et al., 2004

Table 110: Chronic toxicity of acenaphthylene (CASnr: 208-96-8) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am	7.2±0.1	20±1		18 h	EC50	bioluminescence	6570	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		18 h	EC50	bioluminescence	1470	3	3, 6	El-Alawi et al., 2001

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		N	S		am	7.2±0.1	20±1		8+18 h	EC50	bioluminescence	3620	3	24, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		8+18 h	EC50	bioluminescence	530	3	24, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		18 h	EC50	growth	6050	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		18 h	EC50	growth	1390	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		8+18 h	EC50	growth	3540	3	24, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2±0.1	20±1		8+18 h	EC50	growth	520	3	24, 6	El-Alawi et al., 2001

Table 111: Toxicity of acenaphthylene (CASnr: 208-96-8) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Insecta																
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	145	533	3	12, 15, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	146	535	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	132	484	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	23	85	3	12, 15, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	48	176	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	43	157	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	87	321	2	12, 15, 22, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	83	304	2	12, 15, 22, 47, 78	Sverdrup et al., 2002

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	73	269	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	14	**51**	2	12, 15, 22, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	29	106	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	87	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	26	97	2	12, 15, 22, 47, 78	Sverdrup et al., 2002

Table 112: Acute toxicity of acenaphthene (CASnr: 83-32-9) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Daphnia magna	< 24 h	Y	S	-	am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	958	2	5	Bisson et al., 2000
Daphnia magna	< 24 h	N	Sc	≥80%	rw	7.4-9.4	22±1	173	48 h	LC50	mortality	41000	3		LeBlanc 1980
Daphnia magna	< 24 h	N	Sc	≥80%	rw	7.4-9.4	22±1	173	48 h	NOEC	mortality	600	3		LeBlanc 1980
Daphnia magna	< 24 h	N	Sc	≥97%	rw		20±1		48 h	EC50	immobility	1275	3	34	Muñoz & Tarazona, 1993
Daphnia magna	12±12 h 1st instar	N	S		nw	7.7 (7.0-8.2)	22	154.5 (89.5-180)	48 h	EC50	immobility	3450	3		Randall & Knopp, 1980
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	>1024	3	105, 163	Wernersson 2003
Cyanophyta															
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	≥4600	2	210	Bastian & Toetz, 1985

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Insecta															
Paratanytarsus parthenogeneticus	third instar larvae	Y	S		nw	7.4	20	713	48 h	LC50	mortality	>1800	2	239	Meier et al., 2000
Paratanytarsus parthenogeneticus	third instar larvae	Y	S		nw	7.4	20	713	48 h	LC50	mortality	>2100	2	239	Meier et al., 2000
Mollusca															
Aplexa hypnorum	adult	Y	CF	99%	nw	7.5-7.6	22.9 (22.5-23.2)	43.3 (42.3-44.2)	96 h	LC50	mortality	>2040	2	266	Holcombe et al., 1983
Pisces															
Ictalurus punctatus	5.0 g	Y	CF	99%	nw	7.5-7.6	22.9 (22.5-23.2)	43.3 (42.3-44.2)	96 h	LC50	mortality	1720	2	266	Holcombe et al., 1983
Lepomis macrochirus	0.32-1.2 g	N	Sc	>80%	rw	6.5-7.9	22±1	32-48	96 h	LC50	mortality	1700	3	141	Buccafusco et al., 1981
Oncorhynchus mykiss	1.3 g	Y	CF	99%	nw	7.2-7.4	12.0 (11.8-12.2)	45.8 (45.6-46.1)	96 h	LC50	mortality	670	2	266	Holcombe et al., 1983
Oryzias latipes			R		dtw	7.2	20±1	40	48 h	LC50	mortality	23000	3		Yoshioka & Ose, 1993
Pimephales promelas	2 w	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	LC50	mortality	608	2	196	Cairns & Nebeker, 1982
Pimephales promelas	0.16 g, 32 d	Y	CF	99%		7.53±0.04	23.1±0.50	43.3±1.34	96 h	LC50	mortality	1730	4*		Geiger et al., 1985
Pimephales promelas	0.16 g, 32-33 d	Y	CF	99%	nw	7.5-7.6	22.9 (22.5-23.2)	43.3 (42.3-44.2)	96 h	LC50	mortality	1600	2	266	Holcombe et al., 1983

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Salmo trutta	0.16 g	Y	CF	99%	nw	7.2-7.4	12.0 (11.8-12.2)	45.8 (45.6-46.1)	96 h	LC50	mortality	580	2	266	Holcombe et al., 1983

Table 113: Chronic toxicity of acenaphthene (CASnr: 83-32-9) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	38	2	167	Bisson et al., 2000
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	42	2	168	Bisson et al., 2000
Cyanophyta															
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	NOEC	standing crop	≥4500	3	143	Bastian & Toetz, 1982
Insecta															
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	hatchability	196	2	25, 239, 240	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	hatchability	133	2	25, 239, 240	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	larval development (development to fourth instar)	80	2	25, 239, 240	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	larval development (development to fourth instar)	63	2	25, 239, 240	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	pupal formation	76	2	25, 239, 240	Meier et al., 2000

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	pupal formation	46	2	25, 239, 240	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	adult emergence	74	2	25, 239, 240	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	adult emergence	39	2	25, 239, 240	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	adult survival	85	2	25, 92, 239	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC10	adult survival	39	2	25, 92, 239	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC50	adult survival	82	2	25, 92, 239	Meier et al., 2000
Paratanytarsus parthenogeneticus	eggs	Y	F		nw	7.4	20	713	19 - 22 d	EC10	adult survival	6	3	25, 92, 232, 239	Meier et al., 2000
Pisces															
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	NOEC	fork length, wet weight	332	2	196	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	EC50	fork length	2400	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	EC10	fork length	220	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	EC50	wet weight	510	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	EC10	wet weight	190	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	NOEC	fork length, wet weight	345	2	196	Cairns & Nebeker, 1982

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	EC50	fork length	1400	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	EC10	fork length	590	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	EC50	wet weight	760	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	EC10	wet weight	440	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	NOEC	mortality	509	2	196	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	LC50	mortality	690	2	196, 92	Cairns & Nebeker, 1982
Pimephales promelas	ELS, embryos ≤48 h	Y	CF		nw	7.4 (7.1-7.6)	24.5±1	35 (24-70)	96 h	LC10	mortality	590	2	196, 92	Cairns & Nebeker, 1982

Table 114: Acute toxicity of acenaphthene (CASnr: 83-32-9) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Sc		rw		16	~19		EC3	growth inhibition	300	3	214	Boney, 1974
Bacteria															
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	2410	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	2520	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	810	2	4, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	830	2	4, 6	El-Alawi et al., 2001

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	750	3		Johnson & Long, 1998
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC50	bioluminescence	1060	2	115	Loibner et al., 2004
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	310	2	115	Loibner et al., 2004
Mollusca															
Mytilus edulis	40-50 mm shell length	Y	R	≥98%	nw		15	33	48 h	EC50	feeding filtration	382	2		Donkin et al., 1989, 1991
Pisces															
Cyprinodon variegatus	8-15 mm, 14-28 d	N	S	>80%	nw		25-31	10-31	96 h	LC50	mortality	2200	3		Heitmuller et al., 1981
Cyprinodon variegatus	8-15 mm, 14-28 d	N	S	>80%	nw		25-31	10-31	96 h	NOEC	mortality	1000	3		Heitmuller et al., 1981
Cyprinodon variegatus	adult	Y	IF		nw		30±1	25	96 h	LC50	mortality	3100	2	175	Ward et al., 1981

Table 115: Chronic toxicity of acenaphthene (CASnr: 83-32-9) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC50	bioluminescence	5210	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	bioluminescence	8845	3	24, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	bioluminescence	2540	3	24, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC50	growth	4680	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	growth	86750	3	24, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	growth	2390	3	24, 6	El-Alawi et al., 2001
Pisces															
Cyprinodon variegatus	ELS embryo	Y	IF		nw	7.9-8.3	29±1	25±3	4 h after fertiliza-tion - hatching	NOEC	hatching	970	2	175	Ward et al., 1981

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Cyprinodon variegatus	ELS embryo	Y	IF		nw	7.9-8.3	29±1	25±3	4 h after fertiliza-tion – hatching	EC50	hatching	1300	2	92, 175	Ward et al., 1981
Cyprinodon variegatus	ELS embryo	Y	IF		nw	7.9-8.3	29±1	25±3	4 h after fertiliza-tion - hatching	EC10	hatching	760	2	92, 175	Ward et al., 1981
Cyprinodon variegatus	ELS embryo	Y	IF		nw	7.9-8.3	29±1	25±3	28 d after hatching	NOEC	mortality	520	2	175	Ward et al., 1981
Cyprinodon variegatus	ELS embryo	Y	IF		nw	7.9-8.3	29±1	25±3	28 d after hatching	EC50	mortality	860	2	92, 175	Ward et al., 1981
Cyprinodon variegatus	ELS embryo	Y	IF		nw	7.9-8.3	29±1	25±3	28 d after hatching	EC10	mortality	610	2	92, 175	Ward et al., 1981

Table 116: Toxicity of acenaphthene (CASnr: 83-32-9) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Insecta																
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	107	393	3	12, 15, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	101	370	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	88	324	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	31	114	3	12, 15, 21, 78	Sverdrup et al., 2002

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	84	308	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	76	280	3	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	64	236	2	12, 15, 22, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	53	194	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	48	178	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	19	**68**	2	12, 15, 22, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	27	99	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	19	68	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Macrophyta																
Lactuca sativa		N	≥95	loam	7.5	21±4	1.8	21	7 d	EC50	shoot growth	37	206	3	7, 69	Hulzebos et al., 1993
Lactuca sativa		N	≥95	loam	7.5	21±4	1.8	21	14 d	EC50	shoot growth	25	139	3	7, 69	Hulzebos et al., 1993
Lactuca sativa		N	≥95	loam	7.5	21±4	1.8	21	7 d	NOEC	shoot growth	3.2	18	3	7, 69	Hulzebos et al., unpublished data
Lactuca sativa		N	≥95	loam	7.5	21±4	1.8	21	14 d	NOEC	shoot growth	1	5.6	3	7, 69	Hulzebos et al., unpublished data

Table 117: Toxicity of acenaphthene (CASnr: 83-32-9) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Crustacea																
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	LC50	mortality	62.5	142	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	LC50	mortality	62.5	142	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	EC50	reburial	58.1	132	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC50	mortality	63.3	124	2	46, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC50	mortality	55	108	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC10	mortality	49	95	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.8		10 d	LC50	mortality	64.7	136	2	46, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.8		10 d	LC50	mortality	66	138	2	46, 47, 59	Swartz et al., 1997

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.8		10 d	LC10	mortality	47	99	2	46, 47, 59	Swartz et al., 1997

Table 118: Acute toxicity of fluorene (CASnr: 86-73-7) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		N	S	98.6					96 h	EC50	CO2 incorporation, production	3400	3	102	Finger et al., 1985
Pseudokirchneriella subcapitata		N	S	98.6					7 d	EC50	cell number	2200	3	102	Finger et al., 1985
Bacteria															
Escherichia coli		N	S						48 h	EC3	growth	1340	3		Jamroz et al., 2003
Escherichia coli		N	S						48 h	EC2	growth	1340	3	104	Jamroz et al., 2003
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	408	2	5	Bisson et al., 2000
Daphnia magna		Y	S	98.6	nw	7.2-7.4		270	48 h	EC50	immobility	430	3	80, 170	Finger et al., 1985
Daphnia magna		Y	S	98.6	nw	7.2-7.4		270	48 h	EC50	immobility	282	2	80, 171	Finger et al., 1985
Daphnia magna	< 24 h	N	S	98%	nw/dw		20±2		48 h	EC50	immobility	2842	3	80, 260	Lampi et al., 2006
Daphnia magna			S	98%		7.5	17	280	48 h	EC50	immobility	430	4		Mayer & Ellersieck, 1986
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	>1024	3	105, 163	Wernersson 2003
Daphnia pulex	< 24 h	N	S	≥96%	rw		20	160-180	48 h	EC50	immobility	212	3		Smith et al., 1988
Daphnia pulex	< 24 h	N	S	≥96%	rw		20	160-180	48 h	EC10	immobility	23	3		Smith et al., 1988

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Gammarus pseudolimnaeus		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	600	3	80, 170	Finger et al., 1985
Gammarus pseudolimnaeus		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	346	2	80, 171	Finger et al., 1985
Cyanophyta															
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	260	2	210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	EC10	nitrogen fixation	320	2	92, 210	Bastian & Toetz, 1985
Insecta															
Aedes aegypti	< 8 h, first instar	N	S		tw				<24 h	LC50	mortality	2700	3	41	Kagan et al., 1987
Chironomus plumosus			S	98%		7.5	22	280	48 h	EC50	immobility	2350	4		Mayer & Ellersieck, 1986
Chironomus riparius	larvae	Y	S	98.6	nw	7.2-7.4		270	48 h	EC50	immobility	2350	3	80, 170	Finger et al., 1985
Chironomus riparius	larvae	Y	S	98.6	nw	7.2-7.4		270	48 h	EC50	immobility	1539	2	80, 171	Finger et al., 1985
Hexagenia bilineata	nymphs	Y	S	98.6	nw	7.2-7.4		270	120 h	LC50	mortality	5800	3	80, 170	Finger et al., 1985
Hexagenia bilineata	nymphs	Y	S	98.6	nw	7.2-7.4		270	120 h	LC50	mortality	3149	3	80, 171	Finger et al., 1985
Mollusca															
Mudalia potosiensis		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	5600	3	80, 170	Finger et al., 1985
Mudalia potosiensis		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	3230	3	80, 171	Finger et al., 1985
Pisces															
Lepomis macrochirus	0.8 g		S	98%		7.5	22	280	96 h	LC50	mortality	760	4		Mayer & Ellersieck, 1986
Lepomis macrochirus		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	910	3	80, 170	Finger et al., 1985
Lepomis macrochirus		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	525	2	80, 171	Finger et al., 1985
Oncorhynchus mykiss		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	820	3	80, 170	Finger et al., 1985
Oncorhynchus mykiss		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	473	2	80, 171	Finger et al., 1985
Pimephales promelas		Y	S	98.6	nw	7.2-7.4		270	96 h	LC50	mortality	>100000	3	80, 170	Finger et al., 1985

Table 119: Chronic toxicity of fluorene (CASnr: 86-73-7) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	820	2	167	Bisson et al., 2000
Pseudokirchneriella subcapitata		N	S	98.6					7 d	EC10	cell number	1400	3	102	Finger et al., 1985
Pseudokirchneriella subcapitata		N	S	98.6					7 d	NOEC	biomass, cell number, chlorophyll *a*	1670	3		Finger et al., 1985
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	25	2	168	Bisson et al., 2000
Daphnia magna		Y	IF	98.6	nw	7.2-7.4		270	21 d	NOEC	reproduction	62.5	3	80, 170	Finger et al., 1985
Daphnia magna		Y	IF	98.6	nw	7.2-7.4		270	21 d	NOEC	reproduction	15	2	80, 171	Finger et al., 1985
Diporeia sp.	1-2 mm, juvenile, 5-11 m	Y	R	>98%	nw	8.1-8.3		165-250	28 d	LC50	mortality	542.7	2		Landrum et al., 2003
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	10 d	LC50	mortality	525	2		Lee et al., 2001
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	10 d	LC50	mortality	452	2		Lee et al., 2001
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	14 d	LC50	mortality	404	2		Lee et al., 2001
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	525	2	239	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	452	2	239	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	508	2	92	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC10	mortality	327	2	92	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	NOEC	mortality	355	2		Lee et al., 2002
Cyanophyta															
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	NOEC	standing crop	<110	3	143	Bastian & Toetz, 1982
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	EC10	standing crop	430	3	143, 92	Bastian & Toetz, 1982
Insecta															
Chironomus riparius	larvae	Y	IF	98.6	nw	7.2-7.4		270	30 d	NOEC	emergence	290	3	80, 170	Finger et al., 1985
Chironomus riparius	larvae	Y	IF	98.6	nw	7.2-7.4		270	30 d	NOEC	emergence	142	2	80, 171	Finger et al., 1985

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Macrophyta															
Chara sp.	pre-emergence	N	S	98.6	nw				21 d	NOEC	weight	14000	3	90	Finger et al., 1985
Chara sp.	pre-emergence	N	S	98.6	nw				21 d	EC50	weight	20300	3	90	Finger et al., 1985
Chara sp.	21 d, post-emergence	N	S	98.6	nw				21 d	NOEC	weight	>35000	3	90	Finger et al., 1985
Lemna gibba		N	S		am				8 d	EC7	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC30	growth rate	2000	3	94, 113	Huang et al., 1997a
Pisces															
Lepomis macrochirus	fingerlings, 0.74 g	Y	CF	98.6	nw	7.2-7.4	25±1	270	30 d	NOEC	growth	125	3	80, 170	Finger et al., 1985
Lepomis macrochirus	fingerlings, 0.74 g	Y	CF	98.6	nw	7.2-7.4	25±1	270	30 d	NOEC	mortality	250	3	80, 170	Finger et al., 1985
Lepomis macrochirus	fingerlings, 0.74 g	Y	CF	98.6	nw	7.2-7.4	25±1	270	30 d	NOEC	growth	42	2	80, 171	Finger et al., 1985
Lepomis macrochirus	fingerlings, 0.74 g	Y	CF	98.6	nw	7.2-7.4	25±1	270	30 d	NOEC	mortality	79	2	80, 171	Finger et al., 1985

Table 120: Acute toxicity of fluorene (CASnr: 86-73-7) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Dunaliella bioculata	8*10^4 cells/ml	N	S	purified	am		27±1	25	50-72 h	EC50	growth rate	15500	3	169	Heldal et al., 1984
Annelida															
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	1000	2/3	50	Rossi & Neff, 1978
Bacteria															
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	3200	3	4, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	3130	3	4, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S						15 min	EC18	bioluminescence	1340	3		Jamroz et al., 2003

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		N	S						15 min	EC5	bioluminescence	1340	3	104	Jamroz et al., 2003
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	500	3		Johnson & Long, 1998
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC50	bioluminescence	990	2	115	Loibner et al., 2004
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	330	2	115	Loibner et al., 2004
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC50	bioluminescence	756	2	116	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC50	bioluminescence	770	2	102, 116	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC10	bioluminescence	50	2	102, 116	Renoux et al 1999
Vibrio fischeri	NRRL B-11177 (ATCC)	N	S	98	am		15	20	30 min	EC10	bioluminescence	848	2		Shemer & Linden, 2007
Crustacea															
Artemia salina	< 1 d	N	S						3 h	LC50	mortality	3000	3	61	Kagan et al., 1987
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC50	mortality	1800	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC10	mortality	550	2	102	Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC50	immobility	1660	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC10	immobility	510	2	102	Barata et al., 2005
Palaemonetes pugio		Y	R	98%	nw	7.8-8.9	19.4-20.6	18.4-19.8	60 h	LC50	mortality	616	2	274	Unger et al. 2008

Table 121: Chronic toxicity of fluorene (CASnr: 86-73-7) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	80990	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	1040	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	81290	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	1040	3	24, 6	El-Alawi et al., 2002

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Echinodermata															
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	EC50	malformation	1260	3		Pillai et al., 2003
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	EC10	malformation	99	3	102	Pillai et al., 2003
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	NOEC	malformation	100	3		Pillai et al., 2003
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20 ±0.15	48 h	EC50	larval development	>1978	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20 ±0.15	48 h	EC10	larval development	492	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20 ±0.15	48 h	LOEC	larval development	991	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20 ±0.15	48 h	EC50	larval development	>1978	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20 ±0.15	48 h	EC10	larval development	492	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20 ±0.15	48 h	LOEC	larval development	991	2	272, 273	Bellas et al. 2008

Table 122: Toxicity of fluorene (CASnr: 86-73-7) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Allolobophora tuberculata		N	≥98	artificial soil	6.0±0.5	20	10	20	14 d	LC50	mortality	206	206	2/3	60	Neuhauser et al., 1986a
Eisenia fetida	adult, 300-500 mg	N	≥98	artificial soil	6.0±0.5	20	10	20	14 d	LC50	mortality	173	173	2/3	60	Neuhauser et al., 1985, 1986a,b
Eisenia fetida	<1 w, <10 mg	N		artificial soil		25	>90	~0	8 w	NOEC	reproduction (number of cocoons)	500	56	4	65	Neuhauser and Callahan, 1990
Eisenia fetida	<1 w, <10 mg	N		artificial soil		25	>90	~0	8 w	NOEC	mortality	1000	111	4	65	Neuhauser and Callahan, 1990
Eisenia fetida	<1 w, <10 mg	N		artificial soil		25	>90	~0	8 w	EC10	reproduction (number of cocoons)	280	31	4	47, 65	Neuhauser and Callahan, 1990
Eisenia fetida	<1 w, <10 mg	N		artificial soil		25	>90	~0	8 w	EC10	growth	250	28	4	47, 65	Neuhauser and Callahan, 1990
Eisenia veneta	0.3-0.8 g	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	28 d	LC50	mortality	69	254	2/3	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	28 d	EC50	growth	50	184	2/3	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	28 d	EC10	growth	31	114	2/3	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	28 d	NOEC	growth	28	103	2/3	13, 21, 78	Sverdrup et al., 2002a
Enchytraeus crypticus	mature	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	1600	5882	2/3	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	55	202	2/3	12, 21, 78	Sverdrup et al., 2002b

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Enchytraeus crypticus	mature	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	25	92	2/3	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	27	99	2/3	12, 21, 78	Sverdrup et al., 2002b
Eudrilus eugeniae		N	≥98	artificial soil	6.0±0.5	20	10	20	14 d	LC50	mortality	197	197	2/3	60	Neuhauser et al., 1986a
Perionyx excavatus		N	≥98	artificial soil	6.0±0.5	20	10	20	14 d	LC50	mortality	170	170	2/3	60	Neuhauser et al., 1986a
Crustacea																
Oniscus asellus	6-10 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	47 w	NOEC	growth females	66	7.3	2/3	1, 4, 31, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	47 w	EC10	growth females	371	41	2/3	1, 4, 31, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	47 w	NOEC	protein	20.8	2.3	2/3	1, 4, 31, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	47 w	NOEC	survival, reproduction, growth males	≥658	≥73	2/3	1, 4, 31, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	47 w	NOEC	growth females	37	4.1	2	1, 4, 22, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	47 w	EC10	growth females	210	23	2	1, 4, 22, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	47 w	NOEC	protein	12	1.3	2	1, 4, 22, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	47 w	NOEC	survival, reproduction	≥372	≥41	2	1, 4, 22, 46	van Brummelen et al., 1996
Porcellio scaber	7-11 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	16 w	NOEC	growth, protein, survival	≥658	≥73	2/3	1, 4, 31, 46	van Brummelen et al., 1996

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Porcellio scaber	7-11 mg	Y	>96	90% leaves with 10 dogfood		20±1	>90	0	16 w	NOEC	survival, reproduction, growth males	≥372	≥41	2	1, 4, 22, 46	van Brummelen et al., 1996
Insecta																
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	NOEC	mortality	32	114	2/3	64, 67	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC10	mortality	94	336	2/3	64, 67, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC50	mortality	115	411	2/3	64, 67, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC50	mortality	112	400	2/3	64, 67	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	NOEC	reproduction	<32	<114	2/3	64, 67	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC10	reproduction	33	118	2/3	64, 67, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC10	reproduction	68	243	2/3	64, 67, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC50	reproduction	71	254	2/3	64, 67	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	NOEC	mortality	32	114	2/3	64, 67, 68	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC10	mortality	95	339	2/3	64, 67, 68, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC50	mortality	101	361	2/3	64, 67, 68, 47	Sørensen & Holmstrup, 2005

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia candida	19-21 d	N	dessi-cate	sandy loam	6.8	20	2.8	13	21 d	EC50	mortality	104	371	2/3	64, 67, 68	Sørensen & Holmstrup, 2005
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	23	85	2/3	12, 21, 26, 78	Sjursen et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	NOEC	mortality	14	51	2/3	12, 21, 26, 78	Sjursen et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	39	143	2/3	12, 21, 23, 78	Sverdrup et al., 2001, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	37	135	2/3	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	22	80	2/3	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	14	51	2/3	12, 21, 23, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	7.7	28	2/3	12, 21, 23, 78	Sverdrup et al., 2001, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	19	72	2/3	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	10	39	2/3	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	14	51	2/3	12, 21, 23, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	22	83	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	21	78	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	12	46	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	8.1	30	2	12, 22, 23, 78	Sverdrup et al., 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	4.4	**16**	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	11	42	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	6.4	23	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	8.1	30	2	12, 22, 23, 78	Sverdrup et al., 2001
Macrophyta																
Lolium perenne	seeds	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3704	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	950	3493	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	380	1397	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	222	817	2/3	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	880	3235	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	350	1287	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seeds	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3704	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	1200	4412	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	120	441	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Sinapsis alba	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	31	115	2/3	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	>1000	>3704	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	>1000	>3704	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seeds	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	950	3493	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	360	1324	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	55	202	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	18	67	2/3	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	530	1949	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y		sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	76	279	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Microbial process																
nitrification		Y		sandy loam	6.2	20	2.7	13	28 d	EC50		190	699	2/3	10, 21, 78	Sverdrup et al., 2002d
nitrification		Y		sandy loam	6.2	20	2.7	13	28 d	EC10		33	121	2/3	10, 21, 78	Sverdrup et al., 2002d
nitrification		Y		sandy loam	6.2	20	2.7	13	28 d	NOEC		72	265	2/3	10, 21, 78	Sverdrup et al., 2002d
Mollusca																
Helix aspersa	juvenile, 5-7 w, 1.5±0.2 g, 18±2 mm shell	Y		sandy loam	6.2	21±3	2.7	13	21 d	NOEC	growth	≥1029	≥3782	2	20, 78, 84	Sverdrup et al., 2006

Table 123: Acute toxicity of phenanthrene (CASnr: 85-01-8) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Chlamydomonas angulosa	5*10^4 cells/ml	N	S		am	6.5	19		3 h	EC50	photosynthesis/assimilation 14C	940	3	25, 106, 231	Hutchinson et al., 1980
Chlorella vulgaris	20*10^4 cells/ml	N	S		am	6.5	19		3 h	EC50	photosynthesis/assimilation 14C	1200	3	25, 106, 231	Hutchinson et al., 1980
Nitzschia palea		Y	S		am	7.6			4 h	EC50	assimilation 14C	870	2	266	Milleman et al., 1984
Pseudokirchneriella subcapitata		Y	S		am	7.6			4 h	EC50	assimilation 14C	940	2	266	Milleman et al., 1984
Pseudokirchneriella subcapitata	1.3*10^4 cells/ml	N	S	>96%	am	8.1-9.0	22±1		3 d	EC50	growth rate	2021	3	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.3*10^4 cells/ml	N	S	>96%	am	8.1-8.4	22±1		2 d	EC50	growth rate	2028	3	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	2.1*10^4 cells/ml	Y	S/ Sc	>96%	am	8.4-9.0	22±1		2 d	EC50	growth rate	1228	3	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.2*10^4 cells/ml	Y	Sc	>96%	am	7.0-9.0	22±1		2 d	EC50	growth rate	663	3	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.4*10^4 cells/ml	Y	Sc	>96%	am	7.0-7.3	22±1		2 d	EC50	growth rate	180	2	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.4*10^4 cells/ml	Y	Sc	>96%	am	7.0-8.4	22±1		3 d	EC50	growth rate	324	2	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.4*10^4 cells/ml	Y	Sc	>96%	am	7.0-7.3	22±1		2 d	EC50	growth rate	302	2	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.4*10^4 cells/ml	Y	Sc	>96%	am	7.0-8.2	22±1		3 d	EC50	growth rate	333	2	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	10^5 cells/ml	N	S	rg	am		24		4 h	EC50	photosynthesis/assimilation 14C	>1000 (w.s.)	3	231, 268	Giddings 1979
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am	-	25±1	27.2	7 d	EC50	growth, area under the curve	50240	3	203	Djomo et al., 2004

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC50	cell number	590	2	242, 249	Altenburger et al., 2004
Crustacea															
Daphnia magna	4-6 d	N	Sc	≥97%	am	6.0-7.0	23±2		48 h	LC50	mortality	210	3	5, 231	Abernethy et al., 1986
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>400	2	5	Bisson et al., 2000
Daphnia magna	1.5 mm, 4-6 d	N	Sc	≥97%	am	6.0-7.0	23±2		48 h	LC50	mortality	1200	3	231	Bobra et al., 1983
Daphnia magna	adult, mixed age	N	S		nw	7.6±0.2		134±16	48 h	LC50	mortality	843	3	80	Eastmond et al., 1984
Daphnia magna	<24h	N	S		am		20±2		48h	EC50	immobility	570	3		Feldmannová et al. 2006
Daphnia magna	mature	N	S		tw				2 h	LC50	mortality	450	3	40	Kagan et al., 1987
Daphnia magna	< 24 h	N	S	96%	nw/dw		20±2		48 h	EC50	immobility	699	3	80, 259	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	96%	nw/dw		20±2		48 h	EC50	immobility	478	3	80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	96%	nw/dw		20±2		48 h	EC50	immobility	472	3	102, 80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	96%	nw/dw		20±2		48 h	EC10	immobility	355	3	102, 80, 260	Lampi et al., 2006
Daphnia magna	24 h	Y	Sc		nw	7.8	19.5-20.5	140	48 h	EC50	immobility	700	2	25, 266	Milleman et al., 1984
Daphnia magna	< 24 h	N	Sc	≥97%	rw		20±1		48 h	EC50	immobility	383	3	34	Muñoz & Tarazona, 1993
Daphnia magna									48 h	LC50	mortality	1000	4		Parkhurst et al., 1981
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	24 h	EC50	immobility	854	3	5	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48 h	EC50	immobility	731	3	5	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48+2 h	EC50	immobility	725	3	64	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	24 h	EC50	immobility	678	3	65	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48 h	EC50	immobility	604	3	65	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48+2 h	EC50	immobility	273	3	66	Verrhiest et al., 2001
Daphnia magna	<24 h	Y	S		am		20±2		24 h	EC50	immobility	269	3	90, 65	Verrhiest et al., 2001

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna	<24 h	Y	S		am		20±2		48 h	EC50	immobility	199	3	90, 65	Verrhiest et al., 2001
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	378	3	105, 163	Wernersson 2003
Daphnia magna	< 24 h	N	S	>96%	nw/dw	7.2	20±1	240	48 h	EC50	immobility	950	3	80	Xie et al., 2006
Daphnia magna	< 24 h	N	S	>96%	nw/dw	7.2	20±1	240	48 h	EC50	immobility	1032	3	80, 102	Xie et al., 2006
Daphnia magna	< 24 h	N	S	>96%	nw/dw	7.2	20±1	240	48 h	EC10	immobility	391	3	80, 102	Xie et al., 2006
Daphnia pulex	< 24 h	N	S	≥96%	rw		20	160-180	48 h	EC50	immobility	350	3		Smith et al., 1988
Daphnia pulex	< 24 h	N	S	≥96%	rw		20	160-180	48 h	EC10	immobility	140	3		Smith et al., 1988
Daphnia pulex	< 24 h	N	S	≥96%	rw		17	hard	48 h	EC50	immobility	734	3	103	Passino & Smith, 1987
Daphnia pulex	1.9-2.1 mm	Y	Sc		nw	7.5	15±2		96 h	LC50	mortality	100	2	36	Trucco et al., 1983
Daphnia pulex	neonates	N	S	ACS grade	tw	7.2 (6.8-7.5)	20±1	43 (43-48)	48 h	LC50	mortality	>1140	3	35, 80	Geiger & Buikema, 1981, 1982
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3		165-250	2 d	EC50	immobility	295	2		Landrum et al., 2003
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3		165-250	5 d	EC50	immobility	74.3	2		Landrum et al., 2003
Gammarus minus	adult	Y	Sc		nw		21-24		48 h	LC50	mortality	460	2	266	Milleman et al., 1984
Cyanophyta															
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	270	2	210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	EC10	nitrogen fixation	520	2	92, 210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	EC50	nitrogen fixation	1300	2	92, 210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	<130	2	210, 211	Bastian & Toetz, 1985
Insecta															
Aedes aegypti	< 8 h, first instar	N	S		tw				<24 h	LC50	mortality	500	3	41	Kagan et al., 1987
Chironomus riparius	1st instar, <24 h	Y	S	99.5%	DSW				96 h	LC50	mortality	41	2	82	Bleeker et al., 2003

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Chironomus riparius	1st instar, <24 h	Y	S	99.5%	DSW				96 h	LC50	mortality	160	2	83	Bleeker et al., 2003
Chironomus tentans	4th instar	Y	Sc		nw	7.8	23-26	140	48 h	EC50	immobility	490	2	5, 266	Milleman et al., 1984
Macrophyta															
Lemna gibba		N	R		am				8 d	EC50	growth rate	3200	3	10, 102	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC50	growth rate	1900	3	102, 108, 109	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC50	growth rate	880	3	10, 102, 108	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC50	growth rate	3000	3	96	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	2200	3	96, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	710	3	96, 119	Huang et al., 1995
Lemna gibba		N	R	99%	am				8 d	EC50	growth rate	>5000	3	183	McConkey et al., 1997
Lemna gibba		N	R	99%	am				8 d	EC50	growth rate	3480	3	184	McConkey et al., 1997
Lemna gibba		N	R	99%	am				8 d	EC50	growth rate	3414	3	184, 252	McConkey et al., 1997
Pisces															
Oncorhynchus mykiss	fry (Arlee), 13-21 d	N	S	≥95%	nw		12±1.0	160-190	96 h	LC50	mortality	3200	3		Edsall, 1991
Pimephales promelas	larvae	Y	R	high	tw		24		120 h	NOEC	mortality	≥10	2	48	Oris & Giesy, 1987

Table 124: Chronic toxicity of phenanthrene (CASnr: 85-01-8) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	26	2	167	Bisson et al., 2000
Pseudokirchneriella subcapitata	1.3*10^4 cells/ml	N	S	>96%	am	8.1-9.0	22±1		3 d	EC10	growth rate	803	3	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.3*10^4 cells/ml	N	S	>96%	am	8.1-8.4	22±1		2 d	EC10	growth rate	720	3	165	Halling-Sørensen et al., 1996

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Pseudokirchneriella subcapitata	2.1*10^4 cells/ml	Y	S/Sc	>96%	am	8.4-9.0	22±1		2 d	EC10	growth rate	110	3	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.2*10^4 cells/ml	Y	Sc	>96%	am	7.0-9.0	22±1		2 d	EC10	growth rate	139	3	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.4*10^4 cells/ml	Y	Sc	>96%	am	7.0-7.3	22±1		2 d	EC10	growth rate	10	2	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.4*10^4 cells/ml	Y	Sc	>96%	am	7.0-8.4	22±1		3 d	EC10	growth rate	50	2	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.4*10^4 cells/ml	Y	Sc	>96%	am	7.0-7.3	22±1		2 d	EC10	growth rate	24	2	165	Halling-Sørensen et al., 1996
Pseudokirchneriella subcapitata	1.4*10^4 cells/ml	Y	Sc	>96%	am	7.0-8.2	22±1		3 d	EC10	growth rate	37	2	165	Halling-Sørensen et al., 1996
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am	-	25±1	27.2	7 d	EC10	growth, area under the curve	4910	3	203	Djomo et al., 2004
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC10	cell number	150	2	242, 249	Altenburger et al., 2004
Amphibia															
Xenopus laevis	embryo, stage 8-11	N	R		am	7.6-7.9	23±1	107	96 h	NOEC	malformations	≥1600	3		Burýsková et al., 2006
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	13	2	168	Bisson et al., 2000
Daphnia magna		Y	R		am				21 d	NOEC	reproduction	180	3	275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	R		am				19 d	EC50	reproduction	100-180	3	275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	R		am				21 d	EC50	reproduction	~320	3	275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	R		am				19 d	NOEC	mortality	180	3	275	Hooftman & Evers-de Ruiter, 1992d

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna		Y	R		am				19 d	LC50	mortality	280	3	275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	R		am				21 d	NOEC	reproduction	75	2	134	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	R		am				19 d	EC50	reproduction	42-75	2	134	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	R		am				21 d	EC50	reproduction	~130	2	134	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	R		am				19 d	NOEC	mortality	75	2	134	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	R		am				19 d	LC50	mortality	116	2	134	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	IF		am				21 d	NOEC	reproduction	18	2	133, 275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	IF		am				21 d	EC50	reproduction	42	2	133, 275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	IF		am				21 d	NOEC	mortality	56	2	133, 275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	IF		am				21 d	LC50	mortality	110	2	133, 275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna		Y	IF		am				21 d	NOEC	length	32	2	133, 275	Hooftman & Evers-de Ruiter, 1992d
Daphnia magna	< 24 h	N	R	>99%	am		20		7 d	EC50	growth	349	3		Olmstead & Leblanc 2005
Daphnia magna	< 24 h	N	R	>99%	am		20		7 d	EC10	growth	77	3		Olmstead & Leblanc 2005
Daphnia pulex	< 24 h	Y	R	-	tw	6.9-7.5		41-50	lifetime	NOEC	reproduction, growth	110	3	19, 20, 21, 35	Geiger & Buikema, 1982
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	NOEC	reproduction, growth	<60	3	275	Savino & Tanabe, 1989

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	EC50	reproduction, growth	79	3	275, 102	Savino & Tanabe, 1989
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	EC10	reproduction, growth	32	3	275, 102	Savino & Tanabe, 1989
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	EC50	growth	101	3	275, 102	Savino & Tanabe, 1989
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	EC10	growth	42	3	275, 102	Savino & Tanabe, 1989
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	NOEC	reproduction, growth	<25	2	152	Savino & Tanabe, 1989
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	EC50	reproduction, growth	33	2	152, 102	Savino & Tanabe, 1989
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	EC10	reproduction, growth	13	2	152, 102	Savino & Tanabe, 1989
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	EC50	growth	42	2	152, 102	Savino & Tanabe, 1989
Daphnia pulex	neonates	Y	R	≥97%	rw		20	160-200	16 d	EC10	growth	17	2	152, 102	Savino & Tanabe, 1989
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3		165-250	10 d	EC50	immobility	38.2	2		Landrum et al., 2003
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3		165-250	10 d	LC50	mortality	168.4	2		Landrum et al., 2003
Diporeia spp.	1-2 mm, 5-11 m, juvenile	Y	R	>98%	nw	8.1-8.3		165-250	28 d	LC50	mortality	95.2	2		Landrum et al., 2003
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	10 d	LC50	mortality	232	2		Lee et al., 2001
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	10 d	LC50	mortality	235	2		Lee et al., 2001
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	14 d	LC50	mortality	225	2		Lee et al., 2001
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	232	2	239	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	236	2	239	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	288	2	92	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC10	mortality	155	2	92	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	NOEC	mortality	107	2		Lee et al., 2002
Cyanophyta															
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	NOEC	standing crop	320	3	143	Bastian & Toetz, 1982
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	EC10	standing crop	450	3	143, 92	Bastian & Toetz, 1982
Insecta															
Chironomus riparius	<24 h	Y	S	>99%	DSW	8.4		200	28 d	LC50	mortality	55	3	90	Bleeker et al., 2003
Chironomus riparius	<24 h	Y	S	>99%	DSW	8.4		200	28 d	LOEC	emergence	43	3	90	Bleeker et al., 2003

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Macrophyta															
Lemna gibba		N	R		am				8 d	EC10	growth rate	590	3	10, 102	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC10	growth rate	880	3	102, 108, 109	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC10	growth rate	240	3	10, 102, 108	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC32-59	growth rate	2000	3	110	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC29-32	chlorophyll content	2000	3	110	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC33-73	growth rate	2000	3	111	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC42-100	chlorophyll content	2000	3	111	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC16-22	growth rate	2000	3	112	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC18-25	chlorophyll content	2000	3	112	Huang et al., 1993
Lemna gibba		N	S		am				8 d	EC40	growth rate	2000	3	117	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC10	growth rate	530	3	96, 102	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	730	3	96, 102, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	270	3	96, 102, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC16	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC28	growth rate	2000	3	94, 113	Huang et al., 1997a
Lemna gibba		N	R	99%	am				8 d	EC10	growth rate	459	3	183, 252	McConkey et al., 1997
Lemna gibba		N	R	99%	am				8 d	EC10	growth rate	543	3	184, 252	McConkey et al., 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Pisces															
Danio rerio	ELS	Y	R		am				28 d	NOEC	length	32	3	275	Hooftman & Evers-de Ruiter, 1992d
Danio rerio	ELS	Y	R		am				28 d	NOEC	weight	56	3	275	Hooftman & Evers-de Ruiter, 1992d
Danio rerio	ELS	Y	R		am				28 d	NOEC	mortality/hatching	≥560	3	275	Hooftman & Evers-de Ruiter, 1992d
Danio rerio	ELS	Y	R		am				28 d	NOEC	length	14	2	132	Hooftman & Evers-de Ruiter, 1992d
Danio rerio	ELS	Y	R		am				28 d	NOEC	weight	24	2	132	Hooftman & Evers-de Ruiter, 1992d
Danio rerio	ELS	Y	R		am				28 d	NOEC	mortality/hatching	≥ 240	2	132	Hooftman & Evers-de Ruiter, 1992d
Danio rerio	larvae	Y	R	>98%		7.86±0.5	27±1		48 h	NOEC	malformations	<155	2	136, 237	Petersen & Kristensen 1998
Micropterus salmoides	eggs 2-4 d post spawning	Y	CF		am	7.4-8.1	20.2-23.2	86.8-116.3	7 d incl. 4 post-hatch	LC50	mortality	180	2		Black et al., 1983
Micropterus salmoides	eggs 2-4 d post spawning	Y	CF		am	7.4-8.1	20.2-23.2	86.8-116.3	7 d incl. 4 post-hatch	LC10	mortality	11	2	91	Black et al., 1983
Micropterus salmoides	eggs 2-4 d post spawning	Y	CF		rw	7.41-8.1	20.2-23.2	86.8-116.3	7 d incl. 4 post-hatch	LC50	mortality	250	2	266	Milleman et al., 1984
Oncorhynchus mykiss	eggs 20 min post fertilization	Y	CF		rw	7.4-8.1	13.3-14.2	86.8-116.3	27 d incl. 4 post-hatch	LC50	mortality	40	2		Black et al., 1983

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Oncorhynchus mykiss	eggs 20 min post fertilization	Y	CF		rw	7.4-8.1	13.3-14.2	86.8-116.3	27 d incl. 4 post-hatch	LC10	mortality	28	2	92	Black et al., 1983
Oncorhynchus mykiss	eggs 20 min post fertilization	Y	CF		rw	7.41-8.1	13.3-14.2	86.8-116.3	27 d incl. 4 post-hatch	LC50	mortality	30	2	266	Milleman et al., 1984
Oncorhynchus mykiss	ELS	N	S	98%	tw	8.25 0.25	10±1		22 d	NOEC	mortality/hatching/abnormalities	<500	3	5	Hawkins et al., 2002
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	LC50	mortality	100-200	3	275, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC50	mortality	67	3	275, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC10	mortality	46	3	275, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	NOEC	length	<44	3	275, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	NOEC	length	38	3	275, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC50	length	71	3	275, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC10	length	37	3	275, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	NOEC	weight	44	3	275, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	NOEC	weight	38	3	275, 239	Passino-Reader et al., 1995

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC50	weight	63	3	275, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC10	weight	33	3	275, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	LC50	mortality	70-140	2	177, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC50	mortality	47	2	177, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC10	mortality	32	2	177, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	NOEC	length	<31	2	177, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	NOEC	length	27	2	177, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC50	length	50	2	177, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC10	length	26	2	177, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, 4 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	NOEC	weight	31	2	177, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	NOEC	weight	27	2	177, 239	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC50	weight	44	2	177, 102	Passino-Reader et al., 1995
Oncorhynchus mykiss	fry, newly hatched to 7 d	Y	CF	>98%	tw/nw	8.2	10-11	120	60 d	EC10	weight	23	2	177, 102	Passino-Reader et al., 1995

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Oryzias latipes	ELS	N	Rc		am		24±1	~300	18 d	NOEC	hatching, hatch length, time to hatch, malformations	≥200	2	258	Rhodes et al 2005
Oryzias latipes	ELS	N	Rc		am		24±1	~300	18 d	EC10	malformations	93	2	102, 258	Rhodes et al 2005
Protozoa															
Colpidium colpoda		Y	S	≥98%	am		22±1		18 h	NOEC	mortality	≥6600	3	202	Rogerson et al., 1983
Tetrahymena elliotti		Y	Sc	≥98%	am		22±1		24 h	NOEC	mortality	≥6600	3	202	Rogerson et al., 1983

Table 125: Acute toxicity of phenanthrene (CASnr: 85-01-8) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	347	3	279	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	292	3	280	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	297	3	281	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	121	3	282	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	125	3	283	Okay and Karacik 2007
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC50	growth rate	75000	3	102, 243, 244, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC50	growth rate	12000	3	102, 243, 245, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC50	growth rate	12000	3	102, 243, 246, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC50	growth rate	19000	3	102, 243, 247, 248, 275	Aksman & Tukaj, 2004

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Annelida															
Neanthes arenaceodentata	emergent juvenile	N	S	98%	am			30	96 h	LC50	mortality	51	3		Emery & Dillon, 1996
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	600	3	50	Rossi & Neff, 1978
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	187	2	137	Rossi & Neff, 1978
Bacteria															
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	240	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	310	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	230	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	210	3	2	Arfsten et al., 1994
Vibrio fischeri		Y	S	99%	am		15	20	15 min	EC50	bioluminescence	530	2	5, 50	McConkey et al., 1997
Vibrio fischeri		Y	S	99%	am		15	20	15 min	EC50	bioluminescence	562	2	5, 50, 252	McConkey et al., 1997
Vibrio fischeri		Y	S	99%	am		15	20	15 min	EC10	bioluminescence	23	2	5, 50, 252	McConkey et al., 1997
Vibrio fischeri		Y	S	99%	am		15	20	15 min	EC50	bioluminescence	530	2	50, 184	McConkey et al., 1997
Vibrio fischeri		Y	S	99%	am		15	20	15 min	EC50	bioluminescence	528	2	50, 184, 252	McConkey et al., 1997
Vibrio fischeri		Y	S	99%	am		15	20	15 min	EC10	bioluminescence	40	2	50, 184, 252	McConkey et al., 1997
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	480	3		Johnson & Long, 1998
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	7330	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC10	bioluminescence	700	3	3, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	6890	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC10	bioluminescence	690	3	3, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	510	2	4, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC10	bioluminescence	58	2	4, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	520	2	4, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC10	bioluminescence	59	2	4, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	510	2	4, 5	El-Alawi et al., 2002

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	510	2	4, 6	El-Alawi et al., 2002
Vibrio fischeri							15		5 min	EC50	bioluminescence	41.8	4		Kaiser & Palabrica, 1991
Vibrio fischeri							15		15 min	EC50	bioluminescence	49.1	4		Kaiser & Palabrica, 1991
Vibrio fischeri							15		30 min	EC50	bioluminescence	72.6	4		Kaiser & Palabrica, 1991
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC50	bioluminescence	480	2	115	Loibner et al., 2004
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	130	2	115	Loibner et al., 2004
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC50	bioluminescence	142	2	116, 239	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC50	bioluminescence	143	2	102, 116	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC10	bioluminescence	13	2	102, 116	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC50	bioluminescence	144	2	116, 239	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC50	bioluminescence	147	2	102, 116	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			~20	15 min	EC10	bioluminescence	15	2	102, 116	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			20	15 min	EC50	bioluminescence	182	2		Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			20	15 min	EC50	bioluminescence	186	2	102	Renoux et al 1999
Vibrio fischeri		Y	S	>99%	am			20	15 min	EC10	bioluminescence	17	2	102	Renoux et al 1999
Crustacea															
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	LC50	survival	422	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	LC10	survival	316	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	NOEC	survival	321	2	5	Bellas and Thor 2007
Artemia salina	nauplii	N	Sc	≥97%			20±1	30	24 h	LC50	mortality	680	3	5, 231	Abernethy et al., 1986
Artemia salina	nauplii, 2nd stage	Y	S	≥98%	am	8.5-8.7	19	32	24 h	EC50	immobility	520	2	53	Foster & Tullis, 1984
Corophium multisetosum	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	215.2	3	140	Sanz-Lazaro et al. 2008
Gammarus aequicauda	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	173.85	3	140	Sanz-Lazaro et al. 2008

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Gammarus locusta	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	147.64	3	140	Sanz-Lazaro et al. 2008
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC50	mortality	522	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC10	mortality	190	2	102	Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC50	immobility	638	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC10	immobility	310	2	102	Barata et al., 2005
Palaemonetes pugio		Y	Rc		nw	7.89 (7.42-8.00)	20.5±0.4	20.9±0.2	60h	LC50	mortality	360	2	139, 266	Unger et al. 2007
Mollusca															
Mytilus edulis	40-50 mm shell length	Y	R	≥98%	nw		15	33	48 h	EC50	feeding filtration	148	2		Donkin et al., 1989, 1991
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	NOEC	filtration rate	100	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC3	filtration rate	100	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC86	filtration rate	400	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	NOEC	filtration rate	<100	3	185	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC61	filtration rate	100	3	185	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC80	filtration rate	400	3	185	Okay and Karacik 2008
Pisces															
Cyprinodon variegatus	fry, 6-8 d	N	R	98%	am		25	18	96 h	LC50	mortality	478	3	80	Moreau et al., 1999

Table 126: Chronic toxicity of phenanthrene (CASnr: 85-01-8) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC10	growth rate	620	3	102, 243, 244, 248, 275	Aksman & Tukaj, 2004

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	NOEC	cell number	5000	3	243, 244, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC10	growth rate	3800	3	102, 243, 245, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	NOEC	cell number	5000	3	243, 245, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC10	growth rate	6600	3	102, 243, 246, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	NOEC	cell number	5000	3	243, 246, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC10	growth rate	6800	3	102, 243, 247, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	NOEC	cell number	5000	3	243, 247, 248, 275	Aksman & Tukaj, 2004
Annelida															
Neanthes arenaceodentata	immature adult	N	S	98%	am	-		30	14 d	LC50	mortality	501	3		Emery & Dillon, 1996
Neanthes arenaceodentata	emergent juvenile	N	S	98%	am	-		30	8 w	NOEC	growth, fecundity and number of emergent juveniles, time to egg diposition	<20	3	136, 176	Emery & Dillon, 1996
Bacteria															
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC50	bioluminescence	8090	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC10	bioluminescence	960	3	3, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC50	bioluminescence	7150	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC10	bioluminescence	870	3	3, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	bioluminescence	4530	3	24, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC10	bioluminescence	180	3	24, 5, 102	El-Alawi et al., 2001

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	bioluminescence	1930	3	24, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC10	bioluminescence	260	3	24, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC50	growth	7380	3	3, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC10	growth	810	3	3, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC50	growth	6720	3	3, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		18 h	EC10	growth	810	3	3, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	growth	4480	3	24, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC10	growth	170	3	24, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	growth	1920	3	24, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC10	growth	240	3	24, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	4530	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	1930	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	4480	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	1920	3	24, 6	El-Alawi et al., 2002
Crustacea															
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	EC50	egg production rate	222	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	EC10	egg production rate	109	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	NOEC	egg production rate	107	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC50	hatching	>428	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC10	hatching	165	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	NOEC	hatching	321	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC50	recruitment	180	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC10	recruitment	69	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	NOEC	recruitment	107	2	5	Bellas and Thor 2007

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Rhithropanopeus harrissi	zoeae	N	R		am		20, 25, 30	5	zoeal develop-ment until molting to megalops	NOEC	mortality	100	3	25	Laughlin & Neff, 1979
Rhithropanopeus harrissi	zoeae	N	R		am		20, 25, 30	15, 25	zoeal develop-ment until molting to megalops	NOEC	mortality	150	3	25	Laughlin & Neff, 1979
Echinodermata															
Arbacia punctulata	eggs	Y	S	≥98%	nw		20	30	1 h	EC50	fertilization	663	2	261, 262	Evans & Nipper, 2008
Arbacia punctulata	eggs	Y	S	≥98%	nw		20	30	1 h	EC50	fertilization	638	2	102, 261, 262	Evans & Nipper, 2008
Arbacia punctulata	eggs	Y	S	≥98%	nw		20	30	1 h	EC10	fertilization	174	2	102, 261, 262	Evans & Nipper, 2008
Arbacia punctulata	eggs	Y	S	≥98%	nw		20	30	1 h	EC50	fertilization	817	2	102, 261, 263	Evans & Nipper, 2008
Arbacia punctulata	eggs	Y	S	≥98%	nw		20	30	1 h	EC10	fertilization	157	2	102, 261, 263	Evans & Nipper, 2008
Arbacia punctulata	eggs	Y	S	≥98%	nw		20	30	1 h	NOEC	fertilization	184	2	261, 264	Evans & Nipper, 2008
Arbacia punctulata	eggs	Y	S	≥98%	nw		20	30	1 h	EC50	fertilization	712	2	102, 261, 264	Evans & Nipper, 2008
Arbacia punctulata	eggs	Y	S	≥98%	nw		20	30	1 h	EC10	fertilization	164	2	102, 261, 264	Evans & Nipper, 2008
Arbacia punctulata	embryos	Y	S	≥98%	nw		20	30	48 h	NOEC	development	≥734	3	261, 265	Evans & Nipper, 2008
Lytechinus anemesis	ciliated blastula stage	N	S	99.50%	nw	7.8	16		until late gastrula stage	EC50	malformation	410	3		Pillai et al., 2003

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Lytechinus anemesis	ciliated blastula stage	N	S	99.50%	nw	7.8	16		until late gastrula stage	EC10	malformation	100	3	102	Pillai et al., 2003
Lytechinus anemesis	ciliated blastula stage	N	S	99.50%	nw	7.8	16		until late gastrula stage	NOEC	malformation	<200	3		Pillai et al., 2003
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	>428	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	460	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	1280	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	>428	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	105	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	321	2	272, 273	Bellas et al. 2008
Mollusca															
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	144	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	29	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	214	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	224	2	272, 273	Bellas et al. 2008

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	53	2	272, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	214	2	272, 273	Bellas et al. 2008
Pisces															
Clupea harengus	larvae	Y	R	>98%	nw	7.86±0.5	6.5±1	28-30	96 h	NOEC	malformations	<150	2	136, 237	Petersen & Kristensen 1998
Gadus morhua	larvae	Y	R	>98%	nw	7.86±0.5	6.5±1	28-30	120 h	NOEC	malformations	<125	2	136, 237	Petersen & Kristensen 1998
Paralichthys olivaceus	51±4.3 g	N	R	>96%	nw	8.03±0.04	20±1	31.8±0.7	4 w	NOEC	weight gain	89	3	25	Jee et al., 2004
Paralichthys olivaceus	51±4.3 g	N	R	>96%	nw	8.03±0.04	20±1	31.8±0.7	4 w	EC50	weight gain	210	3	25, 102	Jee et al., 2004
Paralichthys olivaceus	51±4.3 g	N	R	>96%	nw	8.03±0.04	20±1	31.8±0.7	4 w	EC10	weight gain	68	3	25, 102	Jee et al., 2004
Scophthalmus maximus	larvae	Y	R	>98%	nw	7.86±0.5	6.5±1	28-30	72 h	NOEC	malformations	<168	2	136, 237	Petersen & Kristensen 1998
Tunicata															
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC50	larval development	>428	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC10	larval development	>428	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	NOEC	larval development	≥428	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC50	larval development	418	2	272, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC10	larval development	262	2	272, 273	Bellas et al. 2008

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	LOEC	larval development	428	2	272, 273	Bellas et al. 2008

Table 127: Toxicity of phenanthrene (CASnr: 85-01-8) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Algae																
Chlorococcum hypnosporum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	282.97		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	3.07		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>500		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	9.27		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	147.92		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	2.98		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum meneghini		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	8.9		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	2.35		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>500		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	7.52		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	29.28		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	1.42		2	25, 27, 59	Chung et al. 2007
Selenastrum capricornutum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	6.54		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	0.59		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>500		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	46.95		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	9.39		3	25, 27, 28, 59	Chung et al. 2007

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Selenastrum capricornutum		N	96	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	0.43		3	25, 27, 28, 59	Chung et al. 2007
Annelida																
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC50	reproduction (number of cocoons)	241	241	3	9, 31, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	NOEC	mortality	320	320	3	9, 31, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	NOEC	reproduction (number of cocoons)	100	100	3	9, 31, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC50	number of cocoons	242	242	3	9, 31, 47, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC10	number of cocoons	105	105	3	9, 31, 47, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC50	total offspring	248	248	3	9, 31, 47, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC10	total offspring	90	90	3	9, 31, 47, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC50	reproduction (number of cocoons)	97	97	2	9, 22, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	NOEC	mortality	128	128	2	9, 22, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	NOEC	reproduction (number of cocoons)	40	40	2	9, 22, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC50	number of cocoons	97	97	2	9, 22, 47, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC10	number of cocoons	42	42	2	9, 22, 47, 58, 59	Bowmer et al., 1993
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC50	total offspring	99	99	2	9, 22, 47, 58, 59	Bowmer et al., 1993

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Eisenia fetida		Y		artificial soil	6.7-7.0	room	10	20	21 d	EC10	total offspring	36	**36**	2	9, 22, 47, 58, 59	Bowmer et al., 1993
Eisenia fetida		N		artificial soil	6.85	20	7.5	10	14 d	LC50	mortality	293	391	3	42, 43	Son et al., 2003
Eisenia fetida		N		artificial soil	6.85	20	7.5	10	14 d	LC50	mortality	468	624	2/3	42, 47	Son et al., 2003
Eisenia fetida		N		artificial soil	6.85	20	7.5	10	14 d	LC10	mortality	272	363	2/3	42, 47	Son et al., 2003
Eisenia fetida		N		artificial soil	6.85	20	7.5	10	14 d	NOEC	growth	80	107	4	42, 44	Son et al., 2003
Eisenia veneta	0.3-0.8 g	Y	>96	sandy loam	6.2	20±1	2.7	13	28 d	LC50	mortality	134	493	2/3	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	>96	sandy loam	6.2	20±1	2.7	13	28 d	EC50	growth	94	346	2/3	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	>96	sandy loam	6.2	20±1	2.7	13	28 d	EC10	growth	25	**92**	2/3	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	>96	sandy loam	6.2	20±1	2.7	13	28 d	NOEC	growth	31	114	2/3	13, 21, 78	Sverdrup et al., 2002a
Enchytraeus crypticus	mature	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>2000	>7400	2/3	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	87	320	2/3	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	40	**147**	2/3	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	34	125	2/3	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	356	912	3	21, 57, 67, 85	Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	376	961	3	21, 57, 67, 85	Droge et al., 2006
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC10	mortality	178	454	3	21, 57, 67, 85	Droge et al., 2006
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	100	255	3	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC10	reproduction	66	169	3	21, 57, 67, 85	Droge et al., 2006
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	<98	<251	3	21, 57, 67, 85	Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	184	470	2	22, 57, 67, 85	Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	194	496	2	22, 57, 67, 85	Droge et al., 2006
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC10	mortality	92	234	2	22, 57, 67, 85	Droge et al., 2006

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	51	131	2	22, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC10	reproduction	34	**87**	2	22, 57, 67, 85	Droge et al., 2006
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	<51	<129	2	22, 57, 67, 85	Bleeker et al., 2003
Crustacea																
Oniscus asellus	6-10 mg	Y	≥99.5	90% leaves with 10 dogfood		20±1	>90%	0	47 w	NOEC	growth, protein, reproduction, survival	≥706	≥78	3	1, 4, 31, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	≥99.5	90% leaves with 10 dogfood		20±1	>90%	0	47 w	NOEC	growth, protein, reproduction, survival	≥205	≥23	2	1, 4, 22, 46	van Brummelen et al., 1996
Porcellio scaber	7-11 mg	Y	≥99.5	90% leaves with 10 dogfood		20±1	>90%	0	16 w	NOEC	growth, protein	≥706	≥78	3	1, 4, 31, 46	van Brummelen et al., 1996
Porcellio scaber	7-11 mg	Y	≥99.5	90% leaves with 10 dogfood		20±1	>90%	0	16 w	NOEC	growth, protein	≥205	≥23	2	1, 4, 22, 46	van Brummelen et al., 1996
Insecta																
Folsomia candida	10-12 d	Y		arificial soil		20	10	20	28 d	LC50	mortality	145	145	2	10, 59, 62	Bowmer et al., 1993
Folsomia candida	10-12 d	Y		arificial soil		20	10	20	28 d	NOEC	reproduction (number of cocoons)	75	75	2	10, 59, 62	Bowmer et al., 1993
Folsomia candida	10-12 d	Y		arificial soil		20	10	20	28 d	EC50	reproduction (number of cocoons)	124	124	2	10, 59, 62	Bowmer et al., 1993
Folsomia candida	10-12 d	Y		arificial soil		20	10	20	28 d	LC50	mortality	177	177	2	10, 47, 59, 62	Bowmer et al., 1993
Folsomia candida	10-12 d	Y		arificial soil		20	10	20	28 d	EC50	reproduction (number of cocoons)	112	112	2	10, 47, 59, 62	Bowmer et al., 1993
Folsomia candida	10-12 d	Y		arificial soil		20	10	20	28 d	EC10	reproduction (number of cocoons)	41	**41**	2	10, 47, 59, 62	Bowmer et al., 1993

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	65	167	3	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC10	mortality	53	134	3	21, 57, 67, 85	Droge et al., 2006
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	46	117	3	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC10	reproduction	25	64	3	21, 57, 67, 85	Droge et al., 2006
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	29	74	3	21, 57, 67, 85	Bleeker et al., 2003
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	34	86	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC10	mortality	27	69	2	21, 57, 67, 85	Droge et al., 2006
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	24	60	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC10	reproduction	13	**33**	2	21, 57, 67, 85	Droge et al., 2006
Folsomia candida	11-13 d	Y	99.5	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	15	38	2	21, 57, 67, 85	Bleeker et al., 2003
Folsomia candida	juvenile 10-12 d	N		arificial soil	6.3±0.3	20±2	10.0	20	33-34 d	EC50	reproduction	175	175	2/3	55, 61	Crouau et al., 1999
Folsomia candida	juvenile 10-12 d	N		arificial soil	6.3±0.3	20±2	10.0	20	33-34 d	NOEC	reproduction	140	140	2/3	55, 61	Crouau et al., 1999
Folsomia candida	juvenile 10-12 d	N		arificial soil	6.3±0.3	20±2	10.0	20	33-34 d	NOEC	mortality	220	220	2/3	55, 61	Crouau et al., 1999
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	41	151	3	12, 21, 23, 78	Sverdrup et al., 2001, 2002, 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	42	154	3	12, 21, 23, 47, 78	Sverdrup et al., 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	30	110	3	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	30	110	3	12, 21, 23, 78	Sverdrup et al., 2001, 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	23	85	3	12, 21, 23, 78	Sverdrup et al., 2001, 2002, 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	35	130	3	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	32	119	3	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	21	77	3	12, 21, 23, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	35	128	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002, 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	37	135	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	26	97	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	26	94	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	20	**72**	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002, 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	29	107	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	24	87	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	18	66	2	12, 22, 23, 78	Sverdrup et al., 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	30	111	2/3	12, 16, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	37	137	2/3	12, 17, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>41	>152	2/3	12, 18, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	22	81	2/3	12, 16, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	24	89	2/3	12, 17, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	47	174	2/3	12, 18, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	14	52	2/3	12, 16, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	14	52	2/3	12, 17, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	>96	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	9.4	35	2/3	12, 18, 21	Sverdrup et al., 2002c
Macrophyta																
Arachis hypogea	seeds, immersed for 3h	N	99.5	uncontaminated forest soil	3.3	29	0.99		10 d	NOEC	gemination	200	20	3	63	Chouychai et al. 2007
Lolium perenne	seeds	N	96	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC50	germination	>1000		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	96	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC10	germination	>1000		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	96	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC50	root length	>1000		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	96	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC10	root length	94.68		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3704	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	760	2815	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	300	1111	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	174	**645**	2/3	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Lolium perenne	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	760	2815	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	300	1111	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	shoot growth	350	3889	4	10, 40, 47	Baek et al 2004
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	shoot growth	10	111	4	10, 40, 41, 47	Baek et al 2004
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	root growth	280	3111	4	10, 40, 47	Baek et al 2004
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	root growth	100	1111	4	10, 40, 41, 47	Baek et al 2004
Sinapsis alba	seeds	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3704	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	480	1778	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	77	285	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	26	**98**	2/3	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	850	3148	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	340	1259	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seeds	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3704	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	79	293	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	37	137	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Trifolium pratense	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	24	**88**	2/3	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	190	704	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y	>96	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	46	170	2/3	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Vigna radiata	seeds, immersed for 3h	N	99.5	uncontaminated forest soil	3.3	29	0.99		10 d	NOEC	gemination	200	20	3	63	Chouychai et al. 2007
Vigna sinensis	seeds, immersed for 3h	N	99.5	uncontaminated forest soil	3.3	29	0.99		10 d	NOEC	gemination	200	20	3	63	Chouychai et al. 2007
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	shoot growth	190	2111	4	10, 40, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	shoot growth	10	111	4	10, 40, 41, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	root growth	81	900	4	10, 40, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	root growth	10	111	4	10, 40, 41, 47	Baek et al 2004
Microbial process																
heterotrophic flagellates		Y	>96	sandy loam	6.2	20	2.7	13	28 d	EC5	number	250	919	2/3	10, 21, 78	Sverdrup et al., 2002d
nitrification		Y	>96	sandy loam	6.2	20	2.7	13	28 d	EC50		250	919	2/3	10, 21, 78	Sverdrup et al., 2002d
nitrification		Y	>96	sandy loam	6.2	20	2.7	13	28 d	EC10		42	**154**	2/3	10, 21, 78	Sverdrup et al., 2002d
nitrification		Y	>96	sandy loam	6.2	20	2.7	13	28 d	NOEC		26	96	2/3	10, 21, 78	Sverdrup et al., 2002d
nitrification		N/Y		heavy loam sand		20±2	2.58		7d	EC50		146	565	3	29	Maliszewska-Kordybach et al. 2007
total protozoa		Y	>96	sandy loam	6.2	20	2.7	13	28 d	EC5	number	2400	8824	2/3	10, 21, 78	Sverdrup et al., 2002d

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Mollusca																
Helix aspersa	juvenile, 5-7 w, 1.5±0.2 g, 18±2 mm shell	Y	>96	sandy loam	6.2	20	2.7	13	21 d	NOEC	growth	≥827	≥3039	2	20, 78, 84	Sverdrup et al., 2006

Table 128: Toxicity of phenanthrene (CASnr: 85-01-8) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Ilyodrilus templetoni	adult	Y	98%	sediment		23±1	4.403		10 d	NOEC	feeding rate	109	248	2	51, 59, 72	Gust & Fleeger, 2006
Ilyodrilus templetoni	adult	Y	98%	sediment		23±1	4.403		10 d	EC50	feeding rate	160	363	2	47, 51, 59	Gust & Fleeger, 2006
Ilyodrilus templetoni	adult	Y	98%	sediment		23±1	4.403		10 d	EC10	feeding rate	93	211	2	47, 51, 59	Gust & Fleeger, 2006
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	LC50	mortality	298	2504	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	LC50	mortality	306	2573	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	LC10	mortality	150	1260	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	NOEC	mortality	143	1202	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	EC25	sediment egestion	24.5	206	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	EC50	sediment egestion	48	407	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	EC10	sediment egestion	11	92	3	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	NOEC	sediment egestion	20	168	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	EC25	sediment egestion	28.4	239	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	EC50	sediment egestion	72	609	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	EC10	sediment egestion	5.4	45	3	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	EC25	reproduction	40.5	340	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	EC50	reproduction	143	1201	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	EC10	reproduction	76	636	3	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	NOEC	reproduction	47	395	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Lumbriculus variegatus	adult	Y		natural sediment, Drontermeer, The Netherlands	7.5-8.5	20±1	12-14	15.5	28d	EC50	reproduction	83	64	2	8, 9, 26, 57, 60	Paumen et al. 2008b
Lumbriculus variegatus	adult	Y		natural sediment, Drontermeer, The Netherlands	7.5-8.5	20±1	12-14	15.5	28d	EC10	reproduction	33	26	2	8, 9, 26, 57, 60	Paumen et al. 2008b
Crustacea																
Daphnia magna	<24 h	Y		artificial sediment		20±2	3.4	30	24 h	EC50	immobility	126	371	3	45, 56, 59	Verrhiest et al., 2001

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Daphnia magna	<24 h	Y		artificial sediment		20±2	3.4	30	48 h	EC50	immobility	49.4	145	3	45, 56, 59	Verrhiest et al., 2001
Hyalella azteca	2-3 w, 0.5-1 mm, subadult	Y	98%	sediment		23±1	4.403		10 d	NOEC	mortality	>333	>756	2	57, 59	Gust 2006
Hyalella azteca	2-3 w, 0.5-1 mm, subadult	Y	98%	sediment		23±1	4.403		10 d	NOEC	growth	32	73	2	50, 57, 59	Gust 2006
Hyalella azteca	2-3 w	Y		artificial sediment		20±2	3.4	30	14 d	LC50	mortality	20.5	60	2	45, 56, 59	Verrhiest et al., 2001
Hyalella azteca	2-3 w	Y		artificial sediment		20±2	3.4	30	14 d	NOEC	mortality/growth	10	29	2	45, 56, 59	Verrhiest et al., 2001
Hyalella azteca	3-10 d	Y		artificial sediment with alpha-cellulose	7.9±0.2	23±2	4.75	~30	14 d	LC50	mortality	3.5	7.4	4	39, 46, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	14 d	LC50	mortality	350	686	2	39, 46, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	14 d	LC50	mortality	470	922	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	14 d	LC10	mortality	333	653	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	14 d	NOEC	mortality	300	588	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	14 d	EC50	length	1449	2841	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	14 d	EC10	length	173	339	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	14 d	NOEC	length	67	131	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	9.7	~30	14 d	LC50	mortality	571	589	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	9.7	~30	14 d	LC10	mortality	468	482	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	9.7	~30	14 d	NOEC	mortality	475	490	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	9.7	~30	14 d	EC50	length	2606	2687	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	9.7	~30	14 d	EC10	length	110	113	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	9.7	~30	14 d	NOEC	length	67	69	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	18.3	~30	14 d	LC50	mortality	1030	563	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	18.3	~30	14 d	LC10	mortality	308	168	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	18.3	~30	14 d	NOEC	mortality	300	164	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	18.3	~30	14 d	EC50	length	1507	823	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	18.3	~30	14 d	EC10	length	223	122	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Hyalella azteca	3-10 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	18.3	~30	14 d	NOEC	length	300	164	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	LC50	mortality	60.7	138	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	LC50	mortality	60.7	138	2	23, 24, 46, 52, 59	Boese et al., 1998

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	EC50	reburial	57.9	132	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC50	mortality	92.4	181	2	46, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC50	mortality	78	154	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC10	mortality	64	125	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.9		10 d	LC50	mortality	64.4	131	2	46, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.9		10 d	LC50	mortality	60	123	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.9		10 d	LC10	mortality	59	120	2	46, 47, 59	Swartz et al., 1997
Schizopera knabeni	adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		4 d	LC50	mortality	524	2055	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		4 d	LC50	mortality	468	1834	2	47, 51, 55, 58	Lotufo, 1997

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Schizopera knabeni	adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		4 d	LC10	mortality	212	831	2	47, 51, 55, 58	Lotufo, 1997
Schizopera knabeni	adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		4 d	NOEC	mortality	261	1024	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		30 h	EC50	grazing rate	51	200	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		30 h	NOEC	grazing rate	<56	<220	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	male+female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		14 d	EC50	reproduction	52	204	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	male+female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		14 d	EC50	reproduction	56	221	2	47, 51, 55, 58	Lotufo, 1997
Schizopera knabeni	male+female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		14 d	EC10	reproduction	2.0	7.8	2	47, 51, 55, 58	Lotufo, 1997
Schizopera knabeni	male+female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		14 d	NOEC	reproduction	<56	<220	2	51, 55, 58	Lotufo, 1997
Insecta																
Chironomus riparius	larvae, 48 h	Y		artificial sediment		20±2	3.4	30	10 d	LC50	mortality	14.7	43	2	45, 56, 59	Verrhiest et al., 2001

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Chironomus riparius	larvae, 48 h	Y		artificial sediment		20±2	3.4	30	10 d	LC50	mortality	15.8	46	2	45, 56, 59	Verrhiest et al., 2001
Chironomus riparius	larvae, 48 h	Y		artificial sediment		20±2	3.4	30	10 d	LC50	mortality	13.6	40	2	45, 56, 59	Verrhiest et al., 2001
Chironomus riparius	larvae, 48 h	Y		artificial sediment		20±2	3.4	30	10 d	NOEC	mortality/growth	10	29	2	45, 56, 59	Verrhiest et al., 2001
Chironomus riparius	1st instar, <24 h	Y	99.5	sediment	8.4	20	9.41	-	28 d	LC50	mortality	107	114	2	20	Bleeker et al., 2003
Chironomus riparius	1st instar, <24 h	Y	99.5	sediment	8.4	20	9.41	-	28 d	LC10	mortality	74	79	2	20, 62	Bleeker et al., 2003
Chironomus riparius	1st instar, <24 h	Y	99.5	sediment	8.4	20	9.41	-	28 d	NOEC	emergence	76	81	2	20, 21	Bleeker et al., 2003
Chironomus riparius	1st instar <24h	Y	98	natural sediment, Drontermeer, The Netherlands	6.0-8.5	20±1	12-14	15.5	28d	LC50	survival	126	97	2	8, 9, 10, 11, 57, 58	Paumen et al. 2008
Chironomus riparius	1st instar <24h	Y	98	natural sediment, Drontermeer, The Netherlands	6.0-8.5	20±1	12-14	15.5	28d	NOEC	survival, emergence (time)	106	82	2	8, 9, 10, 11, 57, 58	Paumen et al. 2008
Chironomus riparius	2 d	Y		artificial sediment with alpha-cellulose	7.9±0.2	23±2	4.75	~30	10 d	LC50	mortality	453	954	4	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with alpha-cellulose	7.9±0.2	23±2	4.75	~30	10 d	LC10	mortality	179	377	4	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with alpha-cellulose	7.9±0.2	23±2	4.75	~30	10 d	NOEC	mortality	67	141	4	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with alpha-cellulose	7.9±0.2	23±2	4.75	~30	28 d	EC50	emergence	35	74	4	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with alpha-cellulose	7.9±0.2	23±2	4.75	~30	28 d	EC10	emergence	5.5	12	4	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with alpha-cellulose	7.9±0.2	23±2	4.75	~30	28 d	NOEC	emergence	<6.6	<14	4	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with blond peat moss	7.9±0.2	23±2	5.5	~30	10 d	LC50	mortality	222	404	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Chironomus riparius	2 d	Y		artificial sediment with blond peat moss	7.9±0.2	23±2	5.5	~30	10 d	LC10	mortality	90	164	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with blond peat moss	7.9±0.2	23±2	5.5	~30	10 d	NOEC	mortality	67	122	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with blond peat moss	7.9±0.2	23±2	5.5	~30	28 d	EC50	emergence	117	213	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with blond peat moss	7.9±0.2	23±2	5.5	~30	28 d	EC10	emergence	46	84	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with blond peat moss	7.9±0.2	23±2	5.5	~30	28 d	NOEC	emergence	6.6	12	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	10 d	LC50	mortality	83	163	3	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	10 d	LC10	mortality	82	161	3	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	10 d	NOEC	mortality	67	131	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	10 d	LC50	mortality	67	131	2	39, 46, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	28 d	EC50	emergence	74	145	2	39, 46, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	28 d	EC50	emergence	89	175	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	28 d	EC10	emergence	58	114	2	39, 45, 47, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	5.1	~30	28 d	NOEC	emergence	6.6	13	2	39, 45, 49, 57, 59	Lamy-Enrici et al., 2003

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	8.7	~30	10 d	LC50	mortality	53	61	2	39, 46, 57, 59	Lamy-Enrici et al., 2003
Chironomus riparius	2 d	Y		artificial sediment with dark peat moss	7.9±0.2	23±2	8.7	~30	28 d	EC50	emergence	42	48	2	39, 46, 57, 59	Lamy-Enrici et al., 2003

Table 129: Acute toxicity of anthracene (CASnr: 120-12-7) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Chlamydomonas angulosa	5*10^4 cells/ml	N	S		am	6.5	19		3 h	EC50	photosynthesis/assimilation 14C	240	3	25, 106, 231	Hutchinson et al., 1980
Chlorella vulgaris	20*10^4 cells/ml	N	S		am	6.5	19		3 h	EC50	photosynthesis/assimilation 14C	530	3	25, 106, 231	Hutchinson et al., 1980
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC50	growth rate	>40000	3	47	Cody et al., 1984
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		34 h	EC50	growth rate	3.9	2	11, 12	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		34 h	EC50	growth rate	6.6	2	11, 122	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		34 h	EC50	growth rate	5.3	2	11, 123	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		34 h	EC50	growth rate	12.1	2	11, 124	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		34 h	EC50	growth rate	37.4	2	11, 125	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		36 h	EC50	primary production	3.3	2	11, 12	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		36 h	EC50	primary production	5.9	2	11, 122	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		36 h	EC50	primary production	4.9	2	11, 123	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		36 h	EC50	primary production	8.1	2	11, 124	Gala & Giesy, 1992
Pseudokirchneriella subcapitata	10^5 cells/ml	Y	R	99.9%	am	7.5	21±1		36 h	EC50	primary production	24	2	11, 125	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC50	number of viable cells	4.5	2	11, 12	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC50	number of viable cells	10.2	2	11, 123	Gala & Giesy, 1994

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC50	number of viable cells	15.8	2	11, 124	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC50	stress index	3.6	4	11, 12	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC50	stress index	6.4	4	11, 123	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC50	stress index	12.2	4	11, 124	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC50	stress index	16.1	4	11, 125	Gala & Giesy, 1994
Pseudokirchneriella subcapitata	10^5 cells/ml	N	S	rg	am		24		4 h	EC10	photosynthesis/assimilation 14C	>46 (w.s.)	3	231, 268	Giddings 1979
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am		25±1	27.2	7 d	EC50	growth, area under the curve	1040	3	203	Djomo et al., 2004
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC50	cell number	500	3	242, 249	Altenburger et al., 2004
Amphibia															
Pleurodeles waltl	larvae (stage 53)	N	R	>98%	am		20±0.5		6 d	LC50	mortality	>6.25 <12.5	3	151	Fernandez & L'Haridon, 1992
Rana pipiens	embryo (stage 25)	N	S	sensitizer grade	nw				0.5 h	LC50	mortality	65	3	84	Kagan et al., 1984
Rana pipiens	embryo (stage 25)	N	S	sensitizer grade	nw				5 h	LC50	mortality	25	3	84	Kagan et al., 1984
Rana pipiens	embryo (stage 24-28)	N	S		nw	tw			24 h	LC50	mortality	110	3	86	Kagan et al., 1987
Crustacea															
Daphnia magna	4-6 d	N	Sc	≥97%	am	6.0-7.0	23±2		48 h	LC50	mortality	36	3	5, 231	Abernethy et al., 1986
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>25	2	5	Bisson et al., 2000
Daphnia magna	1.5 mm, 4-6 d	N	Sc	≥97%	am	6.0-7.0	23±2		48 h	LC50	mortality	3000	3	231	Bobra et al., 1983
Daphnia magna	<24h	N	S		am		20±2		48h	EC50	immobility	>900	3		Feldmannová et al. 2006
Daphnia magna	mature	N	S		tw				2 h	LC50	mortality	20	3	40	Kagan et al., 1985, 1987
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC50	immobility	20	3	80, 259	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC50	immobility	11	3	80, 260	Lampi et al., 2006

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC50	immobility	9.5	3	102, 80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC10	immobility	6.0	3	102, 80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	Sc	≥97%	rw		20±1		48 h	EC50	immobility	95	3	34	Muñoz & Tarazona, 1993
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	5.66	3	105, 163	Wernersson 2003
Daphnia pulex	< 24 h	N	S	≥96%	rw		20	160-180	48 h	EC50	immobility	754	3		Smith et al., 1988
Daphnia pulex	< 24 h	N	S	≥96%	rw		20	160-180	48 h	EC10	immobility	80	3		Smith et al., 1988
Daphnia pulex	adult	Y	S	99.9	nw	7.2	22±1	350	24 h+0.5 h	EC50	immobility	1.0	2	102, 154	Allred & Giesy, 1985; Oris et al., 1984
Daphnia pulex	adult	Y	S	99.9	nw	7.2	22±1	350	24 h+1 h	EC50	immobility	5.1	2	102, 155	Allred & Giesy, 1985; Oris et al., 1984
Daphnia pulex	adult	Y	S	99.9	nw	7.2	22±1	350	24 h+1 h	EC50	immobility	20	2	102, 156	Allred & Giesy, 1985; Oris et al., 1984
Daphnia pulex	adult	Y	S	99.9	nw	7.2	22±1	350	24 h+0.75 h	EC50	immobility	13	2	102, 157	Allred & Giesy, 1985
Daphnia pulex	adult	Y	S	99.9	nw	7.2	22±1	350	24 h+0.75 h	EC50	immobility	11	2	102, 158	Allred & Giesy, 1985
Daphnia pulex	adult	Y	S	99.9	nw	7.2	22±1	350	24 h+0.75 h	EC50	immobility	20	2	102, 159	Allred & Giesy, 1985
Insecta															
Aedes aegypti	3d instar	Y	R	Sigma grade III	am				48 h	LC50	mortality	26.8	2	33	Oris et al., 1984
Aedes aegypti	< 8 h, first instar	N	S		tw				<24 h	LC50	mortality	150	3	41	Kagan et al., 1985, 1987

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Aedes aegypti	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	<1	3	144	Borovsky et al., 1987
Aedes taeniorhynchus	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	260	3	144	Borovsky et al., 1987
Chironomus riparius	1st instar, <24 h	Y	S	>99%	DSW				96 h	LC50	mortality	2.5	2	82	Bleeker et al., 2003
Chironomus riparius	1st instar, <24 h	Y	S	>99%	DSW				96 h	LC50	mortality	110	2	83	Bleeker et al., 2003
Culex quinquefasciatus	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	37	3	144	Borovsky et al., 1987
Macrophyta															
Lemna gibba		Y	S		am		24		4 h	EC50	Chl a fluorescense	6600	3	92, 96	Huang et al., 1997b
Lemna gibba		Y	S		am		24		4 h	EC10	Chl a fluorescense	590	3	92, 96	Huang et al., 1997b
Lemna gibba		Y	S		am		24		4 h	EC50	Chl a fluorescense	6300	3	92, 96, 120	Huang et al., 1997b
Lemna gibba		Y	S		am		24		4 h	EC10	Chl a fluorescense	110	3	92, 96, 120	Huang et al., 1997b
Lemna gibba		Y	S	high	am		23		6 h	EC50	Chl a fluorescense	1800	3	88	Mallakin et al., 2002
Lemna gibba		Y	S	high	am		23		6 h	EC50	Chl a fluorescense	1000	3	88, 186	Mallakin et al., 2002
Lemna gibba		Y	S	high	am		23		6 h	EC50	electron transport	90	3	88	Mallakin et al., 2002
Lemna gibba		Y	S	high	am		23		6 h	EC50	electron transport	50	3	88, 186	Mallakin et al., 2002
Lemna gibba		Y	S	high	am		23		6 h	EC50	t1/2 photosynthetic activity	1200	3	88	Mallakin et al., 2002
Mollusca															
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.09±0.12	22.8±0.5	81.3±5.3	28 h	LC50	mortality	>16.6	2	67	Weinstein & Polk, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.09±0.12	22.8±0.5	81.3±5.3	4 h+8 h	LC50	mortality	2.84	2	68	Weinstein & Polk, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.09±0.12	22.8±0.5	81.3±5.3	4 h+16 h	LC50	mortality	2.01	2	68	Weinstein & Polk, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.09±0.12	22.8±0.5	81.3±5.3	4 h+24 h	LC50	mortality	1.93	2	68	Weinstein & Polk, 2001
Pisces															
Lepomis macrochirus	juv. 0.78±0.05 g, 3.11±0.05 cm	Y	CF	Sigma grade III	tw	7.7	20	326	5 d	LC50	mortality	1.27	2	26	McCloskey & Oris, 1991

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Lepomis macrochirus	juv. 0.78±0.05 g, 3.11±0.05 cm	Y	CF	Sigma grade III	tw	7.7	20	326	5 d	LC50	mortality	7.97	2	27	McCloskey & Oris, 1991
Lepomis macrochirus	juv. 0.78±0.05 g, 3.11±0.05 cm	Y	CF	Sigma grade III	tw	7.7	30	326	5 d	LC50	mortality	3.74	2	26	McCloskey & Oris, 1991
Lepomis macrochirus	juv. 0.78±0.05 g, 3.11±0.05 cm	Y	CF	Sigma grade III	tw	7.7	30	326	5 d	LC50	mortality	8.27	2	27	McCloskey & Oris, 1991
Lepomis macrochirus	juv. 0.78±0.05 g, 3.11±0.05 cm	Y	CF	Sigma grade III	tw	7.7	20	326	5 d	LC50	mortality	7.47	2	28	McCloskey & Oris, 1991
Lepomis macrochirus	juv. 0.78±0.05 g, 3.11±0.05 cm	Y	CF	Sigma grade III	tw	7.7	30	326	5 d	LC50	mortality	6.78	2	28	McCloskey & Oris, 1991
Lepomis macrochirus	Osage hatchery, juvenile 0.5-1 g, 2-3 cm	Y	CF	tech.	tw	8.20±0.27	22	328	6 d	LC50	mortality	2.78	2	30	Oris & Giesy, 1985; Oris et al., 1984
Lepomis spec. *(macrochirus)*	Park Lake, juvenile 0.5-1 g, 2-3 cm	Y	CF	tech.	tw	8.20±0.27	22	328	6 d	LC50	mortality	11.92	2	31	Oris & Giesy, 1985; Oris et al., 1984
Lepomis spec. *(macrochirus)*	Park Lake, juvenile 0.5-1 g, 2-3 cm	Y	CF	tech.	tw	8.20±0.27	22	328	6 d	LC50	mortality	18.23	2	32	Oris & Giesy, 1985; Oris et al., 1984
Lepomis spec. *(macrochirus)*	Park Lake, juvenile 0.5-1 g, 2-3 cm	Y	CF	tech.	tw	8.20±0.27	22	328	6 d	LC50	mortality	26.47	2	30	Oris & Giesy, 1985; Oris et al., 1984
Pimephales promelas	5 cm, 0.8 g	N	S	p.a.	tw		14		~ 24 h	LC50	mortality	360	3	85	Kagan et al., 1985
Pimephales promelas	larvae	Y	R	high	tw		24		120 h	LC50	mortality	<5.4	2	48	Oris & Giesy, 1987
Protozoa															
Paramecium aurelia		N	S		am		room temp		90 min	NOEC	mortality	≥1000	3	5	Joshi and Misra, 1986
Paramecium aurelia		N	S		am		20±2		15 min	LC50	mortality	>100 <1000	3	236	Joshi and Misra, 1986
Paramecium aurelia		N	S		am		20±2		30 min	LC50	mortality	<100	3	236	Joshi and Misra, 1986

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Paramecium aurelia		N	S		am		20±2		45 min	LC50	mortality	<100	3	236	Joshi and Misra, 1986
Paramecium aurelia		N	S		am		20±2		60 min	LC50	mortality	<100	3	236	Joshi and Misra, 1986
Paramecium aurelia		N	S		am		20±2		90 min	LC50	mortality	<100	3	236	Joshi and Misra, 1986
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC50	growth rate	39180	3	239, 251	Bonnet et al., 2005
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC50	growth rate	30970	3	239, 251	Bonnet et al., 2005
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC50	growth rate	36660	3	239, 251	Bonnet et al., 2005
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC50	growth rate	26780	3	239, 251	Bonnet et al., 2005
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC50	biomass	105530	3	239, 251	Bonnet et al., 2005
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC50	biomass	47730	3	239, 251	Bonnet et al., 2005
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC50	biomass	71490	3	239, 251	Bonnet et al., 2005
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC50	biomass	35110	3	239, 251	Bonnet et al., 2005

Table 130: Chronic toxicity of anthracene (CASnr: 120-12-7) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	7.8	2	167	Bisson et al., 2000
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC10	growth rate	290	3	47, 102	Cody et al., 1984
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	EC10	growth rate	1.5	2	11, 12	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	EC10	growth rate	2.5	2	11, 122	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	EC10	growth rate	2.3	2	11, 123	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	EC10	growth rate	8.7	2	11, 124	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	EC10	growth rate	7.8	2	11, 125	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	EC10	primary production	1.7	2	11, 12	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	EC10	primary production	2.7	2	11, 122	Gala & Giesy, 1992

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	EC10	primary production	2.2	2	11, 123	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	EC10	primary production	2.5	2	11, 124	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	EC10	primary production	3.9	2	11, 125	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	NOEC	growth rate	1.42	2	11, 12	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	NOEC	growth rate	2.35	2	11, 122	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	NOEC	growth rate	<5.03	2	11, 123	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	NOEC	growth rate	5.93	2	11, 124	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		34 h	NOEC	growth rate	6.2	2	11, 125	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	NOEC	primary production	1.36	2	11, 12	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	NOEC	primary production	2.26	2	11, 122	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	NOEC	primary production	<4.87	2	11, 123	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	NOEC	primary production	5.75	2	11, 124	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.90%	am	7.5	21±1		36 h	NOEC	primary production	2.81	2	11, 125	Gala & Giesy, 1992
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC10	number of viable cells	1.7	2	11, 12	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC10	number of viable cells	4.1	2	11, 123	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC10	number of viable cells	6.8	2	11, 124	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC10	stress index	1.6	4	11, 12	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC10	stress index	2.9	4	11, 123	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC10	stress index	4.5	4	11, 124	Gala & Giesy, 1994
Pseudokirchneriella subcapitata		Y	R	99.9%	am		21±1		36 h	EC10	stress index	8.3	4	11, 125	Gala & Giesy, 1994
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am	-	25±1	27.2	7 d	EC10	growth, area under the curve	10	3	203	Djomo et al., 2004
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC10	cell number	16	2	242, 249	Altenburger et al., 2004
Amphibia															
Xenopus laevis	embryo, stage 8-11	N	R		am	7.6-7.9	23±1	107	96 h	NOEC	malformations	≥900	3		Burýsková et al., 2006
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	>3.4	2	168	Bisson et al., 2000

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	NOEC	population growth	3.4	2	13, 121	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	EC10	population growth	7.1	2	13, 92	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	NOEC	population growth	2.2	2	14	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	EC10	population growth	2.5	2	14, 92	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	NOEC	population growth	2.2	2	15	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	EC10	population growth	4.7	2	15, 92	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	NOEC	population growth	1.9	2	16	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	EC10	population growth	3.2	2	16, 92	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	EC50	population growth	10	2	16, 92	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	NOEC	fecundity	4.5	2	14	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	EC10	fecundity	3.3	2	14, 92	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	NOEC	fecundity	2.2	2	15	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	EC10	fecundity	2	2	15, 92	Foran et al., 1991

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	NOEC	fecundity	1.9	2	16	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	am	8.1	22-23	230	21 d	EC10	fecundity	1.5	2	16, 92	Foran et al., 1991
Daphnia magna		Y	R	Sigma grade III	nw	8.1±0.2	22-23	230	21 d	NOEC	reproduction (total number of young)	<2.1	2	13, 17	Holst & Giesy, 1989
Daphnia magna		Y	R	Sigma grade III	nw	8.1±0.2	22-23	230	21 d	EC10	reproduction (total number of young)	5.2	2	13, 17, 92	Holst & Giesy, 1989
Daphnia magna		Y	R	Sigma grade III	nw	8.1±0.2	22-23	230	21 d	NOEC	reproduction (total number of young)	<1.9	2	16, 17, 18	Holst & Giesy, 1989
Daphnia magna		Y	R	Sigma grade III	nw	8.1±0.2	22-23	230	21 d	EC50	reproduction (total number of young)	4.4	2	16, 17, 18, 102	Holst & Giesy, 1989
Daphnia magna		Y	R	Sigma grade III	nw	8.1±0.2	22-23	230	21 d	EC10	reproduction (total number of young)	1.9	2	16, 17, 18, 102	Holst & Giesy, 1989
Hyalella azteca	7-14 d	Y	R	98%	nw	7.79-8.88	21-24	140-170	10 d	LC50	mortality	5.6	2	161	Hatch & Burton Jr., 1999
Insecta															
Chironomus riparius	<24 h	Y	S	>99%	DSW	8.4		200	28 d	LC50	mortality	1.8	3	90	Bleeker et al., 2003
Chironomus riparius	<24 h	Y	S	>99%	DSW	8.4		200	28 d	NOEC	emergence	<0.53	3	90	Bleeker et al., 2003
Chironomus tentans	8-10 d	Y	R	98%	nw	7.79-8.88	21-24	140-170	10 d	LC50	mortality	6.0	2	161	Hatch & Burton Jr., 1999
Macrophyta															
Lemna gibba		N	R		am				8 d	EC50	growth rate	1300	3	10, 102	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC10	growth rate	470	3	10, 102	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC50	growth rate	790	3	102, 108, 109	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC10	growth rate	370	3	102, 108, 109	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC50	growth rate	480	3	10, 102, 108	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC10	growth rate	110	3	10, 102, 108	Huang et al., 1993

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Lemna gibba		N	R		am				8 d	EC49-100	growth rate	2000	3	110	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC57-100	chlorophyll content	2000	3	110	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC75-100	growth rate	2000	3	111	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC100	chlorophyll content	2000	3	111	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC6-30	growth rate	2000	3	112	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC43-61	chlorophyll content	2000	3	112	Huang et al., 1993
Lemna gibba		N	S		am				8 d	EC100	growth rate	2000	3	117	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC50	growth rate	1100	3	96	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC10	growth rate	680	3	96, 102	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	470	3	96, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	110	3	96, 102, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	200	3	96, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	67	3	96, 102, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC96	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC100	growth rate	2000	3	94, 113	Huang et al., 1997a
Lemna gibba		N	R		am				8 d	LOEC	growth inhibition	60	3	95	Mallakin et al., 1999
Lemna gibba		N	R		am				8 d	EC10	growth inhibition	45	3	95	Mallakin et al., 1999
Lemna gibba		N	R		am				8 d	EC50	growth inhibition	1300	3	95	Mallakin et al., 1999
Lemna gibba		N	R		am				8 d	LOEC	growth inhibition	10	3	96	Mallakin et al., 1999
Lemna gibba		N	R		am				8 d	EC10	growth inhibition	40	3	96	Mallakin et al., 1999
Lemna gibba		N	R		am				8 d	EC50	growth inhibition	800	3	96	Mallakin et al., 1999

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Lemna gibba		N	R		am				8 d	LOEC	growth inhibition	10	3	97	Mallakin et al., 1999
Lemna gibba		N	R		am				8 d	EC10	growth inhibition	15	3	97	Mallakin et al., 1999
Lemna gibba		N	R		am				8 d	EC50	growth inhibition	300	3	97	Mallakin et al., 1999
Pisces															
Pimephales promelas	eggs	Y	CF	Sigma grade III	dw	8	25.8±1.1	184	6 w	NOEC	hatching	6.7	2	43, 130	Hall & Oris, 1991
Pimephales promelas	eggs	Y	CF	Sigma grade III	dw	7.9	24.9±0.7	191	9 w	NOEC	survival	12	2	43, 131	Hall & Oris, 1991
Protozoa															
Tetrahymena pyriformis	10^4 cells/ml	Y	S	97%	am	6.8-7.0	28		9 h	EC10	growth rate	6550	3	251	Bonnet et al., 2005

Table 131: Acute toxicity of anthracene (CASnr: 120-12-7) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Sc		rw		16	~19		EC20	growth inhibition	300	3	214	Boney, 1974
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC50	growth rate	780	3	102, 243, 244, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC50	growth rate	530	3	102, 243, 245, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC50	growth rate	150	3	102, 243, 246, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC50	growth rate	150	3	102, 243, 247, 248, 275	Aksman & Tukaj, 2004

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	17920	3	4, 5	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC10	bioluminescence	1400	3	4, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC50	bioluminescence	16780	3	4, 6	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		15 min	EC10	bioluminescence	1300	3	4, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	17070	3	4, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	16130	3	4, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	>1000	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	>1000	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	35	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	11	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	640	3		Johnson & Long, 1998
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004
Crustacea															
Artemia salina	nauplii	N	Sc	≥97%			20±1	30	24 h	LC50	mortality	>50	3	5, 231	Abernethy et al., 1986
Artemia salina	< 1 d	N	S				28		3 h	LC50	mortality	20	3	61	Kagan et al., 1985, 1987
Artemia salina	nauplii	N	S		nw		26		10 h	EC50	immobility	34	3	174, 102	Peachey & Crosby, 1996
Artemia salina	nauplii	N	S		nw		26		10 h	EC10	immobility	22	3	174, 102	Peachey & Crosby, 1996
Artemia salina	nauplii	N	S		nw		26		10 h	EC50	immobility	5.2	3	173, 102	Peachey & Crosby, 1996
Artemia salina	nauplii	N	S		nw		26		10 h	EC10	immobility	1.7	3	173, 102	Peachey & Crosby, 1996
Mysidopsis bahia	24-48 h	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	LC50	mortality	535	3	180	Pelletier et al., 1997
Mysidopsis bahia	24-48 h	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	LC50	mortality	3.6	2	181	Pelletier et al., 1997
Mollusca															
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	LC50	mortality	>13300	3	180	Pelletier et al., 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	LC50	mortality	68.9	2/3	181	Pelletier et al., 1997
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	EC50	growth	>13300	3	180	Pelletier et al., 1997
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	EC50	growth	> 82.8	3	181	Pelletier et al., 1997

Table 132: Chronic toxicity of anthracene (CASnr: 120-12-7) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC10	growth rate	220	3	102, 243, 244, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	NOEC	cell number	100	3	243, 244, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC10	growth rate	290	3	102, 243, 245, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	NOEC	cell number	100	3	243, 245, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC10	growth rate	64	3	102, 243, 246, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	NOEC	cell number	75	3	243, 246, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	EC10	growth rate	63	3	102, 243, 247, 248, 275	Aksman & Tukaj, 2004
Scenedesmus armatus	5*10^5 cell/ml	Y	S	p.a.	am	6.9±0.1	30	0.2	24 h	NOEC	cell number	50	3	243, 247, 248, 275	Aksman & Tukaj, 2004

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	bioluminescence	85780	3	24, 5	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC10	bioluminescence	21000	3	24, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	bioluminescence	130	3	24, 6	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC10	bioluminescence	22	3	24, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	growth	84880	3	24, 5	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC10	growth	17000	3	24, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC50	growth	120	3	24, 6	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S		am	7.2	20±1		8+18 h	EC10	growth	23	3	24, 6, 102	El-Alawi et al., 2001
Echinodermata															
Psammechinus miliaris	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	NOEC	larval development	≥2.8	2	29, 80	AquaSense 2004
Psammechinus miliaris	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	EC10	larval development	>2.8	2	29, 80	AquaSense 2004
Mollusca															
Crassostrea gigas	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	NOEC	larval development	≥2.8	2	29, 80	AquaSense 2004
Crassostrea gigas	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	EC10	larval development	>2.8	2	29, 80	AquaSense 2004
Mulinea lateralis	embryo/larval	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	L(E)C50	survival/developm.	4260	3	180	Pelletier et al., 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mulinea lateralis	embryo/larval	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	L(E)C50	survival/developm.	6.47	2	181	Pelletier et al., 1997

Table 133: Toxicity of anthracene (CASnr: 120-12-7) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Eisenia andrei	250-600 g	N	>96	artificial soil	6±0.5	20±2	10	30	14 d	LC50	mortality	>1000	>1000	2	69, 70, 72	Römbke et al 1994, 1995
Eisenia andrei	250-600 g	N	>96	artificial soil	6±0.5	20±2	10	30	14 d	EC10	growth	210	210	2	69, 70, 72, 73	Römbke et al 1994, 1995
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	>900	>2302	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	>900	>2302	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	≥900	≥2302	2	21, 57, 67, 85	Bleeker et al., 2003
Insecta																
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	>680	>1739	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	>680	>1739	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	>99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	≥680	≥1739	2	21, 57, 67, 85	Bleeker et al., 2003
Folsomia candida	>3 mm	N	>96	loamy sand, LUFA 2.2	5.9-6.4	20±2	1.21		48 h	LC50	mortality	>1000	>8264	2	69, 72	Römbke et al 1994, 1995
Folsomia candida	10-12 d	N	>96	loamy sand, LUFA 2.2	5.9-6.4	20±2	1.21		28 d	NOEC	reproduction	>1000	>8264	2	69, 72	Römbke et al 1994, 1995
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	67	246	2	12, 15, 21, 78	Sverdrup et al., 2002

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	45	166	2	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	12	45	2	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	5	18	2	12, 15, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	18	68	2	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	4.2	15	2	12, 15, 21, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	62	227	2	12, 15, 22, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	42	154	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	11	42	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	4.6	17	2	12, 15, 22, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	17	61	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	3.6	13	2	12, 15, 22, 47, 78	Sverdrup et al., 2002
Macrophyta																
Avena sativa	seeds	N		sandy loam	5.5	23-35	2		14 d	LC50	mortalty	525	2625	2		Mitchell et al., 1988
Avena sativa	seeds	N		sandy loam	5.5	23-35	2		14 d	EC50	growth	30	150	2	6	Mitchell et al., 1988
Avena sativa	seeds	N		sandy loam	5.5	23-35	2		14 d	NOEC	emergence time	<10	<50	2		Mitchell et al., 1988
Avena sativa		N	>96	loamy sand, LUFA 2.2	5.6	20±2	2.29		14 d	NOEC	growth, emergence	≥1000	≥4367	2	6, 69, 71	Römbke et al 1994, 1995
Banksia ericifolia	seeds	N		sandy loam	5.5	23-35	2		14 d	LC50	mortalty	>1000	>5000	2		Mitchell et al., 1988

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Banksia ericifolia	seeds	N		sandy loam	5.5	23-35	2		14 d	EC50	growth	>1000	>5000	2	6	Mitchell et al., 1988
Banksia ericifolia	seeds	N		sandy loam	5.5	23-35	2		14 d	NOEC	emergence time	<10	<50	2		Mitchell et al., 1988
Casuarina distyla	seeds	N		sandy loam	5.5	23-35	2		14 d	LC50	mortalty	>1000	>5000	2		Mitchell et al., 1988
Casuarina distyla	seeds	N		sandy loam	5.5	23-35	2		14 d	EC50	growth	>1000	>5000	2	6	Mitchell et al., 1988
Casuarina distyla	seeds	N		sandy loam	5.5	23-35	2		14 d	NOEC	emergence time	>1000	>5000	2		Mitchell et al., 1988
Cucumis sativus	seeds	N		sandy loam	5.5	23-35	2		14 d	LC50	mortalty	>1000	>5000	2		Mitchell et al., 1988
Cucumis sativus	seeds	N		sandy loam	5.5	23-35	2		14 d	EC50	growth	720	3600	2	6	Mitchell et al., 1988
Cucumis sativus	seeds	N		sandy loam	5.5	23-35	2		14 d	NOEC	emergence time	<10	<50	2		Mitchell et al., 1988
Eucalyptus eximia	seeds	N		sandy loam	5.5	23-35	2		14 d	LC50	mortalty	>1000	>5000	2		Mitchell et al., 1988
Eucalyptus eximia	seeds	N		sandy loam	5.5	23-35	2		14 d	EC50	growth	>1000	>5000	2	6	Mitchell et al., 1988
Eucalyptus eximia	seeds	N		sandy loam	5.5	23-35	2		14 d	NOEC	emergence time	<10	<50	2		Mitchell et al., 1988
Glycine max	seeds	N		sandy loam	5.5	23-35	2		14 d	LC50	mortalty	>1000	>5000	2		Mitchell et al., 1988
Glycine max	seeds	N		sandy loam	5.5	23-35	2		14 d	EC50	growth	>1000	>5000	2	6	Mitchell et al., 1988
Glycine max	seeds	N		sandy loam	5.5	23-35	2		14 d	NOEC	emergence time	>1000	>5000	2		Mitchell et al., 1988
Lolium perenne	15 d	Y		gleyic luvisol	6.6	18	2.6	26	40 d	NOEC	shoot/root growth	<100	<392	2	39	Leyval & Binet, 1998
Microbial processes																
dehydrogenase		N	>96	natural sandy soil	6.8	22	1.53	6.9	14 d	EC23		5	33	2	69	Römbke et al 1995
dehydrogenase		N	>96	natural sandy soil	6.8	22	1.53	6.9	14 d	EC28		50	327	2	69	Römbke et al 1995
dehydrogenase		N	>96	natural loamy soil	7.3-7.4	22	1.98	29.5	14 d	EC55		50	253	2	69	Römbke et al 1995
dehydrogenase		N	>96	natural sandy soil	6.8	22	1.53	6.9	28 d	EC13		5	33	2	69	Römbke et al 1994, 1995
dehydrogenase		N	>96	natural sandy soil	6.8	22	1.53	6.9	28 d	EC5		50	327	2	69	Römbke et al 1994, 1995
dehydrogenase		N	>96	natural loamy soil	7.3-7.4	22	1.98	29.5	28 d	EC0		5	25	2	69	Römbke et al 1994, 1995
dehydrogenase		N	>96	natural loamy soil	7.3-7.4	22	1.98	29.5	28 d	EC0		50	253	2	69	Römbke et al 1994, 1995

Table 134: Toxicity of anthracene (CASnr: 120-12-7) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Lumbriculus variegatus	adult	Y		natural sediment, Drontermeer, The Netherlands	7.5-8.5	20±1	12-14	15.5	28d	EC50	reproduction	95	73	2	8, 9, 26, 57, 60	Paumen et al. 2008b
Lumbriculus variegatus	adult	Y		natural sediment, Drontermeer, The Netherlands	7.5-8.5	20±1	12-14	15.5	28d	EC10	reproduction	3.0	2.3	2	8, 9, 26, 57, 60	Paumen et al. 2008b
Crustacea																
Hyalella azteca	7-14 d	Y	98%	sediment from freshwater stream	7.79-8.88	21-24	0.66	15	10 d	LC50	mortality	3.332	50	2	45, 59	Hatch & Burton Jr., 1999
Insecta																
Chironomus riparius	1st instar <24h	Y	99	natural sediment, Drontermeer, The Netherlands	6.0-8.5	20±1	12-14	15.5	28d	LC50	mortality	>29	>22	2	8, 9, 10, 11, 57, 58	Paumen et al. 2008
Chironomus riparius	1st instar <24h	Y	99	natural sediment, Drontermeer, The Netherlands	6.0-8.5	20±1	12-14	15.5	28d	LOEC	emergence time (males only)	14	11	2	8, 9, 10, 11, 57, 58	Paumen et al. 2008
Chironomus riparius	1st instar <24h	Y	99	natural sediment, Drontermeer, The Netherlands	6.0-8.5	20±1	12-14	15.5	28d	NOEC	emergence time (males only)	5.6	4.3	2	8, 9, 10, 11, 12, 57, 58	Paumen et al. 2008
Chironomus riparius	1st instar, <24 h	Y	>99	sediment	8.4	20	9.41	-	28 d	LC50	mortality	14.3	15	2	20	Bleeker et al., 2003
Chironomus riparius	1st instar, <24 h	Y	>99	sediment	8.4	20	9.41	-	28 d	LC10	mortality	8.0	8.5	2	20, 62	Bleeker et al., 2003
Chironomus riparius	1st instar, <24 h	Y	>99	sediment	8.4	20	9.41	-	28 d	NOEC	emergence	<11.8	<13	2	20, 21	Bleeker et al., 2003

Table 135: Acute toxicity of pyrene (CASnr: 129-00-0) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [μg/L]	Ri	Notes	Reference
Algae															
Chlamydomonas angulosa	5*10^4 cells/ml	N	S		am	6.5	19		3 h	EC50	photosynthesis/assimilation 14C	200	3	25, 106, 231	Hutchinson et al., 1980
Chlorella vulgaris	20*10^4 cells/ml	N	S		am	6.5	19		3 h	EC50	photosynthesis/assimilation 14C	330	3	25, 106, 231	Hutchinson et al., 1980
Pseudokirchneriella subcapitata									72 h	EC50	growth inhibition	500	4		Blinova, 2004
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am	-	25±1	27.2	7 d	EC50	growth, area under the curve	18.72	3	203	Djomo et al., 2004
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC50	cell number	49	2	242, 249	Altenburger et al., 2004
Amphibia															
Rana pipiens	embryo (stage 24-28)	N	S		tw				24 h	LC50	mortality	140	3	86	Kagan et al., 1987
Crustacea															
Daphnia magna	4-6 d	N	Sc	≥97%	am	6.0-7.0	23±2		48 h	LC50	mortality	91	3	5, 231	Abernethy et al., 1986
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	24.6	2	5	Bisson et al., 2000
Daphnia magna									48 h	EC50	immobility	440	4		Blinova, 2004
Daphnia magna	1.5 mm, 4-6 d	N	Sc	≥97%	am	6.0-7.0	23±2		48 h	LC50	mortality	1800	3	231	Bobra et al., 1983
Daphnia magna	mature	N	S		tw				2 h	LC50	mortality	4	3	40	Kagan et al., 1987
Daphnia magna	< 24 h	N	S	95%	nw/dw		20±2		48 h	EC50	immobility	4.3	3	80, 259	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	95%	nw/dw		20±2		48 h	EC50	immobility	4.6	3	80, 260	Lampi et al., 2006
Daphnia magna	neonates <24 h	N	S	98.7%	am	7.0±0.1	20±2	10	48 h	EC50	immobility	2.7	3	107	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	am	7.0±0.1	20±2	10	48 h	EC50	immobility	22	3	5	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	am	7.0±0.1	20±2	50	48 h	EC50	immobility	4.1	3	107	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	am	7.0±0.1	20±2	50	48 h	EC50	immobility	30	3	5	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	am	7.0±0.1	20±2	250	48 h	EC50	immobility	1.8	3	107	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	am	7.0±0.1	20±2	250	48 h	EC50	immobility	31	3	5	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	97	48 h	EC50	immobility	2.0	3	107	Nikkilä et al., 1999

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	97	48 h	EC50	immobility	22	3	5	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	200	48 h	EC50	immobility	2.9	3	107	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	200	48 h	EC50	immobility	19	3	5	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	29	48 h	EC50	immobility	6.8	3	107	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	29	48 h	EC50	immobility	19	3	5	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	8.0	48 h	EC50	immobility	7.7	3	107	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	8.0	48 h	EC50	immobility	33	3	5	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	11	48 h	EC50	immobility	20	3	107	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	11	48 h	EC50	immobility	27	3	5	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	6.5	48 h	EC50	immobility	20	3	107	Nikkilä et al., 1999
Daphnia magna	neonates <24 h	N	S	98.7%	nw	7.0±0.1	20±2	6.5	48 h	EC50	immobility	27	3	5	Nikkilä et al., 1999
Daphnia magna	4 d	N	S	99%	rw	8.0	20	250	24 h	EC50	immobility	>1024	3	80	Wernersson & Dave, 1997
Daphnia magna	4 d	N	S	99%	rw	8.0	20	250	28 h	EC50	immobility	5.7	3	81	Wernersson & Dave, 1997
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	1.38	3	105, 163	Wernersson 2003
Thamnocephalus platyurus									24 h	LC50	mortality	180	4		Blinova, 2004
Cyanophyta															
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	≥160	2	210	Bastian & Toetz, 1985
Insecta															
Aedes aegypti	< 8 h, first instar	N	S		tw				<24 h	LC50	mortality	20	3	41	Kagan et al., 1985, 1987
Aedes aegypti	< 8 h, first instar	N	S	p.a.	tw				<24 h	LC50	mortality	12	3	135	Kagan & Kagan, 1986
Aedes aegypti	< 8 h, first instar	N	S	p.a.	tw				<24 h	LC50	mortality	9	3	208	Kagan & Kagan, 1986
Aedes aegypti	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	35	3	144	Borovsky et al., 1987
Aedes taeniorhynchus	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	60	3	144	Borovsky et al., 1987

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Chironomus riparius	1st instar, <24 h	Y	S	0.98	DSW				96 h	LC50	mortality	75	2	82	Bleeker et al., 2003
Chironomus riparius	1st instar, <24 h	Y	S	0.98	DSW				96 h	LC50	mortality	38	2	83	Bleeker et al., 2003
Culex quinquefasciatus	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	37	3	144	Borovsky et al., 1987
Macrophyta															
Lemna minor									7 d	EC50	growth inhibition	300	4		Blinova, 2004
Mollusca															
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.09±0.12	22.8±0.5	81.3±5.3	28 h	LC50	mortality	>28.2	2	67	Weinstein & Polk, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.09±0.12	22.8±0.5	81.3±5.3	4 h+8 h	LC50	mortality	7.71	2	68	Weinstein & Polk, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.09±0.12	22.8±0.5	81.3±5.3	4 h+16 h	LC50	mortality	3.35	2	68	Weinstein & Polk, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.09±0.12	22.8±0.5	81.3±5.3	4 h+24 h	LC50	mortality	2.63	2	68	Weinstein & Polk, 2001
Pisces															
Pimephales promelas	5 cm, 0.8 g	N	S	p.a.			14		~24 h	LC50	mortality	220	3	42	Kagan et al., 1985
Pimephales promelas	larvae	Y	R	high	tw		24		120 h	LC50	mortality	<25.6	2	48	Oris & Giesy, 1987

Table 136: Chronic toxicity of pyrene (CASnr: 129-00-0) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	1.2	2	167	Bisson et al., 2000
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am	-	25±1	27.2	7 d	EC10	growth, area under the curve	2.41	3	203	Djomo et al., 2004
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am	-	25±1	27.2	72 h	EC10	growth rate	8.4	3	102	Djomo et al., 2004
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC10	cell number	21	2	242, 249	Altenburger et al., 2004
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	2.1	2	168	Bisson et al., 2000
Daphnia magna	< 24 h	N	R	>99%	am		20		7 d	EC50	growth	72.7	3		Olmstead & Leblanc 2005
Daphnia magna	< 24 h	N	R	>99%	am		20		7 d	EC10	growth	29	3		Olmstead & Leblanc 2005
Diporeia sp.	1-2 mm, juvenile, 5-11 m	Y	R	>98%	nw	8.1-8.3		165-250	28 d	LC50	mortality	79.1	2		Landrum et al., 2003
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	10 d	LC50	mortality	77.1	2		Lee et al., 2001

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Hyalella azteca	2-3 w	Y	R	>98%	nw	8.2	23	165	14 d	LC50	mortality	60.1	2		Lee et al., 2001
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	77	2		Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC50	mortality	56	2	92	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	LC10	mortality	26	2	92	Lee et al., 2002
Hyalella azteca	2-3 w, 0.5-1 mm	Y	R	>98%	nw	8.1-8.3	23	165-250	10 d	NOEC	mortality	39	2		Lee et al., 2002
Cyanophyta															
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	NOEC	standing crop	≥120	3	143	Bastian & Toetz, 1982
Macrophyta															
Lemna gibba		Y	R		am				8 d	EC50	growth rate	45000	3	10, 102	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC10	growth rate	430	3	10, 102	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC50	growth rate	2600	3	102, 108, 109	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC10	growth rate	270	3	102, 108, 109	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC10	growth rate	2000	3	10, 102, 108	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC14-21	growth rate	2000	3	110	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC0-29	chlorophyll content	2000	3	110	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC11-39	growth rate	2000	3	111	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC0-34	chlorophyll content	2000	3	111	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC0-5	growth rate	2000	3	112	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC0-15	chlorophyll content	2000	3	112	Ren et al., 1994
Lemna gibba		N	S		am				8 d	EC78	growth rate	2000	3	117	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC50	growth rate	>8000	3	96	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC10	growth rate	440	3	96, 102	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	2800	3	96, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	690	3	96, 102, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	1000	3	96, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	230	3	96, 102, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC24	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC46	growth rate	2000	3	94, 113	Huang et al., 1997a
Pisces															
Danio rerio	larvae	Y	R	>98%		7.86±0.5	27±1		48 h	NOEC	malformations	<26	2	136, 237	Petersen & Kristensen 1998

Table 137: Acute toxicity of pyrene (CASnr: 129-00-0) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Sc		rw		16	~19		EC0	growth inhibition	300	3	214	Boney, 1974
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	106	3	279	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	40	3	280	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	53	3	281	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	45	3	282	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	50	3	283	Okay and Karacik 2007
Annelida															
Platynereis dumeralii		N	S		nw		26		10 h	EC50	immobility	22	3	172, 102	Peachey & Crosby, 1996
Platynereis dumeralii		N	S		nw		26		10 h	EC10	immobility	16	3	172, 102	Peachey & Crosby, 1996
Bacteria															
Vibrio fischeri		N	S	-	am	7.2	20±1		15 min	EC50	bioluminescence	15070	3	4, 5	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S	-	am	7.2	20±1		15 min	EC10	bioluminescence	1200	3	4, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S	-	am	7.2	20±1		15 min	EC50	bioluminescence	14530	3	4, 6	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S	-	am	7.2	20±1		15 min	EC10	bioluminescence	1100	3	4, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	>500000	3		Johnson & Long, 1998
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004
Cnidaria															
Fungia scutaria	planulae	N	S		nw		26		10 h	EC50	immobility	32	3	172, 102	Peachey & Crosby, 1996
Fungia scutaria	planulae	N	S		nw		26		10 h	EC10	immobility	26	3	172, 102	Peachey & Crosby, 1996
Crustacea															
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	LC50	survival	>129	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	LC10	survival	42	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	NOEC	survival	65	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	LC50	survival	28	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	LC10	survival	16	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	NOEC	survival	5.1	2	289	Bellas and Thor 2007
Amphilocus likelike	larvae	N	S		nw		26		10 h	EC50	immobility	22	3	172, 102	Peachey & Crosby, 1996
Amphilocus likelike	larvae	N	S		nw		26		10 h	EC10	immobility	8.4	3	172, 102	Peachey & Crosby, 1996
Artemia salina	nauplii	N	Sc	≥97%			20±1	30	24 h	LC50	mortality	>99	3	5, 231	Abernethy et al., 1986
Artemia salina	< 1 d	N	S				28		3 h	LC50	mortality	8	3	61	Kagan et al., 1985, 1987
Artemia salina	nauplii	N	S		nw		26		10 h	EC50	immobility	36	3	172, 102	Peachey & Crosby, 1996
Artemia salina	nauplii	N	S		nw		26		10 h	EC10	immobility	20	3	172, 102	Peachey & Crosby, 1996
Artemia salina	nauplii	N	S		nw		26		10 h	EC50	immobility	3.4	3	173, 102	Peachey & Crosby, 1996
Artemia salina	nauplii	N	S		nw		26		10 h	EC10	immobility	1.8	3	173, 102	Peachey & Crosby, 1996
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	2.7	2	253	Peachey 2005

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	4	2	102, 253	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	1.8	3	102, 253	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	<5.8	2	253	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>23	2	74	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	16.8	2	254	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	26	2	102, 254	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	20	2	102, 254	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	16.6	2	254	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>33.3	2	74	Peachey 2005
Corophium multisetosum	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	25.29	3	140	Sanz-Lazaro et al. 2008
Gammarus aequicauda	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	73.49	3	140	Sanz-Lazaro et al. 2008
Gammarus locusta	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	60.78	3	140	Sanz-Lazaro et al. 2008
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	4.9	2	255	Peachey 2005
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	8.2	2	102, 255	Peachey 2005
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	7.7	3	102, 255	Peachey 2005
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	<8.3	2	255	Peachey 2005
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>33.3	2	74	Peachey 2005
Mysidopsis bahia	24-48 h	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	LC50	mortality	24.8	2	180	Pelletier et al., 1997
Mysidopsis bahia	24-48 h	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	LC50	mortality	0.89	2	181	Pelletier et al., 1997
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC50	mortality	154	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC10	mortality	42	2	102	Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC50	immobility	107	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC10	immobility	16	2	102	Barata et al., 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	11.4	2	256	Peachey 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	11	2	102, 256	Peachey 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	7.6	2	102, 256	Peachey 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	8.2	2	256	Peachey 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>33.4	2	74	Peachey 2005
Mollusca															
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	LC50	mortality	>9454	3	180	Pelletier et al., 1997
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	LC50	mortality	1.68	2	181	Pelletier et al., 1997
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	EC50	growth	>9454	3	180	Pelletier et al., 1997
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	EC50	growth	>0.91	2	181	Pelletier et al., 1997
Mytilus edulis	40-50 mm shell length	Y	R	≥98%	nw		15	33	48 h	EC50	feeding filtration	>40	2		Donkin et al., 1989, 1991
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	NOEC	filtration rate	<40	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC21	filtration rate	40	3	5	Okay and Karacik 2008

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC33	filtration rate	120	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	NOEC	filtration rate	<40	3	185	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC23	filtration rate	40	3	185	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC29	filtration rate	120	3	185	Okay and Karacik 2008

Table 138: Chronic toxicity of pyrene (CASnr: 129-00-0) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S	-	am	7.2	20±1		8+18 h	EC50	bioluminescence	97510	3	24, 5	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S	-	am	7.2	20±1		8+18 h	EC10	bioluminescence	21000	3	24, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S	-	am	7.2	20±1		8+18 h	EC50	bioluminescence	1430	3	24, 6	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S	-	am	7.2	20±1		8+18 h	EC10	bioluminescence	83	3	24, 6, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S	-	am	7.2	20±1		8+18 h	EC50	growth	97210	3	24, 5	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S	-	am	7.2	20±1		8+18 h	EC10	growth	17000	3	24, 5, 102	El-Alawi et al., 2001
Vibrio fischeri		N	S	-	am	7.2	20±1		8+18 h	EC50	growth	1420	3	24, 6	El-Alawi et al., 2001, 2002
Vibrio fischeri		N	S	-	am	7.2	20±1		8+18 h	EC10	growth	75	3	24, 6, 102	El-Alawi et al., 2001
Crustacea															
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	EC50	egg production rate	62	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	EC10	egg production rate	22	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	NOEC	egg production rate	32	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC50	hatching	>129	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC10	hatching	45	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	NOEC	hatching	32	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC50	recruitment	60	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC10	recruitment	27	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	NOEC	recruitment	32	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	EC50	egg production rate	16	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	EC10	egg production rate	6.7	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	NOEC	egg production rate	5.1	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC50	hatching	>51	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC10	hatching	>51	2	289	Bellas and Thor 2007

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	NOEC	hatching	>51	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC50	recruitment	8.3	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC10	recruitment	1.7	2	289	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	NOEC	recruitment	5.1	2	289	Bellas and Thor 2007
Echinodermata															
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	EC50	malformation	1860	3		Pillai et al., 2003
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	EC10	malformation	140	3	102	Pillai et al., 2003
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	NOEC	malformation	<1000	3		Pillai et al., 2003
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	>129	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	69	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	119	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	86	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	23	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	30	2	272, 273	Bellas et al. 2008
Mollusca															
Crassostrea gigas	embryo/larval	N	S	98%	nw		20	32-33	48 h	NOEC	abnormal shell	25	3	182	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	98%	nw		20	32-33	48 h	EC50	abnormal shell	110	3	182, 92	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	98%	nw		20	32-33	48 h	EC10	abnormal shell	32	3	182, 92	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	98%	nw		20	32-33	48 h	NOEC	abnormal shell	0.5	3	89	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	98%	nw		20	32-33	48 h	EC50	abnormal shell	0.98	3	89, 92	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	98%	nw		20	32-33	48 h	EC10	abnormal shell	0.93	3	89, 92	Lyons et al., 2002
Mulinea lateralis	embryo/larval	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	L(E)C50	survival/developm.	>11900	3	180	Pelletier et al., 1997
Mulinea lateralis	embryo/larval	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	L(E)C50	survival/developm.	0.23	2	181	Pelletier et al., 1997
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	>129	2	5, 273	Bellas et al. 2008

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	94	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	129	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	133	2	272, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	8.3	2	272, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	65	2	272, 273	Bellas et al. 2008
Pisces															
Clupea harengus	larvae	Y	R	>98%	nw	7.86±0.5	6.5±1	28-30	96 h	NOEC	malformations	<24	2	136, 237	Petersen & Kristensen 1998
Gadus morhua	larvae	Y	R	>98%	nw	7.86±0.5	6.5±1	28-30	144 h	NOEC	malformations	<47	2	136, 237	Petersen & Kristensen 1998
Tunicata															
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC50	larval development	>129	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC10	larval development	>129	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	NOEC	larval development	≥129	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC50	larval development	>129	2	272, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC10	larval development	>129	2	272, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	NOEC	larval development	≥129	2	272, 273	Bellas et al. 2008

Table 139: Toxicity of pyrene (CASnr: 129-00-0) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Algae																
Chlorococcum hypnosporum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	626.08		3	25, 27, 28, 59	Chung et al. 2007

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Chlorococcum hypnosporum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	26.2		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>1000		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	66.92		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	349.96		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum hypnosporum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	35.62		3	25, 27, 28, 59	Chung et al. 2007
Chlorococcum meneghini		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	944.52		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	34.87		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>1000		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	>1000		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	346.48		2	25, 27, 59	Chung et al. 2007
Chlorococcum meneghini		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	18.82		2	25, 27, 59	Chung et al. 2007
Selenastrum capricornutum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	chlorophyll a	>500		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	chlorophyll a	0.82		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	fluorescence	>500		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	fluorescence	89		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC50	optical density	376.91		3	25, 27, 28, 59	Chung et al. 2007
Selenastrum capricornutum		N	98	quartz sand 0.18-0.5 mm	6.5	25±1	~0	~0	96h	EC10	optical density	0.63		3	25, 27, 28, 59	Chung et al. 2007
Annelida																
Eisenia veneta	0.3-0.8 g	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	28 d	LC50	mortality	155	570	2	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	28 d	EC50	growth	71	261	2	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	28 d	EC10	growth	38	140	2	13, 21, 78	Sverdrup et al., 2002a

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Eisenia veneta	0.3-0.8 g	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	28 d	NOEC	growth	29	107	2	13, 21, 78	Sverdrup et al., 2002a
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	>850	>2174	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	679	1738	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	179	458	2	21, 57, 67, 85	Bleeker et al., 2003
Enchytraeus crypticus	mature	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>2300	>8456	2	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	42	154	2	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	11	40	2	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	18	66	2	12, 21, 78	Sverdrup et al., 2002b
Lumbricus rubellus	adult, >500 mg	N		loam		15±1.5	10		42 d	LC50	mortality	283	283	2	56	Brown et al 2004
Lumbricus rubellus	adult, >500 mg	N		loam		15±1.5	10		42 d	NOEC	mortality	160	160	2	56	Brown et al 2004
Lumbricus rubellus	adult, >500 mg	N		loam		15±1.5	10		42 d	LC50	mortality	308	308	2	47, 56	Brown et al 2004
Lumbricus rubellus	adult, >500 mg	N		loam		15±1.5	10		42 d	LC10	mortality	82	82	2	47, 56	Brown et al 2004
Lumbricus rubellus	adult, >500 mg	N		loam		15±1.5	10		42 d	EC50	cocoon production	90.3	90	2	56	Brown et al 2004

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Lumbricus rubellus	adult, >500 mg	N		loam		15±1.5	10		42 d	NOEC	cocoon production	40	40	2	56	Brown et al 2004
Lumbricus rubellus	adult, >500 mg	N		loam		15±1.5	10		42 d	EC50	cocoon production	83	83	2	47, 56	Brown et al 2004
Lumbricus rubellus	adult, >500 mg	N		loam		15±1.5	10		42 d	EC10	cocoon production	55	55	2	47, 56	Brown et al 2004
Insecta																
Folsomia candida	11-13 d	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	152	390	2	21, 57, 67, 85	Bleeker et al., 2003
Folsomia candida	11-13 d	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	150	383	2	21, 57, 67, 85	Droge et al., 2006
Folsomia candida	11-13 d	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC10	mortality	76	195	2	21, 57, 67, 85	Droge et al., 2006
Folsomia candida	11-13 d	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	21	54	2	21, 57, 67, 85	Bleeker et al., 2003
Folsomia candida	11-13 d	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	21	54	2	21, 57, 67, 85	Droge et al., 2006
Folsomia candida	11-13 d	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC10	reproduction	11	29	2	21, 57, 67, 85	Droge et al., 2006
Folsomia candida	11-13 d	Y	98	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	12	29	2	21, 57, 67, 85	Bleeker et al., 2003
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	LC50	mortality	21.7	22	2	61, 64	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	NOEC	mortality	80	80	2	61, 64	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	LC50	mortality	26	26	2	61, 64, 47	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	LC10	mortality	3.4	3.4	2	61, 64, 47	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	EC50	number of juveniles	7.79	7.8	2	61, 64	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	NOEC	number of juveniles	5.0	5.0	2	61, 64	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	EC50	number of juveniles	6.5	6.5	2	61, 64, 47	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	EC10	number of juveniles	1.6	1.6	2	61, 64, 47	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	NOEC	r population	20	20	2	61, 64	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	EC50	r population	18	18	2	61, 64, 47	Herbert et al., 2004
Folsomia candida	10-12 d	N		artificial soil	6.0±0.5	20±1	10	20	28 d	EC10	r population	6.6	6.6	2	61, 64, 47	Herbert et al., 2004

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	NOEC	mortality	200	714	2	64, 67	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC10	mortality	222	793	2	64, 67, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC50	mortality	257	918	2	64, 67, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC50	mortality	>250	>893	2	64, 67	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	NOEC	reproduction	<50	<179	2	64, 67	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC10	reproduction	36	129	2	64, 67, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC50	reproduction	50	179	2	64, 67, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC50	reproduction	51	182	2	64, 67	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	NOEC	mortality	100	357	2	64, 67, 68	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC10	mortality	104	371	2	64, 67, 68, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC50	mortality	243	868	2	64, 67, 68, 47	Sørensen & Holmstrup, 2005
Folsomia candida	19-21 d	N		sandy loam	6.8	20	2.8	13	21 d	EC50	mortality	≈250	≈893	2	64, 67, 68	Sørensen & Holmstrup, 2005
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	53	195	2	12, 21, 23, 78	Sverdrup et al., 2001, 2002, 2002c

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	56	206	2	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	40	148	2	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	16	59	2	12, 21, 23, 78	Sverdrup et al., 2001, 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	10	37	2	12, 21, 23, 78	Sverdrup et al., 2001, 2002, 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	17	64	2	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	12	45	2	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	13	48	2	12, 21, 23, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	48	176	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002, 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	51	186	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	36	132	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	14	53	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	9.0	**33**	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002, 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	16	59	2	12, 22, 23, 47, 78	Sverdrup et al., 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	11	40	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	12	43	2	12, 22, 23, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	LC50	mortality	74	274	2	12, 16, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	LC50	mortality	49	181	2	12, 17, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	LC50	mortality	44	163	2	12, 18, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	50	184	2	12, 21, 26, 78	Sjursen et al., 2001
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	EC50	reproduction	20	74	2	12, 16, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	EC50	reproduction	25	93	2	12, 17, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	EC50	reproduction	18	67	2	12, 18, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	EC10	reproduction	14	52	2	12, 16, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	EC10	reproduction	17	63	2	12, 17, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	EC10	reproduction	12	44	2	12, 18, 21	Sverdrup et al., 2002c
Folsomia fimetaria	23-26 d	Y	dessi-cate	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	mortality	13	48	2	12, 21, 26, 78	Sjursen et al., 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	LC50	mortality	63	225	2	45, 80	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	EC50	reproduction	22	79	2	45, 80	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	EC10	reproduction	16	57	2	45, 80	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	NOEC	reproduction	15	54	2	45, 80	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	LC50	mortality	79	282	2	45, 80, 87	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	EC50	reproduction	24	86	2	45, 80, 87	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	EC10	reproduction	17	61	2	45, 80, 87	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	NOEC	reproduction	15	54	2	45, 80, 87	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	LC50	mortality	82	293	2	45, 80, 88	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	EC50	reproduction	24	86	2	45, 80, 88	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	EC10	reproduction	12	43	2	45, 80, 88	Jensen & Sverdrup, 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.8	12.3	21 d	NOEC	reproduction	15	54	2	45, 80, 88	Jensen & Sverdrup, 2002
Protaphorura armata	~42 d			sandy loam	6.2	20	2.8	13	21 d	LC50	mortality	92	329	2	47, 78	Sjursen & Holmstrup, 2004
Protaphorura armata	~42 d			sandy loam	6.2	20	2.8	13	21 d	LC10	mortality	30	107	2	47, 78	Sjursen & Holmstrup, 2004
Protaphorura armata	~42 d			sandy loam	6.2	20	2.8	13	21 d+2 d+7 d+2 d	LC50	mortality	23	82	2	47, 78, 79	Sjursen & Holmstrup, 2004
Protaphorura armata	~42 d			sandy loam	6.2	20	2.8	13	21 d+2 d+7 d+2 d	LC10	mortality	5.0	18	2	47, 78, 79	Sjursen & Holmstrup, 2004
Macrophyta																
Lolium perenne	seeds	N	98	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC50	germination	>1000		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	98	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC10	germination	>1000		2	10, 27, 59	Chung et al. 2007

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Lolium perenne	seeds	N	98	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC50	root length	>1000		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	98	quartz sand 0.18-0.5 mm	6.5	25±2	~0	~0	120h	EC10	root length	187.69		2	10, 27, 59	Chung et al. 2007
Lolium perenne	seeds	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3704	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	>1000	>3704	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	1300	4815	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	433	1605	2/3	14, 54, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	>1000	>3704	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	>1000	>3704	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	shoot growth	35	389	4	10, 40, 47	Baek et al 2004
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	shoot growth	<10	<111	4	10, 40, 41, 47	Baek et al 2004
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	root growth	79	878	4	10, 40, 47	Baek et al 2004
Phaseolus nipponesis	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	root growth	10	111	4	10, 40, 41, 47	Baek et al 2004
Sinapsis alba	seeds	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3704	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	1500	5556	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	120	444	2	14, 78	Sverdrup et al 2003; Sverdrup 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Sinapsis alba	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	27	101	2	14, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	>1000	>3704	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	810	3000	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seeds	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3704	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	380	1407	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	49	181	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	15	55	2	14, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	640	2370	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	N	dessi-cate	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	56	207	2	14, 78	Sverdrup et al 2003; Sverdrup 2001
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	shoot growth	5.3	59	4	10, 40, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	shoot growth	<10	<111	4	10, 40, 41, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	EC50	root growth	3.1	34	4	10, 40, 47	Baek et al 2004
Zea mays	seeds	N	99	sandy soil	6.7	23	0.9		14 d	NOEC	root growth	<10	<111	4	10, 40, 41, 47	Baek et al 2004
Microbial process																
nitrification		Y	dessi-cate	sandy loam	6.2	20	2.7	13	28 d	EC10		130	478	2	10, 21, 78	Sverdrup et al., 2002d

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
nitrification		Y	dessi-cate	sandy loam	6.2	20	2.7	13	28 d	NOEC		79	290	2	10, 21, 78	Sverdrup et al., 2002d
Mollusca																
Helix aspersa	juvenile, 5-7 w, 1.5±0.2 g, 18±2 mm shell	Y	dessi-cate	sandy loam	6.2	20	2.7	13	21 d	NOEC	growth	≥2315	≥8510	2	20, 78, 84	Sverdrup et al., 2006

Table 140: Toxicity of pyrene (CASnr: 129-00-0) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	LC50	mortality	>841	>7067	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	LC10	mortality	585	4914	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	NOEC	mortality	≥841	≥7067	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	EC25	sediment egestion	51.6	434	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	EC50	sediment egestion	101	846	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	EC10	sediment egestion	9.2	77	3	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		10 d	EC10	sediment egestion	26.4	222	2	48, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	NOEC	sediment egestion	46	387	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	EC25	sediment egestion	58.9	495	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	EC50	sediment egestion	134	1126	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	EC10	sediment egestion	28	237	2/3	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		5 d	EC10	sediment egestion	26	217	2	48, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	NOEC	reproduction	<98	<824	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	EC25	reproduction	59.1	497	2	51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	EC50	reproduction	115	967	2	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	EC10	reproduction	3.8	32	3	47, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Limnodrilus hoffmeisteri	mature	Y	98%	sediment from drainage system, <125 µm		25	1.2		28 d	EC10	reproduction	30.3	255	2	48, 51, 54, 55, 58	Lotufo & Fleeger, 1996
Lumbriculus variegatus		Y		Lake Michigan sediment	8	23±1	0.75		168 h	EC50	sediment avoidance	226	3021	2	1, 58	Kukkonen and Landrum, 1994
Lumbriculus variegatus		Y		Lake Michigan sediment	8	23±1	0.75		168 h	EC10	mortality	224	3000	2	1, 47, 58	Kukkonen and Landrum, 1994

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Lumbriculus variegatus		Y		Lake Michigan sediment	8	23±1	0.75		168 h	EC50	wet weight (rate of decrease)	492	6578	2	1, 47, 58	Kukkonen and Landrum, 1994
Lumbriculus variegatus		Y		Lake Michigan sediment	8	23±1	0.75		168 h	EC10	wet weight (rate of decrease)	175	2339	2	1, 47, 58	Kukkonen and Landrum, 1994
Crustacea																
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	LC50	mortality	80.4	183	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	LC50	mortality	70.4	161	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	EC50	reburial	<11	<25	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC50	mortality	36.6	72	2	46, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC50	mortality	37	73	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC10	mortality	23	45	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.9		10 d	LC50	mortality	81.5	165	2	46, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.9		10 d	LC50	mortality	87	176	2	46, 47, 59	Swartz et al., 1997

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.9		10 d	LC10	mortality	76	154	2	46, 47, 59	Swartz et al., 1997

Table 141: Acute toxicity of fluoranthene (CASnr: 206-44-0) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Scenedesmus subspicatus		N	S		am	8.3±0.2		in paper	7 d	EC50	growth (rate)	192	3	73	Sepic et al., 2003
Scenedesmus subspicatus		N	S		am	8.3±0.2		in paper	7 d	EC50	biomass	229	3	73	Sepic et al., 2003
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	98%	am	6.9±0.2	28±0.5		24 h	EC50	cell number	36	2	242, 266	Walter et al 2002
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	98%	am	6.9±0.2	28±0.5		24 h	EC50	cell number	34	2	242, 249	Altenburger et al., 2004
Amphibia															
Rana catesbeiana	embryo (Gosner stages 25)	Y	S		dw	7.92±0.058	24.0±0.4	268.2±56 .54	96 h	LC50	mortality	111.3	2	226	Walker et al., 1998
Rana pipiens	96-118 h (Shumway stages 18-19)	Y	CF	98%	tw	7.6-7.8	23±1	70	48 h	LC50	mortality	>30.6	2	74	Monson et al., 1999
Rana pipiens	96-118 h (Shumway stages 18-19)	Y	CF	98%	tw	7.6-7.8	23±1	70	48 h	LC50	mortality	7.3	2	79, 102	Monson et al., 1999
Rana pipiens	96-118 h (Shumway stages 18-19)	Y	CF	98%	tw	7.6-7.8	23±1	70	48 h	LC10	mortality	3.1	2	79, 102	Monson et al., 1999
Rana pipiens	96-118 h (Shumway stages 18-19)	Y	CF	98%	tw	7.6-7.8	23±1	70	48 h	LC50	mortality	2.0	2	78, 102	Monson et al., 1999
Rana pipiens	96-118 h (Shumway stages 18-19)	Y	CF	98%	tw	7.6-7.8	23±1	70	48 h	LC10	mortality	1.3	2	78, 102	Monson et al., 1999
Rana pipiens	embryo (stage 24-28)	N	S		tw				24 h	LC50	mortality	90	3	86	Kagan et al., 1987
Rana pipiens	embryo (Gosner stages 11-25)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	LC50	mortality	366	2	87	Hatch & Burton Jr., 1998
Rana pipiens	embryo (Gosner stage 11)	Y	R	98%	nw	7.96-8.62	18-22	180-220	2 d post-hatching	LC100	mortality	<5	2	198	Hatch & Burton Jr., 1998
Xenopus laevis	embryo (Nieuwkoop & Faber stages 10-46)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	LC50	mortality	193	2	87, 199	Hatch & Burton Jr., 1998
Xenopus laevis	embryo (Nieuwkoop & Faber stages 10-46)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	LC10	mortality	50	2	87, 91, 102, 199	Hatch & Burton Jr., 1998

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Xenopus laevis	embryo (Nieuwkoop & Faber stages 10-46)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	NOEC	mortality	125	2	87, 197, 199	Hatch & Burton Jr., 1998
Annelida															
Lumbriculus variegatus	adult	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	>178	2	69	Spehar et al., 1999
Lumbriculus variegatus	adult	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	1.2	2	71	Spehar et al., 1999
Lumbriculus variegatus	adult	Y	R	98%	nw	7.8-8.4	20±2	43-44	96 h	LC50	mortality	>143	2	5	Ankley et al., 1995
Lumbriculus variegatus	adult	Y	R	98%	nw	7.8-8.4	20±2	43-44	96 h	LC50	mortality	~72	2	228	Ankley et al., 1995
Lumbriculus variegatus	adult	Y	R	98%	nw	7.8-8.4	20±2	43-44	96 h	LC50	mortality	17<>35	2	229	Ankley et al., 1995
Lumbriculus variegatus	adult	Y	R	98%	nw	7.8-8.4	20±2	43-44	96 h	LC50	mortality	4.7<>8.3	2	230	Ankley et al., 1995
Stylaria lacustris		Y	S		nw	6.5-7.3	20±1	4-18	48 h	NOEC	mortality	>220	2	80, 266	Suedel & Rodgers, 1996
Stylaria lacustris		Y	S		nw	6.5-7.3	20±1	4-18	48 h	LC50	mortality	>220	2	80, 266	Suedel & Rodgers, 1996
Cnidaria															
Hydra americana	nonbudding	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	70	2	69	Spehar et al., 1999
Hydra americana	nonbudding	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	2.2	2	71	Spehar et al., 1999
Crustacea															
Ceriodaphnia dubia	< 12 h	Y	R	>99%	rw	8.18±0.04	25±1	57.07±4.14	48 h	LC50	mortality	45	2	178, 266	Oris et al., 1991
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	LC50	mortality	75.22	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	LC10	mortality	73.7	2	160, 266	Barata & Baird, 2000
Daphnia magna	eggs	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	LC50	mortality	58.64	2	160, 266	Barata & Baird, 2000
Daphnia magna	eggs	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	LC10	mortality	35.74	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	EC50	feeding	37.83	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	EC10	feeding	19.51	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	NOEC	feeding	10	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	EC50	number of offspring	51.53	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	EC10	number of offspring	31.37	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	NOEC	number of offspring	30	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	EC50	brood mass	43.85	2	160, 266	Barata & Baird, 2000

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	EC10	brood mass	17.8	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	EC50	body mass	104.38	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	EC10	body mass	13.54	2	160, 266	Barata & Baird, 2000
Daphnia magna	8-9 d female	Y	S	98%	am		20±1	hard	1 instar, 3-4 d	NOEC	body and brood mass	20	2	160, 266	Barata & Baird, 2000
Daphnia magna	4th instar, 4-5 d, genotype A	Y	R	98%	am	8.2±0.2	20	hard	48 h	EC50	immobility	87	2	5, 252, 275	Barata et al 2000
Daphnia magna	4th instar, 4-5 d, genotype F	Y	R	98%	am	8.2±0.2	20	hard	48 h	EC50	immobility	96	2	5, 252, 275	Barata et al 2000
Daphnia magna	4th instar, 4-5 d, genotype C	Y	R	98%	am	8.2±0.2	20	hard	48 h	EC50	immobility	110	2	5, 252, 275	Barata et al 2000
Daphnia magna	4th instar, 4-5 d, genotype S - 1	Y	R	98%	am	8.2±0.2	20	hard	48 h	EC50	immobility	125	2	5, 252, 275	Barata et al 2000
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>112	2	5	Bisson et al., 2000
Daphnia magna	mature	N	S		tw				2 h	LC50	mortality	4	3	40	Kagan et al., 1985, 1987
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC50	immobility	11.4	3	80, 259	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC50	immobility	4.0	3	80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	Sc	≥80%	rw	7.4-9.4	22±1	173	48 h	LC50	mortality	320000	3		LeBlanc 1980
Daphnia magna	< 24 h	N	Sc	≥80%	rw	7.4-9.4	22±1	173	48 h	NOEC	mortality	<8800	3		LeBlanc 1980
Daphnia magna	24 h	N	S		am	7.8±0.2		in paper	24 h	EC50	immobility	190	3	5	Sepic et al., 2003
Daphnia magna	<24 h	Y	R	98%	rw	7.10-8.42	20-25	169-219	48 h	LC50	mortality	117	2	69	Spehar et al., 1999
Daphnia magna	<24 h	Y	R	98%	rw	7.10-8.42	20-25	169-219	48 h	LC50	mortality	1.6	2	70	Spehar et al., 1999
Daphnia magna		Y	S		nw	6.5-7.3	20±1	4-18	48 h	NOEC	mortality	85	2	80, 266	Suedel & Rodgers, 1996
Daphnia magna		Y	S		nw	6.5-7.3	20±1	4-18	48 h	LC50	mortality	105.7	2	80, 266	Suedel & Rodgers, 1996
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48 h	EC30	immobility	180	3	5	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48+2 h	EC50	immobility	20.2	3	64	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	24 h	EC50	immobility	63.3	3	65	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48 h	EC50	immobility	34.4	3	65	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48+2	EC90	immobility	18	3	66	Verrhiest et al., 2001
Daphnia magna	<24 h	Y	S		am		20±2		24 h	EC50	immobility	30.7	3	90, 65	Verrhiest et al., 2001
Daphnia magna	<24 h	Y	S		am		20±2		48 h	EC50	immobility	13.1	3	90, 65	Verrhiest et al., 2001
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	5.01	3	105, 163	Wernersson 2003
Daphnia magna	4 d	N	S	97%	rw	8.0	20	250	24 h	EC50	immobility	196	3	80	Wernersson & Dave, 1997
Daphnia magna	4 d	N	S	97%	rw	8.0	20	250	28 h	EC50	immobility	35	3	81	Wernersson & Dave, 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Gammarus pseudolimnaeus	adult	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	108	2	69	Spehar et al., 1999
Hyalella azteca	juvenile	Y	R		am		23		5 d	LC50	mortality	188.6	2	239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		5 d	LC50	mortality	190	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		5 d	LC10	mortality	100	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		5 d	LC50	mortality	177	2	239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		5 d	LC50	mortality	180	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		5 d	LC10	mortality	89	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	7-14 d	Y	R	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	44	2	69	Spehar et al., 1999
Hyalella azteca		Y	S		nw	6.5-7.3	20±1	4-18	48 h	NOEC	mortality	<74	2	80, 266	Suedel & Rodgers, 1996
Hyalella azteca		Y	S		nw	6.5-7.3	20±1	4-18	48 h	LC50	mortality	92.2	2	80, 266	Suedel & Rodgers, 1996
Hyalella azteca		N	S		nw	7.7-8.4	20	160-180	24 h	LC50	mortality	>500	3	80	Werner & Nagel, 1997
Cyanophyta															
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	230	2	210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	EC10	nitrogen fixation	210	2	92, 210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	≥430	3	210, 211	Bastian & Toetz, 1985
Insecta															
Aedes aegypti	< 8 h, first instar	N	S		tw				<24 h	LC50	mortality	12	3	41	Kagan et al., 1985, 1987
Aedes aegypti	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	10	3	144	Borovsky et al., 1987
Aedes taeniorhynchus	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	48	3	144	Borovsky et al., 1987
Chironomus tentans	third instar	Y	R		am		23		2 d	LC50	mortality	175.5	2	233, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		2 d	LC50	mortality	140	2	92, 233, 239, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		2 d	LC10	mortality	75	2	92, 233, 239, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		2 d	LC50	mortality	310	2	92, 233, 239, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		2 d	LC10	mortality	84	2	92, 233, 239, 250	Schuler et al., 2004
Chironomus tentans		Y	S		nw	6.5-7.3	20±1	4-18	48 h	NOEC	mortality	>250	2	80, 266	Suedel & Rodgers, 1996
Chironomus tentans		Y	S		nw	6.5-7.3	20±1	4-18	48 h	LC50	mortality	>250	2	80, 266	Suedel & Rodgers, 1996
Culex quinquefasciatus	late-3rd/4th instar	N	S	single peak			28-32		24 h	LC50	mortality	45	3	144	Borovsky et al., 1987
Ophiogemphus spec.	nymph	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	>178	2	69	Spehar et al., 1999
Ophiogemphus spec.	nymph	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	>110	2	70	Spehar et al., 1999
Macrophyta															
Lemna minor	2 frond	Y		98%	rw	7.10-8.42	20-25	83.9-85.8	96 h	EC50	growth	>166	2	69	Spehar et al., 1999
Lemna minor	2 frond	Y		98%	rw	7.10-8.42	20-25	83.9-85.8	96 h	EC50	growth	>159	2	70	Spehar et al., 1999

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mollusca															
Physella virgata	adult	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	>178	2	69	Spehar et al., 1999
Physella virgata	adult	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	82	2	70	Spehar et al., 1999
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	28 h	LC50	mortality	>110.48	2	67	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h+8 h	LC50	mortality	5.62	2	68	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h+8 h	LC50	mortality	6.16	2	68, 211	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h+8 h	LC50	mortality	4.98	2	68, 215	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h+16 h	LC50	mortality	3.44	2	68	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h+16 h	LC50	mortality	4.52	2	68, 211	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h+16 h	LC50	mortality	4.31	2	68, 215	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h +24 h	LC50	mortality	2.90	2	68	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h +24 h	LC50	mortality	2.44	2	68, 211	Weinstein, 2001
Utterbackia imbecilis	glochidia	Y	R	98%	rw	8.26±0.03	24.5±1.0	80.3±6.1	4 h +24 h	LC50	mortality	2.00	2	68, 215	Weinstein, 2001
Pisces															
Lepomis macrochirus	juvenile	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	>117	2	69	Spehar et al., 1999
Lepomis macrochirus	juvenile	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	12.3	2	70	Spehar et al., 1999
Lepomis macrochirus	0.32-1.2 g	N	Sc	>80%	rw	6.5-7.9	22±1	32-48	96 h	LC50	mortality	4000	3	141	Buccafusco et al., 1981
Oncorhynchus mykiss	30-50 d	Y	CF	98%	tw	7.10-8.42	16-18	46.5-61.7	96 h	LC50	mortality	>91	2	69	Spehar et al., 1999
Oncorhynchus mykiss	30-50 d	Y	CF	98%	tw	7.10-8.42	16-18	46.5-61.7	96 h	LC50	mortality	7.7	2	70	Spehar et al., 1999
Pimephales promelas	larvae (0-48 h)	Y	CF		tw	7.12±0.6	25±0.5	284.9±10.4	96 h	LC50	mortality	9.46	2	179	Diamond et al., 1995
Pimephales promelas	larvae (0-48 h)	Y	CF		tw	7.12±0.6	25±0.5	284.9±10.4	96 h	LC50	mortality	6.83	2	179, 166	Diamond et al., 1995
Pimephales promelas	5 cm, 0.8 g	N	S	p.a.			14		~ 24 h	LC50	mortality	200	3	42	Kagan et al., 1985
Pimephales promelas	5 d	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	>212	2	69	Spehar et al., 1999
Pimephales promelas	30-50 d	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	96 h	LC50	mortality	12.2	2	70	Spehar et al., 1999

Table 142: Chronic toxicity of fluoranthene (CASnr: 206-44-0) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	8.6	2	167	Bisson et al., 2000
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	98%	am	6.9±0.2	28±0.5		24 h	NOEC	cell number	13	2	242, 266	Walter et al 2002
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	98%	am	6.9±0.2	28±0.5		24 h	EC10	cell number	11	4	242, 266	Walter et al 2002

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	98%	am	6.9±0.2	28±0.5		24 h	EC10	cell number	14	2	242, 249	Altenburger et al., 2004
Amphibia															
Ambystoma maculatum	embryo (Harrison stages 13 to 46)	Y	R	98%	nw	7.96-8.62	22-25	180-220	12 d	L(E)C50	mortality, malformation	247	2	87	Hatch & Burton Jr., 1998
Ambystoma maculatum	embryo (Harrison stages 13 to 46)	Y	R	98%	nw	7.96-8.62	22-25	180-220	12 d	NOEC	mortality	125	2	87, 197	Hatch & Burton Jr., 1998
Rana pipiens	embryo (Gosner stages 11-25)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	EC50	malformation	276	2	87	Hatch & Burton Jr., 1998
Rana pipiens	embryo (Gosner stages 11-25)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	NOEC	mortality, malformation	125	2	87, 197	Hatch & Burton Jr., 1998
Rana pipiens	embryo (Gosner stage 11)	Y	R	98%	nw	7.96-8.62	18-22	180-220	2 d post-hatching	NOEC	hatching	25	2	198	Hatch & Burton Jr., 1998
Xenopus laevis	embryo (Nieuwkoop & Faber stages 10-46)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	EC50	malformation	52	2	87, 199	Hatch & Burton Jr., 1998
Xenopus laevis	embryo (Nieuwkoop & Faber stages 10-46)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	EC10	malformation	30	2	87, 91, 102, 199	Hatch & Burton Jr., 1998
Xenopus laevis	embryo (Gosner stage 11)	Y	R	98%	nw	7.96-8.62	22-25	180-220	96 h	NOEC	malformation	25	2	87, 197, 199	Hatch & Burton Jr., 1998
Annelida															
Stylaria lacustris		Y	S		nw	6.4-7.2	20±1	72-80	10 d	LC50	mortality	>137	3	80, 90, 266	Suedel & Rodgers, 1996
Stylaria lacustris		Y	S		nw	6.4-7.2	20±1	72-80	10 d	NOEC	mortality	115	3	80, 90, 266	Suedel & Rodgers, 1996
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	1.17	2	168	Bisson et al., 2000
Ceriodaphnia dubia	< 12 h	Y	R	>99%	rw	8.18±0.04	25±1	57.07±4.14	7 d	NOEC	reproduction	57	2	178, 239, 266	Oris et al., 1991

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Ceriodaphnia dubia	< 12 h	Y	R	>99%	rw	8.18±0.04	25±1	57.07±4.14	7 d	EC50	reproduction	38.4	2	178, 239, 266	Oris et al., 1991
Ceriodaphnia dubia	< 12 h	Y	R	>99%	rw	8.18±0.04	25±1	57.07±4.14	7 d	NOEC	reproduction	32	2	178, 239, 266	Oris et al., 1991
Ceriodaphnia dubia	< 12 h	Y	R	>99%	rw	8.18±0.04	25±1	57.07±4.14	7 d	EC50	reproduction	28.5	2	178, 239, 266	Oris et al., 1991
Daphnia magna	< 24 h	N	R	>99%	am		20		7 d	EC50	growth	194	3		Olmstead & Leblanc 2005
Daphnia magna	< 24 h	N	R	>99%	am		20		7 d	EC10	growth	59	3		Olmstead & Leblanc 2005
Daphnia magna		Y	R	98%	rw	7.10-8.42	20-25	169-219	21 d	NOEC	mortality	73.2	2	69	Spehar et al., 1999
Daphnia magna		Y	R	98%	rw	7.10-8.42	20-25	169-219	21 d	NOEC	growth	17	2	69	Spehar et al., 1999
Daphnia magna		Y	R	98%	rw	7.10-8.42	20-25	169-219	21 d	NOEC	growth	1.4	2	187	Spehar et al., 1999
Daphnia magna	<48 h	Y	S		nw	7.0±0.5	20±1	120±20	10 d	EC50	immobility	102.6	2	145	Suedel et al., 1993
Daphnia magna	<48 h	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	immobility	91.6	3	90, 145	Suedel et al., 1993
Daphnia magna	<48 h	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	immobility	64.1	3	90, 145	Suedel et al., 1993
Daphnia magna	<48 h	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	immobility	42.7	3	90, 145	Suedel et al., 1993
Daphnia magna		Y	S		nw	8.1-8.4	20±1	100-130	10 d	NOEC	mortality	90	2	80, 266	Suedel & Rodgers, 1996
Daphnia magna		Y	S		nw	6.4-7.2	20±1	72-80	10 d	NOEC	mortality	75	3	80, 90, 266	Suedel & Rodgers, 1996
Daphnia magna		Y	S		nw	8.1-8.4	20±1	100-130	10 d	LC50	mortality	102.6	2	80, 266	Suedel & Rodgers, 1996
Daphnia magna		Y	S		nw	6.4-7.2	20±1	72-80	10 d	LC50	mortality	110.5	3	80, 90, 266	Suedel & Rodgers, 1996
Diporeia sp.		Y	R		nw	8.2	4	165	10 d	LC50	mortality	>388	2	101, 218	Kane Driscoll et al., 1997b
Diporeia sp.		Y	R		nw	8.2	4	165	10 d	LC50	mortality	>273	2	101, 211, 219	Kane Driscoll et al., 1997b
Diporeia sp.		Y	R		nw	8.2	4	165	10 d	NOEC	mortality	66	2	101, 218	Kane Driscoll et al., 1997b

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Diporeia sp.		Y	R		nw	8.2	4	165	10 d	NOEC	mortality	<63	2	101, 211, 219	Kane Driscoll et al., 1997b
Diporeia spp.	juvenile	Y	R		nw		7		10 d	LC10	mortality	160	2	5, 92	Schuler et al., 2004
Diporeia spp.	juvenile	Y	R		nw		7		28 d	LC50	mortality	95.5	2	5	Schuler et al., 2004
Diporeia spp.	juvenile	Y	R		nw		7		28 d	LC50	mortality	91	2	5, 92	Schuler et al., 2004
Diporeia spp.	juvenile	Y	R		nw		7		28 d	LC10	mortality	6.5	2	5, 92	Schuler et al., 2004
Hyalella azteca		Y	S		nw	8.1-8.4	20±1	100-130	10 d	NOEC	mortality	18	2	80, 266	Suedel & Rodgers, 1996
Hyalella azteca		Y	S		nw	6.4-7.2	20±1	72-80	10 d	NOEC	mortality	<24	3	80, 90, 266	Suedel & Rodgers, 1996
Hyalella azteca		Y	S		nw	8.1-8.4	20±1	100-130	10 d	LC50	mortality	30.3	2	80, 266	Suedel & Rodgers, 1996
Hyalella azteca		Y	S		nw	6.4-7.2	20±1	72-80	10 d	LC50	mortality	60.6	3	80, 90, 266	Suedel & Rodgers, 1996
Hyalella azteca	0.5-1 mm; 2-3 w	Y	R		nw	8.2	room temp	165	10 d	NOEC	mortality	14	2	101, 220	Kane Driscoll et al., 1997b
Hyalella azteca	0.5-1 mm; 2-3 w	Y	R		nw	8.2	room temp	165	10 d	NOEC	mortality	44	2	101, 211, 221	Kane Driscoll et al., 1997b
Hyalella azteca	0.5-1 mm; 2-3 w	Y	R		nw	8.2	room temp	165	10 d	LC10	mortality	55	2	91, 101, 220	Kane Driscoll et al., 1997b
Hyalella azteca	0.5-1 mm; 2-3 w	Y	R		nw	8.2	room temp	165	10 d	LC10	mortality	65	2	91, 101, 211, 221	Kane Driscoll et al., 1997b
Hyalella azteca	0.5-1 mm; 2-3 w	Y	R		nw	8.2	room temp	165	10 d	LC50	mortality	114	2	101, 220	Kane Driscoll et al., 1997b
Hyalella azteca	0.5-1 mm; 2-3 w	Y	R		nw	8.2	room temp	165	10 d	LC50	mortality	97	2	101, 211, 221	Kane Driscoll et al., 1997b
Hyalella azteca	0.5-1 mm; 2-3 w	Y	R		nw	8.2	room temp	165	10 d	LC50	mortality	128	2	91, 101, 220	Kane Driscoll et al., 1997b
Hyalella azteca	0.5-1 mm; 2-3 w	Y	R		nw	8.2	room temp	165	10 d	LC50	mortality	97	2	91, 101, 211, 221	Kane Driscoll et al., 1997b

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Hyalella azteca	0.355-0.5 mm	Y	R		nw	8.2±0.18	23	259±23	10 d	LC50	mortality	83.1	2	98	Wilcoxen et al., 2003
Hyalella azteca	0.355-0.5 mm	Y	R		nw	8.2±0.18	23	259±23	10 d	LC10	mortality	56	2	98	Wilcoxen et al., 2003
Hyalella azteca	0.355-0.5 mm	Y	R		nw	8.2±0.18	23	259±23	10 d	LC50	mortality	13.8	2	99	Wilcoxen et al., 2003
Hyalella azteca	0.355-0.5 mm	Y	R		nw	8.2±0.18	23	259±23	10 d	LC10	mortality	8.0	2	99	Wilcoxen et al., 2003
Hyalella azteca	0.355-0.5 mm	Y	R		nw	8.2±0.18	23	259±23	10 d	LC50	mortality	2.22	2	100	Wilcoxen et al., 2003
Hyalella azteca	0.355-0.5 mm	Y	R		nw	8.2±0.18	23	259±23	10 d	LC10	mortality	1.1	2	100	Wilcoxen et al., 2003
Hyalella azteca	7-14 d	Y	R	98%	nw	7.79-8.88	21-24	140-170	10 d	LC50	mortality	7.3	2	161	Hatch & Burton Jr., 1999
Hyalella azteca	7-14 d	Y	R	98%	nw	7.79-8.88	21-24	140-170	10 d	LC50	mortality	71	2	162	Hatch & Burton Jr., 1999
Hyalella azteca	juvenile	Y	R		am		23		10 d	LC50	mortality	110	2	239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		10 d	LC50	mortality	110	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		10 d	LC10	mortality	57	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		10 d	LC50	mortality	112	2	239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		10 d	LC50	mortality	120	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		10 d	LC10	mortality	66	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		28 d	LC50	mortality	65	2	239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		28 d	LC50	mortality	62	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		28 d	LC10	mortality	26	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		28 d	LC50	mortality	59	2	239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		28 d	LC50	mortality	61	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	juvenile	Y	R		am		23		28 d	LC10	mortality	30	2	92, 239, 250	Schuler et al., 2004
Hyalella azteca	0.6-1.0 mm (2-3 w)	Y	S		nw	7.0±0.5	20±1	120±20	10 d	EC50	immobility	44.9	2	145	Suedel et al., 1993
Hyalella azteca	0.6-1.0 mm (2-3 w)	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	immobility	44.7	3	90, 145	Suedel et al., 1993
Hyalella azteca	0.6-1.0 mm (2-3 w)	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	immobility	54	3	90, 145	Suedel et al., 1993
Hyalella azteca	0.6-1.0 mm (2-3 w)	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	immobility	32.4	3	90, 145	Suedel et al., 1993
Cyanophyta															
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	NOEC	standing crop	<38	3	143	Bastian & Toetz, 1982

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	EC10	standing crop	220	3	143, 92	Bastian & Toetz, 1982
Insecta															
Chironomus riparius	larvae, 24 h post-hatch	Y	S	98%	rw	8.2	20±1	82	11 d	LC50	mortality	64.1	3	80, 90	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	S	98%	rw	8.2	20±1	82	11 d	LC50	mortality	70.5	3	80, 90	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	S	98%	rw	8.2	20±1	82	11 d	LC50	mortality	61.5	3	80, 90	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	S	98%	rw	8.2	20±1	82	11 d	LC50	mortality	86.1	3	80, 90	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	S	98%	rw	8.2	20±1	82	28 d	NOEC	total emergence, emergence time and onset	43	3	80, 90	Stewart & Thompson, 1995
Chironomus tentans	8-10 d	Y	R	98%	nw	7.79-8.88	21-24	140-170	10 d	LC50	mortality	12.6	2	161	Hatch & Burton Jr., 1999
Chironomus tentans	third instar	Y	R		am		23		10 d	LC50	mortality	34.5	2	233, 239, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		10 d	LC50	mortality	31	2	92, 233, 239, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		10 d	LC10	mortality	15	2	92, 233, 239, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		10 d	LC50	mortality	37.2	2	233, 239, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		10 d	LC50	mortality	41	2	92, 233, 239, 250	Schuler et al., 2004
Chironomus tentans	third instar	Y	R		am		23		10 d	LC10	mortality	13	2	92, 233, 239, 250	Schuler et al., 2004
Chironomus tentans	10-12 d	Y	S		nw	7.0±0.5	20±1	120±20	10 d	EC50	growth	31.9	2	145	Suedel et al., 1993
Chironomus tentans	10-12 d	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	growth	61	3	90, 145	Suedel et al., 1993
Chironomus tentans	10-12 d	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	growth	50.6	3	90, 145	Suedel et al., 1993

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Chironomus tentans	10-12 d	Y	S		nw	6.5-8.5	20±1	100-140	10 d	EC50	growth	30.4	3	90, 145	Suedel et al., 1993
Chironomus tentans		Y	S		nw	8.1-8.4	20±1	100-130	10 d	NOEC	mortality	30	2	80, 266	Suedel & Rodgers, 1996
Chironomus tentans		Y	S		nw	6.4-7.2	20±1	72-80	10 d	NOEC	mortality	20	3	80, 90, 266	Suedel & Rodgers, 1996
Chironomus tentans		Y	S		nw	8.1-8.4	20±1	100-130	10 d	LC50	mortality	37.8	2	80, 266	Suedel & Rodgers, 1996
Chironomus tentans		Y	S		nw	6.4-7.2	20±1	72-80	10 d	LC50	mortality	23.6	3	80, 90, 266	Suedel & Rodgers, 1996
Macrophyta															
Lemna gibba		Y	R		am				8 d	EC50	growth rate	20000	3	10, 102	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC10	growth rate	130	2	10, 102	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC50	growth rate	860	3	102, 108, 109	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC10	growth rate	110	3	102, 108, 109	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC10	growth rate	780	3	10, 102, 108	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC27-47	growth rate	2000	3	110	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC0-39	chlorophyll content	2000	3	110	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC20-55	growth rate	2000	3	111	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC14-100	chlorophyll content	2000	3	111	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC0-7	growth rate	2000	3	112	Ren et al., 1994
Lemna gibba		Y	R		am				8 d	EC11-15	chlorophyll content	2000	3	112	Ren et al., 1994
Lemna gibba		N	S		am				8 d	EC90	growth rate	2000	3	117	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC50	growth rate	7500	3	96	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC10	growth rate	210	3	96, 102	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	2100	3	96, 118	Huang et al., 1995

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Lemna gibba		N	S		am				8 d	EC10	growth rate	120	3	96, 102, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	1000	3	96, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	94	3	96, 102, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC57	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC88	growth rate	2000	3	94, 113	Huang et al., 1997a
Pisces															
Danio rerio	ELS	Y	IF	96%	rw	7.3-7.8	25±1	210	41 d	NOEC	mortality	47	2	22, 266	Hooftman & Evers-de Ruiter, 1992a
Danio rerio	ELS	Y	IF	96%	rw	7.3-7.8	25±1	210	41 d	NOEC	length	4.4	2	22, 266	Hooftman & Evers-de Ruiter, 1992a
Danio rerio	ELS	Y	IF	96%	rw	7.3-7.8	25±1	210	41 d	EC10	length	18	2	22, 92, 266	Hooftman & Evers-de Ruiter, 1992a
Danio rerio	ELS	Y	IF	96%	rw	7.3-7.8	25±1	210	41 d	NOEC	weight	16	2	22, 266	Hooftman & Evers-de Ruiter, 1992a
Danio rerio	ELS	Y	IF	96%	rw	7.3-7.8	25±1	210	41 d	EC10	weight	21	2	22, 92, 266	Hooftman & Evers-de Ruiter, 1992a
Danio rerio	ELS	Y	IF	96%	rw	7.3-7.8	25±1	210	41 d	LC100	mortality	130	2	22, 266	Hooftman & Evers-de Ruiter, 1992a
Danio rerio	ELS	Y	IF		rw	7.8-8.2	25±1	204	42 d	LC100	mortality	240	2	80, 136, 284	Hooftman & Evers-de Ruiter, 1992b
Pimephales promelas	full life-cycle	Y	CF		tw	7.12±0.6	25±0.5	284.9±10.4	14 w	NOEC	number of eggs	<7.9	2	179	Diamond et al., 1995
Pimephales promelas	full life-cycle	Y	CF		tw	7.12±0.6	25±0.5	284.9±10.4	11 w	NOEC	survival of hatchlings	<6.2	2	179	Diamond et al., 1995
Pimephales promelas	ELS	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	32 d	NOEC	growth	10.4	2	69	Spehar et al., 1999
Pimephales promelas	ELS	Y	CF	98%	tw	7.10-8.42	20-25	46.5-61.7	32 d	NOEC	growth	1.4	2	188	Spehar et al., 1999

Table 143: Acute toxicity of fluoranthene (CASnr: 206-44-0) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	36 h	EC50	growth	190	3	102, 222	Southerland & Lewitus, 2004
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	24 h	EC50	growth	11.46	3	223	Southerland & Lewitus, 2004
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	36 h	EC50	growth	3.7	3	102, 223	Southerland & Lewitus, 2004
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	107	3	279	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	107	3	280	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	82	3	281	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	76	3	282	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	64	3	283	Okay and Karacik 2007
Annelida															
Monopylephorus rubroniveus	~10 mm, 0.275±0.153 mg	Y	R	98	nw	8.1±0.1	22.7±1.2	29.0±1.9	144 h	LC50	mortality	>120.4	3	5, 227	Weinstein et al., 2003
Monopylephorus rubroniveus	~10 mm, 0.275±0.153 mg	Y	R	98	nw	8.1±0.1	22.7±1.2	29.0±1.9	72 h+72 h	LC50	mortality	0.7	3	204, 227	Weinstein et al., 2003
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	500	3	50	Rossi & Neff, 1978
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	258	2	60	Rossi & Neff, 1978
Neanthes arenaceodentata	adult	Y	R	98%	nw		20-25	30-32	96 h	LC50	mortality	>127	2	189	Spehar et al., 1999
Bacteria															
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	>20000	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	>20000	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	1090	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	470	3	2	Arfsten et al., 1994

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	2160	3	4, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	2120	3	4, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	830	3		Johnson & Long, 1998
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004
Crustacea															
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	LC50	survival	120	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	LC10	survival	86	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	NOEC	survival	81	2	5	Bellas and Thor 2007
Ampelisca abdita	juvenile	Y	R	98%	nw		20-25	30-32	96 h	LC50	mortality	67	2	189	Spehar et al., 1999
Ampelisca abdita		N	S		nw	7.7-8.4	20	25	24 h	LC50	mortality	>100	3	5	Werner & Nagel, 1997
Artemia salina	< 1 d	N	S				28		3 h	LC50	mortality	40	3	61	Kagan et al., 1985, 1987
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	17.6	2	253	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	18	2	102, 253	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	7.1	2	102, 253	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	6.5	2	253	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>26	2	74	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	25.1	2	254	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	33	2	102, 254	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	23	2	102, 254	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>33.3	2	254	Peachey 2005
Callinectes sapidus	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>33.3	2	74	Peachey 2005
Corophium insidiosum		Y	R		nw		20	28	96 h	LC50	mortality	85	2	74	Boese et al., 1997
Corophium insidiosum		Y	R		nw		20	28	96 +1 h	LC50	mortality	32	2	75	Boese et al., 1997
Corophium insidiosum		Y	R		nw		20	28	96 +1 h	EC50	reburial	54	2	76	Boese et al., 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Corophium insidiosum		Y	R		nw		20	28	96+1+1 h	EC50	reburial	20	2	77	Boese et al., 1997
Corophium multisetosum	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	2.85	3	140	Sanz-Lazaro et al. 2008
Emerita analoga		Y	R		nw		15	28	96 h	LC50	mortality	74	2	74	Boese et al., 1997
Emerita analoga		Y	R		nw		15	28	96 +1 h	LC50	mortality	74	2	75	Boese et al., 1997
Emerita analoga		Y	R		nw		15	28	96 +1 h	EC50	reburial	74	2	76	Boese et al., 1997
Emerita analoga		Y	R		nw		15	28	96+1+1 h	EC50	reburial	73	2	77	Boese et al., 1997
Eohaustorius estuarius		Y	R		nw		15	28	96 h	LC50	mortality	>70	2	74	Boese et al., 1997
Eohaustorius estuarius		Y	R		nw		15	28	96 +1 h	LC50	mortality	66	2	75	Boese et al., 1997
Eohaustorius estuarius		Y	R		nw		15	28	96 +1 h	EC50	reburial	>70	2	76	Boese et al., 1997
Eohaustorius estuarius		Y	R		nw		15	28	96+1+1 h	EC50	reburial	7	2	77	Boese et al., 1997
Excirolana vancouverensis		Y	R		nw		15	28	96 h	LC50	mortality	>70	2	74	Boese et al., 1997
Excirolana vancouverensis		Y	R		nw		15	28	96 +1 h	LC50	mortality	>70	2	75	Boese et al., 1997
Excirolana vancouverensis		Y	R		nw		15	28	96 +1 h	EC50	reburial	>70	2	76	Boese et al., 1997
Excirolana vancouverensis		Y	R		nw		15	28	96+1+1 h	EC50	reburial	>70	2	77	Boese et al., 1997
Gammarus aequicauda	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	49.99	3	140	Sanz-Lazaro et al. 2008
Gammarus locusta	2 to 5 mm, male and non-egg-bearing female	N	S	99%	nw		18	35	48h	LC50	mortality	42.71	3	140	Sanz-Lazaro et al. 2008
Grandidierella japonica		Y	R		nw		20	28	96 h	LC50	mortality	36	2	74	Boese et al., 1997
Grandidierella japonica		Y	R		nw		20	28	96 +1 h	LC50	mortality	26	2	75	Boese et al., 1997
Grandidierella japonica		Y	R		nw		20	28	96 +1 h	EC50	reburial	27	2	76	Boese et al., 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Grandidierella japonica		Y	R		nw		20	28	96+1+1 h	EC50	reburial	19	2	77	Boese et al., 1997
Homarus americanus	larvae	Y	R	98%	nw		20-25	30-32	96 h	LC50	mortality	317	2	189	Spehar et al., 1999
Homarus americanus	larvae	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	13	3	190	Spehar et al., 1999
Homarus americanus	larvae	N	R	98%	nw			30-32	96 h	LC50	mortality	22	3	72	Spehar et al., 1999
Leptocheirus plumulosus		Y	R		nw		25	20	96 h	LC50	mortality	>98	2	74	Boese et al., 1997
Leptocheirus plumulosus		Y	R		nw		25	28	96 +1 h	LC50	mortality	69	2	75	Boese et al., 1997
Leptocheirus plumulosus		Y	R		nw		25	28	96 +1 h	EC50	reburial	51	2	76	Boese et al., 1997
Leptocheirus plumulosus		Y	R		nw		25	28	96+1+1 h	EC50	reburial	20	2	77	Boese et al., 1997
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	17.1	2	255	Peachey 2005
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	17	2	102, 255	Peachey 2005
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	14	2	102, 255	Peachey 2005
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	11.9	2	255	Peachey 2005
Libinia dubia	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>47.5	2	74	Peachey 2005
Menippe adina	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	39	2	102, 257	Peachey 2005
Menippe adina	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	14	2	102, 257	Peachey 2005
Menippe adina	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>47.5	4	257	Peachey 2005
Menippe adina	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>47.5	2	74	Peachey 2005
Mysidopsis bahia	24-48 h	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	LC50	mortality	63.8	2	180	Pelletier et al., 1997
Mysidopsis bahia	24-48 h	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	LC50	mortality	5.32	2	181	Pelletier et al., 1997
Mysidopsis bahia	< 24 h	Y	CF	98%	nw		20-25	30-32	96 h	LC50	mortality	31	2	189	Spehar et al., 1999
Mysidopsis bahia	< 24 h	Y	CF	98%	nw		20-25	30-32	96 h	LC50	mortality	1.4	2	190	Spehar et al., 1999
Mysidopsis bahia	< 24 h	Y	CF	98%	nw			30-32	96 h	LC50	mortality	1.7	2	72	Spehar et al., 1999
Mysidopsis bahia	< 24 h	Y	CF	98%	nw		20-25	30-32	96 h	LC50	mortality	58	2	191	Spehar et al., 1999
Mysidopsis bahia	< 24 h	Y	CF	98%	nw		20-25	30-32	96 h	LC50	mortality	12	2	192	Spehar et al., 1999

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mysidopsis bahia	< 24 h	Y	CF	98%	nw		20-25	30-32	96 h	LC50	mortality	12	2	193	Spehar et al., 1999
Mysidopsis bahia	< 24 h	Y	CF	98%	nw		20-25	30-32	96 h	LC50	mortality	2.8	2	194	Spehar et al., 1999
Mysidopsis bahia	< 24 h	Y	CF	98%	nw		20-25	30-32	96 h	LC50	mortality	1.7	2	195	Spehar et al., 1999
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC50	mortality	196	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	LC10	mortality	71	2	102	Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC50	immobility	133	2		Barata et al., 2005
Oithona davisae	adult	Y	S	>96%	nw		20		48 h	EC10	immobility	27	2	102	Barata et al., 2005
Palaemonetes spec.	3 d	Y	R	98%	nw		20-25	30-32	96 h	LC50	mortality	142	2	189	Spehar et al., 1999
Palaemonetes spec.	3 d	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	22	3	190	Spehar et al., 1999
Palaemonetes spec.	3 d	N	R	98%	nw			30-32	96 h	LC50	mortality	6.6	3	72	Spehar et al., 1999
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	25.3	2	256	Peachey 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	LC50	mortality	25	2	256	Peachey 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	LC10	mortality	12	2	256	Peachey 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>52.55	4	256	Peachey 2005
Panopeus herbstii	1 d, larvae	Y	S		nw		25	30	1 h	NOEC	mortality	>52.55	2	74	Peachey 2005
Rhepoxynius abronius		Y	R		nw		15	28	96 h	LC50	mortality	>70	2	74	Boese et al., 1997
Rhepoxynius abronius		Y	R		nw		15	28	96 +1 h	LC50	mortality	14	2	75	Boese et al., 1997
Rhepoxynius abronius		Y	R		nw		15	28	96 +1 h	EC50	reburial	63	2	76	Boese et al., 1997
Rhepoxynius abronius		Y	R		nw		15	28	96+1+1 h	EC50	reburial	<5	2	77	Boese et al., 1997
Rhepoxynius abronius		N	S		nw	7.7-8.4	15	31	24 h	LC50	mortality	>100	3	5	Werner & Nagel, 1997
Echinodermata															
Arbacia punctulata	embryo/larval	Y	S	98%	nw		20-25	30-32	96 h	LC50	mortality	>127	2	189	Spehar et al., 1999
Arbacia punctulata	embryo/larval	N	S	98%	nw		20-25	30-32	96 h	LC50	mortality	3.9	3	190	Spehar et al., 1999
Arbacia punctulata	embryo/larval	N	S	98%	nw			30-32	96 h	LC50	mortality	3.9	3	72	Spehar et al., 1999

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mollusca															
Macomona liliana	0.5-2 mm juvenile	N	S		nw		20	34	96 h	EC50	reburial	153	3	205, 216	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	N	S		nw		20	34	96 h	NOEC	reburial	50	3	205, 216	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	N	S		nw		20	34	96 h	EC50	reburial	46	3	206, 216	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	N	S		nw		20	34	96 h	NOEC	reburial	10	3	206, 216	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	N	S		nw		20	34	96 h	EC50	reburial	165	3	205, 207, 216	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	N	S		nw		20	34	96 h	EC50	reburial	56	3	206, 207, 216	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	N	S		nw		20	34	96 h	EC50	reburial	49	3	206, 216, 102	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	N	S		nw		20	34	96 h	EC10	reburial	14	3	206, 216, 102	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	Y	S		nw		20	34	96 h	EC50	reburial	48	2/3	205, 211, 217	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	Y	S		nw		20	34	96 h	EC50	reburial	207	2/3	205, 215, 217	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	Y	S		nw		20	34	96 h	EC50	reburial	12	2/3	206, 211, 217	Ahrens et al., 2002
Macomona liliana	0.5-2 mm juvenile	Y	S		nw		20	34	96 h	EC50	reburial	51	2/3	206, 215, 217	Ahrens et al., 2002
Mercenaria mercenaria	juvenile, 212-350 µm	N	S		nw	7.5-8.2	19.1-20.9	29-32	24h	LC50	mortality	650	3	25, 267	Chung et al. 2007a
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	LC50	mortality	3310	3	180	Pelletier et al., 1997
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	LC50	mortality	1.8	2	181	Pelletier et al., 1997
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	EC50	growth	900	3	180	Pelletier et al., 1997
Mulinea lateralis	juv. 1-1.5 mm	Y	S	r.g.	nw		21.5±0.7	30±2	96 h	EC50	growth	>0.81	2	181	Pelletier et al., 1997
Mulinea lateralis	embryo/larval	Y	S	98%	nw		20-25	30-32	96 h	LC50	mortality	>127	2	189	Spehar et al., 1999
Mulinea lateralis	embryo/larval	N	S	98%	nw		20-25	30-32	96 h	LC50	mortality	2.8	3	190	Spehar et al., 1999
Mytilus edulis	40-50 mm shell length	Y	R	≥98%	nw		15	33	48 h	EC50	feeding filtration	80	2		Donkin et al., 1989, 1991
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	NOEC	filtration rate	<100	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC42	filtration rate	100	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC64	filtration rate	250	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	NOEC	filtration rate	<100	3	185	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC32	filtration rate	100	3	185	Okay and Karacik 2008

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC74	filtration rate	250	3	185	Okay and Karacik 2008
Pisces															
Cyprinodon variegatus	8-15 mm, 14-28 d	N	S	>80%	nw			10-31	96 h	LC50	mortality	>560000	3		Heitmuller et al., 1981
Cyprinodon variegatus	42 d	Y	R	98%	nw		20-25	30-32	96 h	LC50	mortality	>127	2	189	Spehar et al., 1999
Cyprinodon variegatus	42 d	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	159	3	190	Spehar et al., 1999
Cyprinodon variegatus	42 d	N	R	98%	nw			30-32	96 h	LC50	mortality	172	3	72	Spehar et al., 1999
Menidia beryllina	21 d	Y	R	98%	nw		20-25	30-32	96 h	LC50	mortality	616	3	189	Spehar et al., 1999
Menidia beryllina	21 d	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	30	3	190	Spehar et al., 1999
Menidia beryllina	21 d	N	R	98%	nw			30-32	96 h	LC50	mortality	13	3	72	Spehar et al., 1999
Menidia beryllina	21 d	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	620	3	191	Spehar et al., 1999
Menidia beryllina	21 d	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	103	3	192	Spehar et al., 1999
Menidia beryllina	21 d	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	49	3	193	Spehar et al., 1999
Menidia beryllina	21 d	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	30	3	194	Spehar et al., 1999
Menidia beryllina	21 d	N	R	98%	nw		20-25	30-32	96 h	LC50	mortality	13	3	195	Spehar et al., 1999
Pleuronectus americanus	28 d	Y	S	98%	nw		6	30-32	96 h	LC50	mortality	>188	2	189	Spehar et al., 1999
Pleuronectus americanus	28 d	Y	S	98%	nw		6	30-32	96 h	LC50	mortality	0.1	2	190	Spehar et al., 1999

Table 144: Chronic toxicity of fluoranthene (CASnr: 206-44-0) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	36 h	NOEC	growth	95	3	63, 222	Southerland & Lewitus, 2004
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	36 h	EC10	growth	130	3	102, 222	Southerland & Lewitus, 2004

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	36 h	NOEC	growth	1.9	3	63, 223	Southerland & Lewitus, 2004
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	36 h	EC10	growth	0.8	3	102, 223	Southerland & Lewitus, 2004
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	48 h	NOEC	growth	≥19	3	136, 224	Southerland & Lewitus, 2004
Ankistrodesmus sp.	HP9101	N	S	99%	am		23	17	48 h	NOEC	growth	≥19	3	136, 225	Southerland & Lewitus, 2004
Bacteria															
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	83960	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	700	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	83850	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	700	3	24, 6	El-Alawi et al., 2002
Crustacea															
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	EC50	egg production rate	88	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	EC10	egg production rate	46	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	48 h	NOEC	egg production rate	81	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC50	hatching	160	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC10	hatching	41	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	NOEC	hatching	162	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC50	recruitment	78	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	EC10	recruitment	45	2	5	Bellas and Thor 2007
Acartia tonsa	fertilised females	N	Rc	a.g.	nw		18	30	72 h	NOEC	recruitment	51	2	5	Bellas and Thor 2007
Corophium spinicorne	<1 mm, >0.5 mm	Y	S		nw		15	28	10 d	LC50	mortality	23.9	3	90	Swartz et al., 1990
Mysidopsis bahia		Y	CF	98%	nw		20-25	30-32	31 d	NOEC	reproduction	11.1	2	189	Spehar et al., 1999
Mysidopsis bahia		Y	CF	98%	nw		20-25	30-32	31 d	NOEC	reproduction	0.6	2	190	Spehar et al., 1999

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Rhepoxynius abronius		Y	S		nw			28	10 d	EC4	mortality	77	3	74, 90, 94	Boese et al., 1999
Rhepoxynius abronius		Y	S		nw			28	10 d	EC3	mortality	77	3	93, 90, 94	Boese et al., 1999
Rhepoxynius abronius		Y	S		nw			28	10 d	EC4	reburial	77	3	74, 90, 94	Boese et al., 1999
Rhepoxynius abronius		Y	S		nw			28	10 d	EC100	reburial	77	3	93, 90, 94	Boese et al., 1999
Rhepoxynius abronius	<1 mm, >0.5 mm	Y	S		nw		15	28	10 d	LC50	mortality	11.1	3	90	Swartz et al., 1990
Echinodermata															
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	EC50	malformation	820	3		Pillai et al., 2003
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	EC10	malformation	82	3	102	Pillai et al., 2003
Lytechinus anemesis	ciliated blastula stage	N	S	99%	nw	7.8	16		until late gastrula stage	NOEC	malformation	100	3		Pillai et al., 2003
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	>253	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	27	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	34	2	5, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	48	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	21	2	272, 273	Bellas et al. 2008
Paracentrotus lividus	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	34	2	272, 273	Bellas et al. 2008

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Mollusca															
Mulinea lateralis	embryo/larval	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	L(E)C50	survival/developm.	58.8	2	180	Pelletier et al., 1997
Mulinea lateralis	embryo/larval	Y	S	r.g.	nw		21.5±0.7	30±2	48 h	L(E)C50	survival/developm.	1.09	2	181	Pelletier et al., 1997
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	>253	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	>253	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	NOEC	larval development	≥253	2	5, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC50	larval development	53	2	272, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	EC10	larval development	34	2	272, 273	Bellas et al. 2008
Mytilus galloprovincialis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	48 h	LOEC	larval development	63	2	272, 273	Bellas et al. 2008
Tunicata															
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC50	larval development	>253	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC10	larval development	>253	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	NOEC	larval development	≥253	2	5, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC50	larval development	>253	2	272, 273	Bellas et al. 2008

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	EC10	larval development	242	2	272, 273	Bellas et al. 2008
Ciona intestinalis	fertilized eggs	Y	Sc		am	8.29±0.11	18	34.20±0.15	20h	LOEC	larval development	253	2	272, 273	Bellas et al. 2008

Table 145: Toxicity of fluoranthene (CASnr: 206-44-0) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg_{dw}]	Value standard soil [mg/kg_{dw}]	Ri	Notes	Reference
Annelida																
Eisenia f. fetida	0.3-0.5 g	N		natural soil, LUFA 2.2	5.6	20±2	3.9		28 d	NOEC	weight, mortality	≥100	≥257	2	69, 74, 75	Schaub & Achazi, 1996
Eisenia f. fetida	0.3-0.5 g	N		natural soil, agricultural	5.3	20±2	1.7		28 d	NOEC	weight	≥100	≥600	2	69, 74, 75	Schaub & Achazi, 1996
Eisenia f. fetida	0.3-0.5 g	N		natural soil, LUFA 2.2	5.6	20±2	3.9		28 d	NOEC	cocoon production	≥100	≥257	2	69, 74, 75	Schaub & Achazi, 1996
Eisenia veneta	0.3-0.8 g	Y	>99	sandy loam	6.2	20±1	2.7	13	28 d	LC50	mortality	416	1529	2	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	>99	sandy loam	6.2	20±1	2.7	13	28 d	EC50	growth	166	610	2	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	>99	sandy loam	6.2	20±1	2.7	13	28 d	EC10	growth	113	415	2	13, 21, 78	Sverdrup et al., 2002a
Eisenia veneta	0.3-0.8 g	Y	>99	sandy loam	6.2	20±1	2.7	13	28 d	NOEC	growth	98	360	2	13, 21, 78	Sverdrup et al., 2002a
Enchytraeus crypticus	mature	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>2500	>9191	2	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	61	224	2	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	15	55	2	12, 21, 78	Sverdrup et al., 2002b
Enchytraeus crypticus	mature	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	38	140	2	12, 21, 78	Sverdrup et al., 2002b
Crustacea																
Oniscus asellus	6-10 mg	Y	>99	90% leaves with 10 dogfood	20±1	>90%	0		47 w	NOEC	growth, protein, reproduction, survival	≥801	≥89	3	1, 4, 31, 46	van Brummelen et al., 1996

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Oniscus asellus	6-10 mg	Y	>99	90% leaves with 10 dogfood	20±1	>90%	0		47 w	NOEC	growth, protein, reproduction, survival	≥507	≥56	2	1, 4, 22, 46	van Brummelen et al., 1996
Porcellio scaber	7-11 mg	Y	>99	90% leaves with 10 dogfood	20±1	>90%	0		16 w	NOEC	growth, protein, reproduction, survival	≥801	≥89	3	1, 4, 31, 46	van Brummelen et al., 1996
Porcellio scaber	7-11 mg	Y	>99	90% leaves with 10 dogfood	20±1	>90%	0		16 w	NOEC	growth, protein, reproduction, survival	≥507	≥56	2	1, 4, 22, 46	van Brummelen et al., 1996
Insecta																
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d+2 d+6 d+2 d	LC50	mortality	65	239	2	12, 21, 26, 78	Sjursen et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d+2 d+6 d+2 d	NOEC	mortality	47	173	2	12, 21, 26, 78	Sjursen et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	81	298	2	12, 21, 23, 78	Sverdrup et al., 2001, 2002
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	91	335	2	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	86	314	2	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	51	188	2	12, 21, 23, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	37	136	2	12, 21, 23, 78	Sverdrup et al., 2001, 2002

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	65	240	2	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	47	172	2	12, 21, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	47	173	2	12, 21, 23, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	76	279	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	85	314	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	LC10	mortality	79	292	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	48	176	2	12, 22, 23, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	35	**127**	2	12, 22, 23, 78	Sverdrup et al., 2001, 2002
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC50	reproduction	61	225	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	44	161	2	12, 22, 23, 47, 78	Sverdrup et al., 2001
Folsomia fimetaria	23-26 d	Y	>99	sandy loam	6.2	20±1	2.7	13	21 d	NOEC	reproduction	44	162	2	12, 22, 23, 78	Sverdrup et al., 2001
Macrophyta																
Lolium perenne	seeds	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3676	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	1200	4412	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	490	1801	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Lolium perenne	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	290	1067	2	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	1200	4412	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Lolium perenne	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	480	1765	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seeds	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3676	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	1600	5882	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	650	2390	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	384	1411	2	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	>1000	>3676	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Sinapsis alba	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	1200	4412	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seeds	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	LC50	emergence	>1000	>3676	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	fresh weight	710	2610	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	fresh weight	140	515	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC10	fresh weight	54	199	2	14, 24, 48, 78	Sverdrup et al 2003; Sverdrup 2001

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Trifolium pratense	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC50	dry weight	750	2757	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Trifolium pratense	seedlings	Y	>99	sandy loam	6.2	15-25	2.7	13	19-21 d	EC20	dry weight	150	551	2	14, 24, 78	Sverdrup et al 2003; Sverdrup 2001
Microbial process																
dehydrogenase		N		gleyic luvisol	6.5	room temp	1.4	16.4	10 d	NOEC		≥200	≥1384	2		Eschenbach et al., 1991
heterotrophic flagellates		Y	>99	sandy loam	6.2	20	2.7	13	28 d	EC5	number	2200	8088	2	10, 21, 78	Sverdrup et al., 2002d
nitrification		Y	>99	sandy loam	6.2	20	2.7	13	28 d	EC10		13	48	2	10, 21, 78	Sverdrup et al., 2002d
nitrification		Y	>99	sandy loam	6.2	20	2.7	13	28 d	NOEC		24	88	2	10, 21, 78	Sverdrup et al., 2002d
respiration (CO_2)		N		gleyic luvisol	6.5	room temp	1.4	16.4	20 h	NOEC		≥200	≥1384	2		Eschenbach et al., 1991
Mollusca																
Helix aspersa	juvenile, 5-7 w, 1.5±0.2 g, 18±2 mm shell	Y	>99%	sandy loam	6.2	20	2.7	13	21 d	NOEC	growth	≥2722	≥10008	2	78, 84	Sverdrup et al., 2006

Table 146: Toxicity of fluoranthene (CASnr: 206-44-0) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Arenicola marina				muddy fine sand					10 d	LC50	mortality	155.8		2	60	Bowmer, 1994
Arenicola marina				muddy fine sand			0.204		10 d	LC50	mortality	>3300	>161765	2	60	Bowmer, 1994

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Arenicola marina				muddy fine sand					10 d	LC50	mortality	>1000		2	60	Bowmer, 1994
Arenicola marina				muddy fine sand			0.323		10 d	LC50	mortality	>1000	>30960	2	60	Bowmer, 1994
Arenicola marina				muddy fine sand			0.731		10 d	LC50	mortality	>1000	>13680	2	60	Bowmer, 1994
Arenicola marina				muddy fine sand					10 d	LC50	mortality	>1000		2	60	Bowmer, 1994
Monopylephorus rubroniveus	~10 mm, 0.275±0.153 mg	Y	98	tidal creek -salt marsh sediment	8.3±0.1	24.1± 0.6	3.5	32.1	10 d	LC50	mortality	>3912	>11280	2	2	Weinstein et al., 2003
Monopylephorus rubroniveus	adult	Y		tidal creek -salt marsh sediment	8.33±0.08		3.5	32.1	10 d	LC50	mortality	>3912	>11280	2	15	Weinstein & Sanger 2003
Monopylephorus rubroniveus	adult	Y		tidal creek -salt marsh sediment	8.56±0.19		3.5	32.1	10 d	LC50	mortality	>3719	>10724	2	16	Weinstein & Sanger 2003
Streblospio benedicti	adult	Y		tidal creek -salt marsh sediment	8.65±0.33		3.5	32.1	10 d	LC50	mortality	65.6	189	2	17	Weinstein & Sanger 2003
Streblospio benedicti	adult	Y		tidal creek -salt marsh sediment	9.02±0.11		3.5	32.1	10 d	LC50	mortality	39.9	115	2	18	Weinstein & Sanger 2003
Stylaria lacustris		Y		pond sediment	6	20±1	2.4	2.7	10 d	NOEC	mortality	26.8	112	2	19, 46, 57, 59	Suedel & Rodgers, 1996
Crustacea																
Corophium spinicorne	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.31		10 d	LC50	mortality	5.1	167	2	58	Swartz et al., 1990
Corophium spinicorne	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.31		10 d	LC50	mortality	5.0	163	2	47, 58	Swartz et al., 1990
Corophium spinicorne	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.31		10 d	LC10	mortality	3.3	108	2	47, 58	Swartz et al., 1990
Corophium spinicorne	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.53		10 d	LC50	mortality	~13.6	~258	2	58	Swartz et al., 1990

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Corophium spinicorne	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.82		10 d	LC50	mortality	>13.6	>167	2	58	Swartz et al., 1990
Corophium volutator				muddy fine sand			1.088		10 d	LC50	mortality	33.1	304	2	60	Bowmer, 1994
Corophium volutator				muddy fine sand					10 d	LC50	mortality	33.1		2	60	Bowmer, 1994
Corophium volutator				muddy fine sand			0.204		10 d	LC50	mortality	14.8	725	2	60	Bowmer, 1994
Corophium volutator				muddy fine sand					10 d	LC50	mortality	<33		2	60	Bowmer, 1994
Corophium volutator				muddy fine sand			0.323		10 d	LC50	mortality	5.8	180	2	60	Bowmer, 1994
Corophium volutator				muddy fine sand			0.731		10 d	LC50	mortality	19.6	268	2	60	Bowmer, 1994
Corophium volutator				muddy fine sand					10 d	LC50	mortality	22.1		2	60	Bowmer, 1994
Corophium volutator				muddy fine sand					10 d	LC50	mortality	<26.2		2	60	Bowmer, 1994
Corophium volutator				muddy fine sand			2.074		10 d	LC50	mortality	23.8	115	2	60	Bowmer, 1994
Corophium volutator				muddy fine sand			1.241		10 d	LC50	mortality	22.3	180	2	60	Bowmer, 1994
Corophium volutator				muddy fine sand			0.357		10 d	LC50	mortality	4.1	115	2	60	Bowmer, 1994
Corophium volutator				muddy fine sand			0.629		10 d	LC50	mortality	<33	<525	2	60	Bowmer, 1994
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	LC50	mortality	132	518	2	6, 7, 55, 58	Lotufo, 1998b
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	NOEC	mortality	47	184	2	6, 7, 55, 58	Lotufo, 1998b
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	LC10	mortality	40	157	2	6, 7, 47, 55, 58	Lotufo, 1998b

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	EC50	reproduction	49	192	2	6, 7, 47, 55, 58	Lotufo, 1998b
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	NOEC	reproduction	47	184	2	6, 7, 55, 58	Lotufo, 1998b
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	EC10	reproduction	44	173	2	6, 7, 47, 55, 58	Lotufo, 1998b
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		27 h	EC50	grazing rate	35	137	2	6, 7, 25, 55, 58	Lotufo, 1998b
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		27 h	EC25	grazing rate	19	75	2	6, 7, 25, 55, 58	Lotufo, 1998b
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		27 h	NOEC	grazing rate	18	71	2	6, 7, 25, 55, 58	Lotufo, 1998b
Coullana spec.	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		27 h	EC10	grazing rate	10	39	2	6, 7, 25, 48, 55, 58	Lotufo, 1998b
Daphnia magna	<24 h	Y		artificial sediment		20±2	3.4	30	24 h	EC50	immobility	52.6	155	3	45, 56, 59	Verrhiest et al., 2001
Daphnia magna	<24 h	Y		artificial sediment		20±2	3.4	30	48 h	EC50	immobility	9.61	28	3	45, 56, 59	Verrhiest et al., 2001
Daphnia magna	<48 h	Y		water research field station, Denton County, TX, USA	6.5-8.5	20±1	0.782	1.36	10 d	EC50	immobility	15	192	3	53, 58	Suedel et al., 1993

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Daphnia magna	<48 h	Y		lake sediment, Lake Fork Reservoir, Quitman, TX, USA	6.5-8.5	20±1	0.85	0.94	10 d	EC50	immobility	11.9	140	3	53, 58	Suedel et al., 1993
Daphnia magna	<48 h	Y		river sediment, Trinity River, Ennis, TX, USA	6.5-8.5	20±1	0.748	0.93	10 d	EC50	immobility	4.2	56	3	53, 58	Suedel et al., 1993
Daphnia magna		Y		pond sediment	6	20	2.4	2.7	10 d	NOEC	mortality	13.1	55	3	19, 46, 57, 59	Suedel & Rodgers, 1996
Diporeia sp.		Y		Lake Michigan sediment	8.4	4.8	0.37		30 d	NOEC	mortality	<16, ≥0.02	<432, ≥0.54	3	30	Kane Driscoll et al., 1997a
Diporeia sp.		Y		Lake Michigan sediment		4.7	0.53		30 d	NOEC	mortality	<28, ≥0.02	<528, ≥0.38	4	30	Kane Driscoll et al., 1997a
Diporeia sp.		Y	>98%	Lake Michigan sediment	8.3	4	1.9		30 d	NOEC	mortality	≥566	≥2979	2	4, 46, 59	Kane Driscoll & Landrum, 1997
Hyalella azteca	0.5-1 mm, 2-3 w	Y		Lake Michigan sediment	8.1	20	0.37		30 d	NOEC	mortality, growth	≥28	≥757	3	30	Kane Driscoll et al., 1997a
Hyalella azteca	0.5-1 mm, 2-3 w	Y		Lake Michigan sediment		24	0.53		30 d	NOEC	mortality	79	1491	4	30	Kane Driscoll et al., 1997a
Hyalella azteca	0.5-1 mm, 2-3 w	Y		Lake Michigan sediment		24	0.53		30 d	NOEC	growth	≥177	≥3340	4	30	Kane Driscoll et al., 1997a
Hyalella azteca	0.5-1 mm, 2-3 w	Y	>98%	Lake Michigan sediment	8.3	20	1.9		16 d	LC50	mortality	718	3779	2	4, 46, 59	Kane Driscoll & Landrum, 1997
Hyalella azteca	0.5-1 mm, 2-3 w	Y	>98%	Lake Michigan sediment	8.3	20	1.9		16 d	NOEC	mortality	114	600	2	4, 46, 59	Kane Driscoll & Landrum, 1997
Hyalella azteca	0.5-1 mm, 2-3 w	Y	>98%	Lake Michigan sediment	8.3	20	1.9		30 d	NOEC	mortality	210	1105	4	4, 46, 59	Kane Driscoll & Landrum, 1997
Hyalella azteca	0.5-1 mm, 2-3 w	Y	>98%	Lake Michigan sediment	8.3	20	1.9		30 d	NOEC	growth rate	≥797	≥4195	2	4, 46, 59	Kane Driscoll & Landrum, 1997
Hyalella azteca	7-14 d	Y	98%	sediment from freshwater stream	7.79-8.88	21-24	0.66	15	10 d	LC50	mortality	3.248	49	2	45, 59	Hatch & Burton Jr., 1999

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Hyalella azteca	0.6-1.0 mm (2-3 w)	Y		water research field station, Denton County, TX, USA	6.5-8.5	20±1	0.782	1.36	10 d	EC50	immobility	2.3	29	2	53, 58	Suedel et al., 1993
Hyalella azteca	0.6-1.0 mm (2-3 w)	Y		lake sediment, Lake Fork Reservoir, Quitman, TX, USA	6.5-8.5	20±1	0.85	0.94	10 d	EC50	immobility	7.4	87	2	53, 58	Suedel et al., 1993
Hyalella azteca	0.6-1.0 mm (2-3 w)	Y		river sediment, Trinity River, Ennis, TX, USA	6.5-8.5	20±1	0.748	0.93	10 d	EC50	immobility	5.5	74	2	53, 58	Suedel et al., 1993
Hyalella azteca		Y		pond sediment	6	20	2.4	2.7	10 d	NOEC	mortality	<12.9	<54	2	19, 46, 57, 59	Suedel & Rodgers, 1996
Hyalella azteca	2-3 w	Y		artificial sediment		20±2	3.4	30	14 d	LC50	mortality	5.2	15	2	45, 56, 59	Verrhiest et al., 2001
Hyalella azteca	2-3 w	Y		artificial sediment		20±2	3.4	30	14 d	NOEC	mortality/growth	3	9	2	45, 56, 59	Verrhiest et al., 2001
Hyalella azteca	0.355-0.5 mm	Y		Lake Michigan sediment	8.2±0.18	23	0.765		10 d	LC50	mortality	146	1908	2	5, 27, 59	Wilcoxen et al., 2003
Hyalella azteca	0.355-0.5 mm	Y		Lake Michigan sediment	8.2±0.18	23	0.765		10 d	LC50	mortality	61.1	799	2	5, 28, 59	Wilcoxen et al., 2003
Hyalella azteca	0.355-0.5 mm	Y		Lake Michigan sediment	8.2±0.18	23	0.765		10 d	LC50	mortality	108	1412	2	5, 29, 59	Wilcoxen et al., 2003
Rhepoxynius abronius	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.31		10 d	LC50	mortality	3.4	111	2	58	Swartz et al., 1990
Rhepoxynius abronius	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.53		10 d	LC50	mortality	6.5	123	2	58	Swartz et al., 1990
Rhepoxynius abronius	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.82		10 d	LC50	mortality	10.7	131	2	58	Swartz et al., 1990
Rhepoxynius abronius	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.82		10 d	LC50	mortality	11.6	142	2	47, 58	Swartz et al., 1990
Rhepoxynius abronius	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.82		10 d	LC10	mortality	4.7	58	2	47, 58	Swartz et al., 1990
Rhepoxynius abronius	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.26		10 d	LC50	mortality	4.2	163	2	45, 59	Swartz et al., 1988

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.26		10 d	LC50	mortality	3.1	120	2	46, 59	Swartz et al., 1988
Rhepoxynius abronius	<1 mm, >0.5 mm	Y		fine sand sediment, Yaquina Bay, OR, USA		15	0.26		10 d	LC10	mortality	2.9	113	2	45, 59	Swartz et al., 1988
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	LC50	mortality	80.4	183	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	LC50	mortality	54.8	125	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment		15	4.4		10 d	EC50	reburial	<17	<39	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC50	mortality	69.6	136	2	46, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC50	mortality	72	141	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	5.1		10 d	LC10	mortality	42	83	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.8		10 d	LC50	mortality	92.7	195	2	46, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.8		10 d	LC50	mortality	92	193	2	46, 47, 59	Swartz et al., 1997

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		medium silt marine sediment, McKinney Slough, OR, USA		15	4.8		10 d	LC10	mortality	56	117	2	46, 47, 59	Swartz et al., 1997
Rhepoxynius abronius		Y		fine sand from subtidal channel, Yaquina Bay, OR, USA		15	0.37	3 silt/ clay	10 d	LC50	mortality	16	436	2	31, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		fine sand from subtidal channel, Yaquina Bay, OR, USA		15	0.37	3 silt/ clay	10 d	LC50	mortality	22.1	602	2	32, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		fine sand from subtidal channel, Yaquina Bay, OR, USA		15	0.37	3 silt/ clay	10 d	LC50	mortality	22.1	602	2	33, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		fine sand from subtidal channel, Yaquina Bay, OR, USA		15	0.37	3 silt/ clay	10 d	LC50	mortality	25.5	695	2	34, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		fine sand from subtidal channel, Yaquina Bay, OR, USA		15	0.37	3 silt/ clay	10 d	LC50	mortality	22.6	616	2	35, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		fine sand from subtidal channel, Yaquina Bay, OR, USA		15	0.37	3 silt/ clay	10 d	LC50	mortality	23.1	629	2	36, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		fine sand from subtidal channel, Yaquina Bay, OR, USA		15	0.37	3 silt/ clay	10 d	LC50	mortality	52.2	1422	2	37, 45, 52, 59	Cole et al., 2000

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		fine sand from subtidal channel, Yaquina Bay, OR, USA		15	0.37	3 silt/ clay	10 d	LC50	mortality	59.4	1619	2	38, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		silty sand from a tide flat, Yaquina Bay, OR, USA		15	1.0	24.2 silt/ clay	10 d	LC50	mortality	31.8	313	2	31, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		silty sand from a tide flat, Yaquina Bay, OR, USA		15	1.0	24.2 silt/ clay	10 d	LC50	mortality	37.2	367	2	32, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		silty sand from a tide flat, Yaquina Bay, OR, USA		15	1.0	24.2 silt/ clay	10 d	LC50	mortality	36.2	357	2	33, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		silty sand from a tide flat, Yaquina Bay, OR, USA		15	1.0	24.2 silt/ clay	10 d	LC50	mortality	38.7	381	2	34, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		silty sand from a tide flat, Yaquina Bay, OR, USA		15	1.0	24.2 silt/ clay	10 d	LC50	mortality	36.6	361	2	35, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		silty sand from a tide flat, Yaquina Bay, OR, USA		15	1.0	24.2 silt/ clay	10 d	LC50	mortality	32.2	317	2	36, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		silty sand from a tide flat, Yaquina Bay, OR, USA		15	1.0	24.2 silt/ clay	10 d	LC50	mortality	39.3	387	2	37, 45, 52, 59	Cole et al., 2000

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		silty sand from a tide flat, Yaquina Bay, OR, USA		15	1.0	24.2 silt/ clay	10 d	LC50	mortality	38.8	382	2	38, 45, 52, 59	Cole et al., 2000
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	1.8 silt/ clay	10 d	LC50	mortality	19.1	321	2	3, 40, 45, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	1.8 silt/ clay	10 d	LC10	mortality	14	235	2	3, 40, 45, 47, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	8.7 silt/ clay	10 d	LC50	mortality	15.64	263	2	3, 41, 45, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	8.7 silt/ clay	10 d	LC50	mortality	14.9	251	2	3, 41, 46, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	8.7 silt/ clay	10 d	LC10	mortality	10.3	173	2	3, 41, 45, 47, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	10.3 silt/ clay	10 d	LC50	mortality	13.87	233	2	3, 42, 45, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	10.3 silt/ clay	10 d	LC50	mortality	12.4	209	2	3, 42, 46, 59	DeWitt et al., 1992

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	10.3 silt/ clay	10 d	LC10	mortality	13	218	2	3, 42, 45, 47, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	-	10 d	LC50	mortality	12.4	208	2	3, 43, 45, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	-	10 d	LC50	mortality	9.5	160	2	3, 43, 46, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	-	10 d	LC10	mortality	11.2	188	2	3, 43, 45, 47, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	1.2 silt/ clay	10 d	LC50	mortality	11.13	187	2	3, 44, 45, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	1.2 silt/ clay	10 d	LC50	mortality	6.9	116	2	3, 44, 46, 59	DeWitt et al., 1992
Rhepoxynius abronius		Y		fine sand from subtidal channel		15	0.60	1.2 silt/ clay	10 d	LC10	mortality	8.4	141	2	3, 44, 45, 47, 59	DeWitt et al., 1992
Schizopera knabeni	non-ovigerous adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		4 d	LC50	mortality	>2100	>8235	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	non-ovigerous adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		4 d	LC50	mortality	3381	13257	2	47, 51, 55, 58	Lotufo, 1997

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Schizopera knabeni	non-ovigerous adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		4 d	LC10	mortality	131	512	2	47, 51, 55, 58	Lotufo, 1997
Schizopera knabeni	non-ovigerous adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		4 d	NOEC	mortality	249	976	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	non-ovigerous adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		6 h	EC50	grazing rate	94	369	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	non-ovigerous adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		6 h	EC50	grazing rate	85	332	2	47, 51, 55, 58	Lotufo, 1997
Schizopera knabeni	non-ovigerous adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		6 h	EC10	grazing rate	48	189	2	47, 51, 55, 58	Lotufo, 1997
Schizopera knabeni	non-ovigerous adult female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		6 h	NOEC	grazing rate	61	239	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	male+female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		14 d	EC50	reproduction	38	149	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	male+female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		14 d	EC50	reproduction	33	128	2	47, 51, 55, 58	Lotufo, 1997

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Schizopera knabeni	male+female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		14 d	EC10	reproduction	10	41	2	47, 51, 55, 58	Lotufo, 1997
Schizopera knabeni	male+female	Y	98%	mudflat salt marsh sediment, Cocodrie, LA, USA		25	2.6		14 d	NOEC	reproduction	<61	<239	2	51, 55, 58	Lotufo, 1997
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	LC50	mortality	213	819	2	6, 7, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	NOEC	mortality	132	508	2	6, 7, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	LC10	mortality	160	615	2	6, 7, 47, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	EC50	reproduction	55	212	2	6, 7, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	EC25	reproduction	29	112	2	6, 7, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	NOEC	reproduction	18	69	2	6, 7, 55, 58	Lotufo, 1998b

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		10 d	EC10	reproduction	15	58	2	6, 7, 48, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		27 h	EC50	grazing rate	34	131	2	6, 7, 25, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		27 h	EC25	grazing rate	9	35	2	6, 7, 25, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		27 h	NOEC	grazing rate	5	19	2	6, 7, 25, 55, 58	Lotufo, 1998b
Schizopera knabeni	non-ovigerous female	Y	98%	silt and clay sieved from a salt marsh near Cocodrie, LA, USA		25	2.6		27 h	EC10	grazing rate	2.4	9	2	6, 7, 25, 48, 55, 58	Lotufo, 1998b
Echinodermata																
Echinocardium cordata				muddy fine sand					14 d	LC50	mortality	33		2	60	Bowmer, 1994
Echinocardium cordata				muddy fine sand			0.204		14 d	LC50	mortality	34	1667	2	60	Bowmer, 1994
Echinocardium cordata				muddy fine sand			0.731		14 d	LC50	mortality	77	1053	2	60	Bowmer, 1994
Echinocardium cordata				muddy fine sand					14 d	LC50	mortality	116		2	60	Bowmer, 1994
Insecta																
Chironomus riparius	larvae, 24 h post-hatch	Y	98%	river sediment from river Frome, Dorset, UK	8.2	20±1	1.9		28 d	NOEC	total emergence, emergence time and onset	31	166	2	46, 57	Stewart & Thompson, 1995

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Chironomus riparius	larvae, 24 h post-hatch	Y	98%	river sediment from river Frome, Dorset, UK	8.2	20±1	1.9		28 d	EC50	total emergence, emergence time and onset	93	497	2	46, 47, 57	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	98%	river sediment from river Frome, Dorset, UK	8.2	20±1	1.9		28 d	EC10	total emergence, emergence time and onset	66	352	2	46, 47, 57	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	98%	river sediment from river Frome, Dorset, UK	8.2	20±1	0.9		11 d	LC50	mortality	32	352	2	46, 57, 58	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	98%	river sediment from river Frome, Dorset, UK	8.2	20±1	0.9		11 d	LC50	mortality	30	330	2	46, 57, 59	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	98%	river sediment from river Frome, Dorset, UK	8.2	20±1	0.9		11 d	LC50	mortality	32	354	2	46, 57, 60	Stewart & Thompson, 1995
Chironomus riparius	larvae, 24 h post-hatch	Y	98%	river sediment from river Frome, Dorset, UK	8.2	20±1	0.9		11 d	LC50	mortality	42	461	2	46, 57, 61	Stewart & Thompson, 1995
Chironomus riparius	larvae, 48 h	Y		artificial sediment		20±2	3.4	30	10 d	LC50	mortality	14.7	43	2	45, 56, 59	Verrhiest et al., 2001
Chironomus riparius	larvae, 48 h	Y		artificial sediment		20±2	3.4	30	10 d	NOEC	mortality/growth	<3	<8.8	2	45, 56, 59	Verrhiest et al., 2001
Chironomus tentans	10-12 d	Y		water research field station, Denton County, TX, USA	6.5-8.5	20±1	0.782	1.36	10 d	EC50	immobility	7.3	93	2	53, 58	Suedel et al., 1993
Chironomus tentans	10-12 d	Y		lake sediment, Lake Fork Reservoir, Quitman, TX, USA	6.5-8.5	20±1	0.85	0.94	10 d	EC50	immobility	8.7	102	2	53, 58	Suedel et al., 1993
Chironomus tentans	10-12 d	Y		river sediment, Trinity River, Ennis, TX, USA	6.5-8.5	20±1	0.748	0.93	10 d	EC50	immobility	3	40	2	53, 58	Suedel et al., 1993
Chironomus tentans		Y		pond sediment	6	20	2.4	2.7	10 d	NOEC	mortality	13.9	58	2	19, 46, 57, 59	Suedel & Rodgers, 1996

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Mollusca																
Abra alba				organic rich muddy sediment					96-120 h	EC50	defecation rate of faecal pellets	100		4	2	Bowmer, 1994
Abra alba				organic rich muddy sediment					96-120 h	EC50	defecation rate of faecal pellets	187.5		4	2	Bowmer, 1994
Abra alba				organic rich muddy sediment					96-120 h	EC50	defecation rate of faecal pellets	16.3		4	2	Bowmer, 1994
Abra alba				organic rich muddy sediment					96-120 h	EC50	defecation rate of faecal pellets	137.5		4	2	Bowmer, 1994
Abra alba				organic rich muddy sediment					96-120 h	EC50	defecation rate of faecal pellets	>625		4	2	Bowmer, 1994
Mercanaria mercenaria	juvenile, 212-350 µm	Y		river sediment from folly River, SC, USA	7.9-8.1	19.8-20.4	0.99	13	10d	LC50	mortality	1.75	18	2	13, 14, 45, 58	Chung et al. 2007a

Table 147: Acute toxicity of chrysene (CASnr: 218-01-9) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Escherichia coli		N	S	95					48 h	EC2	growth	0.96	3		Jamroz et al., 2003
Escherichia coli		N	S	95					48 h	EC1	growth	0.96	3	104	Jamroz et al., 2003
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>1.3	2	5	Bisson et al., 2000
Daphnia magna	mature	N	S		tw				2 h	LC50	mortality	1900	3	40	Kagan et al., 1987

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna	< 24 h	N	S	98%	nw/dw		20±2		48 h	EC50	immobility	3.97	3	80, 260	Lampi et al., 2006
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	>1024	3	105, 163	Wernersson 2003
Cyanophyta															
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	5.0	3	210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	EC10	nitrogen fixation	5.3	3	92, 210	Bastian & Toetz, 1985
Insecta															
Aedes aegypti	< 8 h, first instar	N	S		tw				<24 h	LC50	mortality	1700	3	41	Kagan et al., 1987

Table 148: Chronic toxicity of chrysene (CASnr: 218-01-9) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	>1	2	167	Bisson et al., 2000
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	>0.09	2	168	Bisson et al., 2000
Daphnia magna	<24 h	Y	IF	99-100%	rw	7.3-8.1		212	21 d	NOEC	mortality	≥1.4	2	45	Hooftman, 1991
Daphnia magna	<24 h	Y	IF	99-100%	rw	7.3-8.1		212	21 d	NOEC	reproduction	≥1.4	2	45	Hooftman, 1991
Cyanophyta															
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	NOEC	standing crop	640	3	143	Bastian & Toetz, 1982
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	EC10	standing crop	440	3	143, 92	Bastian & Toetz, 1982
Macrophyta															
Lemna gibba		N	S		am				8 d	EC5	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC74	growth rate	2000	3	94, 113	Huang et al., 1997a

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Pisces															
Danio rerio	ELS	Y	IF		rw	7.8-8.2	25±1	204	42 d	NOEC	mortality, hatchability, length, weight	≥0.91	2	80, 136, 284	Hooftman & Evers-de Ruiter, 1992b

Table 149: Acute toxicity of chrysene (CASnr: 218-01-9) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Sc		rw		16	~19		EC58	growth stimulation	300	3	214	Boney, 1974
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	1.0	3	282	Okay and Karacik 2007
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC50	growth	0.63	3	283	Okay and Karacik 2007
Annelida															
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	>1000	3	50	Rossi & Neff, 1978
Bacteria															
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	>100000	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	>100000	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	>100000	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	>100000	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	1430	3	4, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	1370	3	4, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	920	3		Johnson & Long, 1998
Vibrio fischeri		N	S	95					15 min	EC7	bioluminescence	0.96	3		Jamroz et al., 2003
Vibrio fischeri		N	S	95					15 min	EC5	bioluminescence	0.96	3	104	Jamroz et al., 2003

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004
Crustacea															
Artemia salina	< 1 d	N	S						3 h	LC50	mortality	3000	3	61	Kagan et al., 1987
Mollusca															
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	NOEC	filtration rate	≥1.8	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC0	filtration rate	1.8	3	5	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	NOEC	filtration rate	≥1.8	3	185	Okay and Karacik 2008
Mytilus galloprovincialis	4-5 cm	N	R		nw		22±2	22	7d	EC0	filtration rate	1.8	3	185	Okay and Karacik 2008

Table 150: Chronic toxicity of chrysene (CASnr: 218-01-9) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Phaeodactylum tricornutum	10^4 cells/ml	N	S		rw		22±2	22	96h	EC10	growth	>1.8	3	279	Okay and Karacik 2007
Bacteria															
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	89980	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	84750	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	89680	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	84940	3	24, 6	El-Alawi et al., 2002

Table 151: Toxicity of chrysene (CASnr: 218-01-9) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Eisenia fetida		Y		artificial soil		room temp	10	20	14 d	NOEC	mortality	≥1000	≥1000	2	11, 45, 59, 70	Bowmer et al., 1993
Insecta																
Folsomia candida	10-12 d	Y		artificial soil		20	10	20	28 d	NOEC	reproduction (number of cocoons)	≥180	≥180	3	30, 31, 59	Bowmer et al., 1993
Folsomia candida	10-12 d	Y		artificial soil		20	10	20	28 d	NOEC	reproduction (number of cocoons)	≥180	≥135	2	30, 49, 59	Bowmer et al., 1993
Folsomia fimetaria	23-26 d	Y	>95	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>1030	>3787	2	12, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	>95	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	>1030	>3787	2	12, 21, 78	Sverdrup et al., 2002

Table 152: Acute toxicity of benz[a]anthracene (CASnr: 56-55-3) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC50	growth rate	>40000	3	47	Cody et al., 1984
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC50	cell number	14	2	242, 249	Altenburger et al., 2004
Amphibia															
Pleurodeles waltl	larvae (stage 53)	N	R	~95%	am		20±0.5		6 d	LC50	mortality	3.125<>6.25	3	151	Fernandez & L'Haridon, 1992
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>9.1	2	5	Bisson et al., 2000

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC50	immobility	1.48	3	80, 259	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC50	immobility	0.96	3	80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC50	immobility	0.98	3	102, 80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	99%	nw/dw		20±2		48 h	EC10	immobility	0.60	3	102, 80, 260	Lampi et al., 2006
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	3.37	3	105, 163	Wernersson 2003
Daphnia pulex	1.9-2.1 mm	Y	Sc		nw	7.5	15±2		96 h	LC50	mortality	10	2	36	Trucco et al., 1983
Cyanophyta															
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	19	3	210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	EC10	nitrogen fixation	13	2	92, 210	Bastian & Toetz, 1985
Anabaena flos-aqua	2*10^5 cells/ml	Y	S	a.g.	am		29		2 h	NOEC	nitrogen fixation	≥30	3	210, 211	Bastian & Toetz, 1985
Pisces															
Pimephales promelas	larvae	Y	R	high	tw		24		120 h	LC50	mortality	<1.8	2	48	Oris & Giesy, 1987

Table 153: Chronic toxicity of benz[a]anthracene (CASnr: 56-55-3) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	1.2	2	167	Bisson et al., 2000
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC10	growth rate	18	3	47, 102	Cody et al., 1984
Scenedesmus vacuolatus	7.5*10^4 cells/ml	Y	Sc	99%	am	6.9±0.2	28±0.5		24 h	EC10	cell number	8.0	2	242, 249	Altenburger et al., 2004

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	>8.7	2	168	Bisson et al., 2000
Cyanophyta															
Anabaena flos-aqua	10^4 cells/ml	Y	S	p.a.	am		29		2 w	NOEC	standing crop	8.3	3	143	Bastian & Toetz, 1982
Macrophyta															
Lemna gibba		N	S		am				8 d	EC70	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC100	growth rate	2000	3	94, 113	Huang et al., 1997a
Pisces															
Oryzias latipes	ELS	N	Rc		am		24±1	~300	18 d	NOEC	hatching, time to hatch	≥200	3	258	Rhodes et al 2005
Oryzias latipes	ELS	N	Rc		am		24±1	~300	18 d	NOEC	malformations, hatch length	100	3	102, 258	Rhodes et al 2005
Oryzias latipes	ELS	N	Rc		am		24±1	~300	18 d	EC10	malformations	79	3	102, 258	Rhodes et al 2005
Protozoa															
Tetrahymena pyriformis	2*10^4 cells/ml	N	S		am		28		6 h	NOEC	cell viability	>8400	3	251	Bamdad et al., 1997

Table 154: Acute toxicity of benz[a]anthracene (CASnr: 56-55-3) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Sc		rw		16	~19	7 d	EC50	growth inhibition	100	3	92, 214	Boney & Corner, 1962
Bacteria															
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	300	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	290	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	730	3		Johnson & Long, 1998

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004

Table 155: Chronic toxicity of benz[a]anthracene (CASnr: 56-55-3) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Sc		rw		16	~19	7 d	NOEC	growth inhibition	<10	3	214	Boney & Corner, 1962
Antithamnion plumula	spores	N	Sc		rw		16	~19	7 d	EC10	growth inhibition	5.4	3	92, 214	Boney & Corner, 1962
Bacteria															
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	89810	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	230	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	89250	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	220	3	24, 6	El-Alawi et al., 2002

Table 156: Toxicity of benz[a]anthracene (CASnr: 56-55-3) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	>930	>2379	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	>930	>2379	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	≥930	≥2379	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Crustacea																
Oniscus asellus	6-10 mg	Y	99	90% leaves with 10 dogfood		20±1	>90%	0	47 w	NOEC	growth females	9.0	1.0	2/3	1, 4, 31, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	99	90% leaves with 10 dogfood		20±1	>90%	0	47 w	EC10	growth females	21	2.3	2/3	1, 4, 31, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	99	90% leaves with 10 dogfood		20±1	>90%	0	47 w	NOEC	protein, reproduction, survival, growth males	≥285	≥32	2/3	1, 4, 31, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	99	90% leaves with 10 dogfood		20±1	>90%	0	47 w	NOEC	growth females	7.4	0.82	2	1, 4, 22, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	99	90% leaves with 10 dogfood		20±1	>90%	0	47 w	EC10	growth females	17	1.9	2	1, 4, 22, 46	van Brummelen et al., 1996
Oniscus asellus	6-10 mg	Y	99	90% leaves with 10 dogfood		20±1	>90%	0	47 w	NOEC	protein, reproduction, survival, growth males	≥233	≥26	2	1, 4, 22, 46	van Brummelen et al., 1996
Porcellio scaber	7-11 mg	Y	99	90% leaves with 10 dogfood		20±1	>90%	0	16 w	NOEC	growth, protein	≥285	≥32	2/3	1, 4, 31, 46	van Brummelen et al., 1996
Porcellio scaber	7-11 mg	Y	99	90% leaves with 10 dogfood		20±1	>90%	0	16 w	NOEC	growth, protein	≥233	≥26	2	1, 4, 22, 46	van Brummelen et al., 1996
Insecta																
Folsomia candida	11-13 d	Y	99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	>990	>2532	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia candida	11-13 d	Y	99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	>990	>2532	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	99	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	≥990	≥2532	2	21, 57, 67, 85	Bleeker et al., 2003
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>980	>3603	2	12, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	99	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	>980	>3603	2	12, 21, 78	Sverdrup et al., 2002

Table 157: Toxicity of benz[a]anthracene (CASnr: 56-55-3) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Crustacea																
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	LC50	mortality	>28	>64	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	EC50	reburial	>28	>64	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	LC50	mortality	>28	>64	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	EC50	reburial	>28	>64	2	23, 24, 46, 52, 59	Boese et al., 1998

Table 158: Acute toxicity of benzo[k]fluoranthene (CASnr: 207-08-9) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>1.1	2	5	Bisson et al., 2000
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48 h	EC50	immobility	>1	3	5	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48+2 h	EC50	immobility	>1	3	64	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48 h	EC50	immobility	>1	3	65	Verrhiest et al., 2001
Daphnia magna	<24 h	N	S		am	7.8	20±1	250±25	48+2	EC90	immobility	>1	3	66	Verrhiest et al., 2001

Table 159: Chronic toxicity of benzo[k]fluoranthene (CASnr: 207-08-9) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	>1	2	167	Bisson et al., 2000
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	>1.08	2	168	Bisson et al., 2000
Daphnia magna	< 24 h	Y	R		am		20		21 d	NOEC	mortality, offspring intrinsic growth rate	≥2.2	2	80, 287	AquaSense 2004
Daphnia magna	< 24 h	Y	R		am		20		21 d	EC10	mortality, offspring intrinsic growth rate	>2.2	2	80, 287	AquaSense 2004
Pisces															
Danio rerio	ELS	Y	IF		rw	7.8-8.2	25±1	204	42 d	NOEC	length, weight	<0.58	2	80, 284	Hooftman & Evers-de Ruiter, 1992b
Danio rerio	ELS	Y	IF		rw	7.8-8.2	25±1	204	42 d	LC52	length, weight	0.58	2	80, 284	Hooftman & Evers-de Ruiter, 1992b

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.0	206	42 d	NOEC	mortality	0.35	2	23, 80, 284	Hooftman & Evers-de Ruiter, 1992c
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.1	206	42 d	LC50	mortality	0.65	2	23, 80, 92, 284	Hooftman & Evers-de Ruiter, 1992c
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.2	206	42 d	LC10	mortality	0.62	2	23, 80, 92, 284	Hooftman & Evers-de Ruiter, 1992c
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.3	206	42 d	NOEC	length	<0.19	2	23, 80, 284	Hooftman & Evers-de Ruiter, 1992c
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.4	206	42 d	EC50	length	0.86	2	23, 80, 92, 284	Hooftman & Evers-de Ruiter, 1992c
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.5	206	42 d	EC10	length	0.17	2	23, 80, 92, 284	Hooftman & Evers-de Ruiter, 1992c
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.6	206	42 d	NOEC	weight	0.35	2	23, 80, 284	Hooftman & Evers-de Ruiter, 1992c
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.7	206	42 d	EC50	weight	0.50	2	23, 80, 92, 284	Hooftman & Evers-de Ruiter, 1992c
Danio rerio	ELS	Y	IF	100%	rw	7.9-8.2	24.6-25.8	206	42 d	EC10	weight	0.31	2	23, 80, 92, 284	Hooftman & Evers-de Ruiter, 1992c

Table 160: Acute toxicity of benzo[k]fluoranthene (CASnr: 207-08-9) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004

Table 161: Chronic toxicity of benzo[k]fluoranthene (CASnr: 207-08-9) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Echinodermata															
Psammechinus miliaris	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	NOEC	larval development	≥2.6	2	80, 288	AquaSense 2004
Psammechinus miliaris	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	EC10	larval development	>2.6	2	80, 288	AquaSense 2004
Mollusca															
Crassostrea gigas	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	NOEC	larval development	≥2.6	2	80, 286	AquaSense 2004
Crassostrea gigas	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	EC10	larval development	>2.6	2	80, 286	AquaSense 2004

Table 162: Toxicity of benzo[k]fluoranthene (CASnr: 207-08-9) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg_{dw}]	Value standard soil [mg/kg_{dw}]	Ri	Notes	Reference
Insecta																
Folsomia candida	10-12 d	Y		artificial soil		20	10	20	28 d	NOEC	reproduction (number of cocoons)	≥180	≥180	2	10, 45, 50, 59	Bowmer et al., 1993
Folsomia fimetaria	23-26 d	Y	98	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>560	>2059	2	12, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	98	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	>560	>2059	2	12, 21, 78	Sverdrup et al., 2002

Table 163: Toxicity of benzo[k]fluoranthene (CASnr: 207-08-9) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Crustacea																
Daphnia magna	<24 h	Y		artificial sediment		20±2	3.4	30	24 h	EC5	immobility	300	882	3	45, 56, 59	Verrhiest et al., 2001
Daphnia magna	<24 h	Y		artificial sediment		20±2	3.4	30	48 h	EC45	immobility	300	882	3	45, 56, 59	Verrhiest et al., 2001
Hyalella azteca	2-3 w	Y		artificial sediment		20±2	3.4	30	14 d	NOEC	mortality/growth	≥300	≥882	2	45, 56, 59	Verrhiest et al., 2001
Insecta																
Chironomus riparius	larvae, 48 h	Y		artificial sediment		20±2	3.4	30	10 d	NOEC	mortality/growth	≥300	≥1500	2	45, 56, 59	Verrhiest et al., 2001

Table 164: Acute toxicity of benzo[b]fluoranthene (CASnr: 205-99-2) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>1.1	2	5	Bisson et al., 2000
Daphnia magna	4 d	N	S	99%	rw	8.0	20	250	24 h	EC50	immobility	>1024	3	80	Wernersson & Dave, 1997
Daphnia magna	4 d	N	S	99%	rw	8.0	20	250	28 h	EC50	immobility	4.2	3	81	Wernersson & Dave, 1997

Table 165: Chronic toxicity of benzo[b]fluoranthene (CASnr: 205-99-2) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	>1	2	167	Bisson et al., 2000
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	>1.083	2	168	Bisson et al., 2000

Table 166: Acute toxicity of benzo[b]fluoranthene (CASnr: 205-99-2) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004

Table 167: Toxicity of benzo[b]fluoranthene (CASnr: 205-99-2) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Insecta																
Folsomia fimetaria	23-26 d	Y	>98	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>360	>1324	2	12, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	>98	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	>360	>1324	2	12, 21, 78	Sverdrup et al., 2002

Table 168: Toxicity of benzo[b]fluoranthene (CASnr: 205-99-2) to benthic organisms

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Crustacea																
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	LC50	mortality	>46	>105	2	22, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	EC50	reburial	>46	>105	2	22, 24, 46, 52, 59	Boese et al., 1998

Species	Species properties	A	Purity [%]	Sediment type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test sediment [mg/kg$_{dw}$]	Value standard sediment [mg/kg$_{dw}$]	Ri	Notes	Reference
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	LC50	mortality	>46	>105	2	23, 24, 46, 52, 59	Boese et al., 1998
Rhepoxynius abronius		Y		muddy sand marine sediment, McKinney Slough, OR, USA		15	4.4		10 d	EC50	reburial	>46	>105	2	23, 24, 46, 52, 59	Boese et al., 1998

Table 169: Acute toxicity of benzo[a]pyrene (CASnr: 50-32-8) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Ankistrodesmus braunii	5*10^5 cells/ml	N	S	≥99%	am		23		72 h	EC50	growth	1300	3	37	Schoeny et al., 1988
Chlamydomonas reinhardtii	5*10^5 cells/ml	N	S	≥99%	am		23		72 h	EC50	growth	>4000	3	37	Schoeny et al., 1988
Euglena gracilis	5*10^5 cells/ml	N	S	≥99%	am		23		72 h	EC50	growth	>4000	3	37	Schoeny et al., 1988
Ochromonas malhamensis	5*10^5 cells/ml	N	S	≥99%	am		23		72 h	EC50	growth	>4000	3	37	Schoeny et al., 1988
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC50	growth rate	>13000	3	38	Cody et al., 1984
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC50	growth rate	40	3	47, 102	Cody et al., 1984
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC50	growth rate	2.8	3	46, 102	Cody et al., 1984
Pseudokirchneriella subcapitata	5*10^5 cells/ml	N	S	≥99%	am		23		72 h	EC50	growth	15	3	37	Schoeny et al., 1988
Scenedesmus acutus	5*10^5 cells/ml	N	S	≥99%	am		23		72 h	EC50	growth	5	3	37	Schoeny et al., 1988
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am		25±1	27.2	7 d	EC50	growth, area under the curve	1.48	3	203	Djomo et al., 2004
Amphibia															
Pleurodeles waltl	embryo (stage 7 to 20)	N	R	98%	tw		20±0.5		48 h	LC50	mortality	11	3	92, 200	Fernandez & L'Haridon, 1994

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Pleurodeles waltl	larvae	N	R	98%	tw		20±0.5		6 d	LC100	mortality	<12.5	3	201	Fernandez & L'Haridon, 1994
Pleurodeles waltl	larvae	N	R	98%	tw		20±0.5		6 d	LC100	mortality	25	3	200	Fernandez & L'Haridon, 1994
Pleurodeles waltl	larvae	N	R	98%	tw		20±0.5		48 h	LC50	mortality	11	3	92, 200	Fernandez & L'Haridon, 1994
Xenopus leavis	embryo (stage 46)	N	R		am		23±1		96 h	LC50	mortality	13400	3	199	Propst et al., 1997
Xenopus leavis	embryo (stage 46)	N	R		am		23±1		96 h	LC50	mortality	16700	3	199	Propst et al., 1997
Bacteria															
Escherichia coli		N	S	98					48 h	EC2	growth	0.96	3		Jamroz et al., 2003
Escherichia coli		N	S	98					48 h	EC2	growth	0.96	3	104	Jamroz et al., 2003
Crustacea															
Daphnia magna	neonates <48 h	N	S		am		20±1		48 h	LC50	mortality	250	3	146	Atienzar et al., 1999
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>2.7	2	5	Bisson et al., 2000
Daphnia magna	< 24 h	N	S	97%	nw/dw		20±2		48 h	EC50	immobility	1.62	3	80, 259	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	97%	nw/dw		20±2		48 h	EC50	immobility	0.98	3	80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	97%	nw/dw		20±2		48 h	EC50	immobility	1.02	3	102, 80, 260	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	97%	nw/dw		20±2		48 h	EC10	immobility	0.82	3	102, 80, 260	Lampi et al., 2006
Daphnia magna	4 d	N	S	pract	rw	8.0	20	250	24 h	EC50	immobility	40	3	80	Wernersson & Dave, 1997
Daphnia magna	4 d	N	S	pract	rw	8.0	20	250	28 h	EC50	immobility	8.6	3	81	Wernersson & Dave, 1997
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	59.7	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	1.16	3	105, 163	Wernersson 2003

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia pulex	1.9-2.1 mm	Y	Sc		nw	7.5	15±2		96 h	LC50	mortality	5	2/3	36	Trucco et al., 1983
Cyanophyta															
Anabaena flosaquae	5*10^5 cells/ml	N	S	≥99%	am		23		72 h	EC50	growth	>4000	3	37	Schoeny et al., 1988
Insecta															
Aedes aegypti	< 8 h, first instar	N	S	p.a.	tw				<24 h	LC50	mortality	8	3	135	Kagan & Kagan, 1986
Aedes aegypti	< 8 h, first instar	N	S	p.a.	tw				<24 h	LC50	mortality	1.8	3	208	Kagan & Kagan, 1986
Pisces															
Pimephales promelas	larvae	Y	R	high	tw		24		120 h	LC50	mortality	<5.6	2/3	48	Oris & Giesy, 1987
Poeciliopsis lucida	female, 3-9 mo, 0.2-0.46 g	N	S	gold label	dw				24 h	LC50	mortality	3200	3	92	Goddard et al, 1987

Table 170: Chronic toxicity of benzo[a]pyrene (CASnr: 50-32-8) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	0.78	2	167	Bisson et al., 2000
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC10	growth	4400	3	38, 102	Cody et al., 1984
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC10	growth	10	3	47, 102	Cody et al., 1984
Pseudokirchneriella subcapitata		N	S	≥99%	am		23		96 h	EC10	growth	0.96	3	46, 102	Cody et al., 1984
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am		25±1	27.2	7 d	EC10	growth, area under the curve	0.03	3	203	Djomo et al., 2004
Scenedesmus subspicatus	10^4 cells/ml	N	S	>98%	am		25±1	27.2	72 h	EC10	growth rate	30	3	102	Djomo et al., 2004
Amphibia															
Xenopus leavis	embryo (stage 46)	N	R		am		23±1		96 h	EC50	malformations	8700	3	199	Propst et al., 1997
Xenopus leavis	embryo (stage 46)	N	R		am		23±1		96 h	EC50	malformations	9600	3	199	Propst et al., 1997
Xenopus leavis	embryo (stage 46)	N	R		am		23±1		96 h	LOEC	growth	10000	3	199	Propst et al., 1997

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	0.503	2	168	Bisson et al., 2000
Daphnia magna	neonates <48 h	N	S		am		25±1		14 d	EC50	total number of young	30	3	92, 146	Atienzar et al., 1999
Daphnia magna	neonates <48 h	N	S		am		25±1		14 d	EC10	total number of young	12.5	3	92, 146	Atienzar et al., 1999
Daphnia magna	neonates <48 h	N	S		am		25±1		14 d	NOEC	total number of young	12.5	3	146	Atienzar et al., 1999
Macrophyta															
Lemna gibba		N	R		am				8 d	EC10	growth rate	6200	3	10, 102	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC50	growth rate	1200	3	102, 108, 109	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC10	growth rate	860	3	102, 108, 109	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC50	growth rate	730	3	10, 102, 108	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC10	growth rate	250	3	10, 102, 108	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC0-44	growth rate	2000	3	110	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC0-49	chlorophyll content	2000	3	110	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC3-21	growth rate	2000	3	111	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC6-42	chlorophyll content	2000	3	111	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC2-17	growth rate	2000	3	112	Huang et al., 1993
Lemna gibba		N	R		am				8 d	EC22-51	chlorophyll content	2000	3	112	Huang et al., 1993
Lemna gibba		N	S		am				8 d	EC35	growth rate	2000	3	117	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC50	growth rate	>8000	3	96	Huang et al., 1995
Lemna gibba		N	R		am				8 d	EC10	growth rate	5600	3	96, 102	Huang et al., 1995

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Lemna gibba		N	S		am				8 d	EC50	growth rate	560	3	96, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	160	3	96, 102, 118	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC50	growth rate	130	3	96, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC10	growth rate	54	3	96, 102, 119	Huang et al., 1995
Lemna gibba		N	S		am				8 d	EC21	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC99	growth rate	2000	3	94, 113	Huang et al., 1997a
Pisces															
Danio rerio	ELS	Y	IF		rw	7.8-8.2	25±1	204	42 d	NOEC	mortality, hatchability, length, weight	≥4.0	2	80, 136, 284	Hooftman & Evers-de Ruiter, 1992b
Danio rerio	larvae	Y	R	>98%		7.86±0.5	27±1		168 h	NOEC	malformations	≥0.44	2	136, 237	Petersen & Kristensen 1998
Oncorhynchus kisutch	eggs 24 h post fertilization	N	CF		nw		7-8.5		24 h	NOEC	hatching	≥25000	3		Ostrander et al., 1988
Oncorhynchus kisutch	eggs 7 d before hatching	N	CF		nw		7-8.5		24 h	NOEC	hatching	<25000	3		Ostrander et al., 1988
Oncorhynchus kisutch	eggs 24 h post fertilization	N	CF		rtw/nw		7-8.5		24 h	NOEC	emergence	10000	3		Ostrander et al., 1988
Oncorhynchus kisutch	eggs 7 d before hatching	N	CF		rtw/nw		7-8.5		24 h	NOEC	hatching	(<)10000	3	212	Ostrander et al., 1988
Oncorhynchus mykiss	ELS	Y	R	purified >99%	nw	6.85-7.10	10±1		36 d	NOEC	abnormalities	1.48	2	233	Hannah et al., 1982
Oncorhynchus mykiss	ELS	Y	R	purified >99%	nw	6.85-7.10	10±1		36 d	EC10	abnormalities	2.9	2	92, 233	Hannah et al., 1982
Oncorhynchus mykiss	ELS	Y	R	purified >99%	nw	6.85-7.10	10±1		36 d	NOEC	mortality, hatchability, hatching time	≥2.99	2	233	Hannah et al., 1982
Oncorhynchus mykiss	ELS	Y	R	purified >99%	nw	6.85-7.10	10±1		36 d	NOEC	length	<0.08	4	232, 233	Hannah et al., 1982

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Oryzias latipes	eggs	N	R		am		25±1		12-16 d (until hatching)	NOEC	post-hatching mortality, hatching time, gonadosomatic index male	<0.01	3	232, 235	Chikae et al., 2004
Oryzias latipes	eggs	N	R		am		25±1		12-16 d (until hatching)	NOEC	body weight (both male and female), gonadosomatic index female	0.1	3	235	Chikae et al., 2004
Oryzias latipes	eggs	N	R		am		25±1		12-16 d (until hatching)	NOEC	eyeing, hatching, sex ratio	≥10	3	235	Chikae et al., 2004
Protozoa															
Tetrahymena pyriformis	2*10^4 cells/ml	N	S		am		28		6 h	NOEC	cell viability	>9300	3	251	Bamdad et al., 1997

Table 171: Acute toxicity of benzo[a]pyrene (CASnr: 50-32-8) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Sc		rw		16	~19	0.5 h	EC34	growth stimulation	3000	3	214	Boney, 1974
Annelida															
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	>1000	3	50, 138	Rossi & Neff, 1978
Bacteria															
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	>100000	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	>100000	3	1	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		15 min	EC50	bioluminescence	49950	3	2	Arfsten et al., 1994
Vibrio fischeri		N	S	p.a.	am		19		30 min	EC50	bioluminescence	27240	3	2	Arfsten et al., 1994

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	8040	3	4, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	7930	3	4, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S	p.a.	am		17		5 min	EC50	bioluminescence	10700	3		Johnson & Long, 1998
Vibrio fischeri		N	S	98					15 min	EC2	bioluminescence	0.96	3		Jamroz et al., 2003
Vibrio fischeri		N	S	98					15 min	EC2	bioluminescence	0.96	3	104	Jamroz et al., 2003
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004
Crustacea															
Eurytemora affinis	nauplii	N	S		am		18±1	2	96 h	EC50	immobility	58	3	25	Forget-Leray et al., 2005
Paleomonetes pugio	embryos	N	S		nw		25		12 h	NOEC	hatching	≥50	3	136, 234	Hook & Lee 2004

Table 172: Chronic toxicity of benzo[a]pyrene (CASnr: 50-32-8) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Rc		rw		16	~19	96 h	NOEC	growth stimulation	<10	3	214	Boney & Corner, 1962
Gyrodinium sp.		N	S		am		20±0.5		12 d	EC10	growth rate	7.6	3	92, 213	Ishio et al, 1977
Bacteria															
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	67810	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	810	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	67110	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	800	3	24, 6	El-Alawi et al., 2002
Crustacea															
Eurytemora affinis	nauplii	R	S		am		18±1	2	10 d	NOEC	immobility	12	3	25	Forget-Leray et al., 2005

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Eurytemora affinis	nauplii	R	S		am		18±1	2	≥ 21 d	NOEC	development	<12	3	25	Forget-Leray et al., 2005
Echinodermata															
Psammechinus miliaris	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	NOEC	larval development	≥1.6	2	80, 290	AquaSense 2004
Psammechinus miliaris	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	EC10	larval development	>1.6	2	80, 290	AquaSense 2004
Strongylocentrotus purpuratus	eggs and sperm	Y	S	99%	nw	7.88	15	33-34	48 h	NOEC	deformities of gastrula	0.5	2	150	Hose et al., 1983; Hose 1985
Mollusca															
Crassostrea gigas	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	NOEC	larval development	≥1.6	2	80, 290	AquaSense 2004
Crassostrea gigas	fertilized eggs, 2-8 cells, <4 h	Y	S		nw		20	32	48 h	EC10	larval development	>1.6	2	80, 290	AquaSense 2004
Crassostrea gigas	embryo/larval	N	S	97%	nw		20	32-33	48 h	NOEC	abnormal shell	1	3	182	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	97%	nw		20	32-33	48 h	EC50	abnormal shell	3.1	3	182, 92	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	97%	nw		20	32-33	48 h	EC10	abnormal shell	1.1	3	182, 92	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	97%	nw		20	32-33	48 h	NOEC	abnormal shell	0.5	3	89	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	97%	nw		20	32-33	48 h	EC50	abnormal shell	0.44	3	89, 92	Lyons et al., 2002
Crassostrea gigas	embryo/larval	N	S	97%	nw		20	32-33	48 h	EC10	abnormal shell	0.22	3	89, 92	Lyons et al., 2002
Pisces															
Fundulus heteroclitus	eggs	N	S		am			20	7 d	NOEC	EROD activity	0.25	3		Wassenberg et al., 2002
Fundulus heteroclitus	eggs	N	S		am			20	7 d	NOEC	deformities	<0.25	3	232	Wassenberg et al., 2002
Leuresthes tenuis	eggs	Y	Sc		nw	7.7-7.9	20.0-21.5	31-32	14 d	EC10	hatchability	7.3	3	92, 209	Winkler et al., 1983
Leuresthes tenuis	eggs	Y	Sc		nw	7.7-7.9	20.0-21.5	31-32	14 d	NOEC	malformations	9.0	3	209	Winkler et al., 1983
Leuresthes tenuis	eggs	Y	Sc		nw	7.7-7.9	20.0-21.5	31-32	14 d	EC10	length embryos and larvae	7.9	3	102, 209	Winkler et al., 1983

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Psettichtys melanostichus	eggs	Y	S	technical purified	am	7.1-7.5	10±1	25	6 d	NOEC	hatchability	<0.1	2	136	Hose et al., 1982

Table 173: Toxicity of benzo[a]pyrene (CASnr: 50-32-8) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Annelida																
Eisenia andrei	300-600 mg	N		Lincolnshire topsoil	6.4		2		28 d	NOEC	mortality/growth	≥126-132	≥630-660	2	66	Eason et al, 1999
Eisenia f. fetida		N	98%			20±2	3.9		28 d	EC51	mortality	10	26	4	3	Achazi et al., 1995
Eisenia f. fetida		N	98%			20±2	3.9		28 d	EC59	mortality	100	256	4	3	Achazi et al., 1995
Eisenia f. fetida		N	98%			20±2	3.9		28 d	EC90	cocoon production	10	26	4	3	Achazi et al., 1995
Eisenia f. fetida		N	98%			20±2	3.9		28 d	EC96	cocoon production	100	256	4	3	Achazi et al., 1995
Eisenia fetida		Y		sandy soil	5.5		1.7	3.6		EC50	reproduction	>128	>753	2	32, 33, 38	Hund-Rinke & Simon, 2005
Eisenia fetida		Y		silty soil	6.1		2.9	14.6		EC50	reproduction	>128	>443	2	32, 33, 38	Hund-Rinke & Simon, 2005
Eisenia fetida		Y		loamy soil	5.4		5.6	31.5		EC50	reproduction	>128	>228	2	32, 33, 38	Hund-Rinke & Simon, 2005
Eisenia f. fetida	0.3-0.5 g	N		natural soil, LUFA 2.2	5.6	20±2	3.9		28 d	NOEC	weight, mortality	≥100	≥257	2	69, 74, 75	Schaub & Achazi, 1996
Eisenia f. fetida	0.3-0.5 g	N		natural soil, agricultural	5.3	20±2	1.7		28 d	NOEC	weight	≥100	≥600	2	69, 74, 75	Schaub & Achazi, 1996
Eisenia f. fetida	0.3-0.5 g	N		natural soil, LUFA 2.2	5.6	20±2	3.9		28 d	NOEC	cocoon production	<1	<3	3	69, 74, 75, 76	Schaub & Achazi, 1996
Eisenia f. fetida	0.3-0.5 g	N		natural soil, LUFA 2.2	5.6	20±2	3.9		28 d	NOEC	cocoon production	10	26	2	69, 74, 75, 77	Schaub & Achazi, 1996
Enchytraeus buchholzi					5.3-5.8				2w	LOEC	reporduction	100		4		GSF 1998
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	97	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	>930	>2379	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	97	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	>930	>2379	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Enchytraeus crypticus	adult 0.4-0.6 cm	Y	97	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	≥930	≥2379	2	21, 57, 67, 85	Bleeker et al., 2003
Enchytraeus crypticus		N	98%			22-25	3.9		30 d	EC24	reproduction	10	26	2	2	Achazi et al., 1995
Enchytraeus crypticus	7-8 w; adult	Y	>95%	sandy loam	6.2	20±1	2.8	13	21 d	NOEC	reproduction	≥947	≥3382	2	78, 80, 81	Sverdrup et al., 2007

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Arachnida																
Hypoaspis aculeifer	16-19 d; 10 females and 5 males per replicate	Y	>95%	sandy loam	6.2	20±1	2.8	13	21 d	NOEC	reproduction	≥947	≥3382	2	78, 80, 82	Sverdrup et al., 2007
Crustacea																
Oniscus asellus	2.82±0.59 mg	Y	98	90% leaves with 10 dogfood		20	>90%	0	9 w	NOEC	weight/length	31.6	3.5	2	1, 4	van Brummelen & Stuijfzand, 1993
Oniscus asellus	2.82±0.59 mg	Y	98	90% leaves with 10 dogfood		20	>90%	0	9 w	EC10	fresh weight	73	8.1	2	1, 4, 47	van Brummelen & Stuijfzand, 1993
Oniscus asellus	2.82±0.59 mg	Y	98	90% leaves with 10 dogfood		20	>90%	0	9 w	EC10	length	110	12.2	2	1, 4, 47	van Brummelen & Stuijfzand, 1993
Oniscus asellus	2.82±0.59 mg	Y	98	90% leaves with 10 dogfood		20	>90%	0	9 w	EC10	dry weight	81	9.0	2	1, 4, 47	van Brummelen & Stuijfzand, 1993
Oniscus asellus	2.82±0.59 mg	Y	98	90% leaves with 10 dogfood		20	>90%	0	9 w	NOEC	survival	100	11.1	2	1, 4	van Brummelen & Stuijfzand, 1993
Oniscus asellus	6-10 mg	Y	98	90% leaves with 10 dogfood		20±1	>90%	0	47 w	NOEC	growth, protein, reproduction, survival	≥315	≥35	2	1, 4, 46	van Brummelen et al., 1996
Porcellio scaber	8.52±2.85 mg	Y	98	90% leaves with 10 dogfood		20	>90%	0	9 w	NOEC	weight	31.6	3.5	2	1, 4	van Brummelen & Stuijfzand, 1993
Porcellio scaber	8.52±2.85 mg	Y	98	90% leaves with 10 dogfood		20	>90%	0	9 w	NOEC	length	≥316	≥35	2	1, 4	van Brummelen & Stuijfzand, 1993
Porcellio scaber	adult male	Y		poplar leaves		17	>90%	0	4 w	NOEC	growth efficiency	25	2.8	2	4, 5	Van Straalen & Verwey, 1991
Porcellio scaber	adult male	Y		poplar leaves		17	>90%	0	4 w	EC50	growth efficiency	50	5.6	2	4, 5, 47	Van Straalen & Verwey, 1991
Porcellio scaber	adult male	Y		poplar leaves		17	>90%	0	4 w	EC10	growth efficiency	14	1.6	2	4, 5, 47	Van Straalen & Verwey, 1991
Porcellio scaber	7-11 mg	Y	98	90% leaves with 10 dogfood		20±1	>90%	0	16 w	NOEC	growth	≥315	≥35	2	1, 4, 31, 46	van Brummelen et al., 1996
Insecta																
Folsomia candida	11-13 d	Y	97	sandy loam	5.6±0.4	20	3.9	8.1	28 d	LC50	mortality	>930	>2379	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	97	sandy loam	5.6±0.4	20	3.9	8.1	28 d	EC50	reproduction	>930	>2379	2	21, 57, 67, 85	Droge et al., 2006; Bleeker et al., 2003
Folsomia candida	11-13 d	Y	97	sandy loam	5.6±0.4	20	3.9	8.1	28 d	NOEC	reproduction	≥930	≥2379	2	21, 57, 67, 85	Bleeker et al., 2003
Folsomia candida		Y		sandy soil	5.5		1.7	3.6		EC50	reproduction	>128	>753	2	32, 34, 38	Hund-Rinke & Simon, 2005

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Folsomia candida		Y		silty soil	6.1		2.9	14.6		EC50	reproduction	>128	>443	2	32, 34, 38	Hund-Rinke & Simon, 2005
Folsomia candida		Y		loamy soil	5.4		5.6	31.5		EC50	reproduction	>128	>228	2	32, 34, 38	Hund-Rinke & Simon, 2005
Folsomia fimetaria	23-26 d	Y	>98	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>840	>3088	2	12, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	>98	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	>840	>3088	2	12, 21, 78	Sverdrup et al., 2002
Macrophyta																
Avena sativa		Y		sandy soil	5.8		3.9	8.2		EC50	growth	>512	>1309	2	32, 35, 38	Hund-Rinke & Simon, 2005
Avena sativa		Y		silty soil	6.1		2.9	14.6		EC50	growth	>512	>1772	2	32, 35, 38	Hund-Rinke & Simon, 2005
Avena sativa		Y		loamy soil	5.4		5.6	31.5		EC50	growth	>512	>913	2	32, 35, 38	Hund-Rinke & Simon, 2005
Brassica rapa		Y		sandy soil	5.8		3.9	8.2		EC50	growth	>512	>1309	2	32, 35, 38	Hund-Rinke & Simon, 2005
Brassica rapa		Y		silty soil	6.1		2.9	14.6		EC50	growth	>512	>1772	2	32, 35, 38	Hund-Rinke & Simon, 2005
Brassica rapa		Y		loamy soil	5.4		5.6	31.5		EC50	growth	>512	>913	2	32, 35, 38	Hund-Rinke & Simon, 2005
Lolium perenne	seeds	Y		sandy loam	6.2	15->25	2.8	13	19 d	NOEC	growth	86	307	2	14, 6, 78	Sverdrup et al., 2007
Phaseolus spp.	seeds	N		quartz sand						NOEC	growth (length)	≥0.5		4	53	El-Fouly 1980
Sinapsis alba	seeds	Y		sandy loam	6.2	15->25	2.8	13	19 d	NOEC	growth	≥470	≥1679	2	14, 6, 78	Sverdrup et al., 2007
Trifolium pratense	seeds	Y		sandy loam	6.2	15->25	2.8	13	19 d	NOEC	growth	≥470	≥1679	2	14, 6, 78	Sverdrup et al., 2007
Triticum spp.	seeds	N		quartz sand						NOEC	growth (length and dry weight)	≥0.5		4	53	El-Fouly 1980
Zea mays	seeds	N		quartz sand						NOEC	growth (length and dry weight)	≥0.5		4	53	El-Fouly 1980
Microbial process																
dehydrogenase		N		gleyic luvisol	6.5	room temp	1.4	16.4	10 d	NOEC		≥10	≥69	2		Eschenbach et al., 1991
nitrification		Y	>95%	sandy loam	6.2	20±1	2.8	13	28 d	NOEC		293	1046	2	78, 83	Sverdrup et al., 2007
nitrification		Y		sandy soil	5.5		1.7	3.6	6 h	EC50		>128	>753	2	32, 37, 38	Hund-Rinke & Simon, 2005
nitrification		Y		silty soil	6.1		2.9	14.6	6 h	EC50		>128	>443	2	32, 37, 38	Hund-Rinke & Simon, 2005

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg_{dw}]	Value standard soil [mg/kg_{dw}]	Ri	Notes	Reference
nitrification		Y		loamy soil	5.4		5.6	31.5	6 h	EC50		>128	>228	2	32, 37, 38	Hund-Rinke & Simon, 2005
respiration (CO_2)		N		gleyic luvisol	6.5	room temp	1.4	16.4	20 h	NOEC		≥10	≥69	2		Eschenbach et al., 1991
respiration (basal)		Y		sandy soil	5.5		1.7	3.6		EC50		>128	>753	2	32, 36, 38	Hund-Rinke & Simon, 2005
respiration (basal)		Y		silty soil	6.1		2.9	14.6		EC50		>128	>443	2	32, 36, 38	Hund-Rinke & Simon, 2005
respiration (basal)		Y		loamy soil	5.4		5.6	31.5		EC50		>128	>228	2	32, 36, 38	Hund-Rinke & Simon, 2005
respiration (substrate induced)		Y		sandy soil	5.5		1.7	3.6		EC50		>128	>753	2	32, 36, 38	Hund-Rinke & Simon, 2005
respiration (substrate induced)		Y		silty soil	6.1		2.9	14.6		EC50		>128	>443	2	32, 36, 38	Hund-Rinke & Simon, 2005
respiration (substrate induced)		Y		loamy soil	5.4		5.6	31.5		EC50		>128	>228	2	32, 36, 38	Hund-Rinke & Simon, 2005

Table 174: Acute toxicity of benzo[ghi]perylene (CASnr: 191-21-2) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>0.2	2	5	Bisson et al., 2000
Daphnia magna	< 24 h	N	S	98%	nw/dw		20±2		48 h	EC50	immobility	1.04	3	80, 259	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	98%	nw/dw		20±2		48 h	EC50	immobility	0.13	3	80, 260	Lampi et al., 2006
Pisces															
Pimephales promelas	larvae	Y	R	high	tw		24		120 h	LC20	mortality	>0.15	2	48	Oris & Giesy, 1987

Table 175: Chronic toxicity of benzo[ghi]perylene (CASnr: 191-21-2) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	>0.16	2	167	Bisson et al., 2000
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	0.082	2	168	Bisson et al., 2000
Macrophyta															
Lemna gibba		N	S		am				8 d	EC13	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC27	growth rate	2000	3	94, 113	Huang et al., 1997a
Pisces															
Danio rerio	ELS	Y	IF		rw	7.8-8.2	25±1	204	42 d	NOEC	mortality, hatchability, length, weight	≥0.16	2	80, 136, 284	Hooftman & Evers-de Ruiter, 1992b

Table 176: Acute toxicity of benzo[ghi]perylene (CASnr: 191-21-2) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	89380	3	4, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	88910	3	4, 6	El-Alawi et al., 2002
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004

Table 177: Chronic toxicity of benzo[ghi]perylene (CASnr: 191-21-2) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	93770	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	18490	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	93210	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	17750	3	24, 6	El-Alawi et al., 2002

Table 178: Toxicity of benzo[ghi]perylene (CASnr: 191-21-2) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg$_{dw}$]	Value standard soil [mg/kg$_{dw}$]	Ri	Notes	Reference
Insecta																
Folsomia candida	10-12 d	Y		artificial soil		20	10	20	28 d	NOEC	reproduction (number of cocoons)	≥180	≥180	2	10, 45, 51, 59	Bowmer et al., 1993

Table 179: Acute toxicity of dibenz[a,h]anthracene (CASnr: 53-70-3) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Amphibia															
Pleurodeles waltl	larvae (stage 53)	N	R	97%	am		20±0.5		6 d	LC50	mortality	>200	3	151	Fernandez & L'Haridon, 1992
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>0.35	2	5	Bisson et al., 2000

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Daphnia magna	< 24 h	N	S	97%	nw/dw		20±2		48 h	EC50	immobility	1.56	3	80, 259	Lampi et al., 2006
Daphnia magna	< 24 h	N	S	97%	nw/dw		20±2		48 h	EC50	immobility	0.55	3	80, 260	Lampi et al., 2006
Daphnia magna	4 d	N	S	97%	rw	8.0	20	250	24 h	EC50	immobility	496	3	80, 163	Wernersson & Dave, 1997
Daphnia magna	4 d	N	S	97%	rw	8.0	20	250	28 h	EC50	immobility	4.6	3	81, 163	Wernersson & Dave, 1997
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	24 h	EC50	immobility	>1024	3	80, 163	Wernersson 2003
Daphnia magna	neonates <24 h	N	S		am	8.0	21±1	250	27 h	EC50	immobility	1.76	3	105, 163	Wernersson 2003
Pisces															
Pimephales promelas	larvae	Y	R	high	tw		24		120 h	NOEC	mortality	≥0.15	2	48	Oris & Giesy, 1987

Table 180: Chronic toxicity of dibenz[a,h]anthracene (CASnr: 53-70-3) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	0.14	2	167	Bisson et al., 2000
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	>0.032	2	168	Bisson et al., 2000
Macrophyta															
Lemna gibba		N	S		am				8 d	EC11	growth rate	2000	3	94	Huang et al., 1997a
Lemna gibba		N	S		am				8 d	EC18	growth rate	2000	3	94, 113	Huang et al., 1997a

Table 181: Acute toxicity of dibenz[a,h]anthracene (CASnr: 53-70-3) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Annelida															
Neanthes arenaceodentata	immature young adult	Y	S	>98%	am		22±2	32	96 h	LC50	mortality	>1000	3	50	Rossi & Neff, 1978
Bacteria															
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	97180	3	4, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	room temp		15 min	EC50	bioluminescence	96550	3	4, 6	El-Alawi et al., 2002
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004

Table 182: Chronic toxicity of dibenz[a,h]anthracene (CASnr: 53-70-3) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Antithamnion plumula	spores	N	Sc		rw		16	~19	7 d	NOEC	growth stimulation	<10	3	214	Boney & Corner, 1962
Antithamnion plumula	spores	N	Sc		rw		16	~19	7 d	NOEC	growth inhibition	100	3	214	Boney & Corner, 1962
Bacteria															
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	94850	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	bioluminescence	1350	3	24, 6	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	93990	3	24, 5	El-Alawi et al., 2002
Vibrio fischeri		N	S		am	7.2	20		8+18 h	EC50	growth	1340	3	24, 6	El-Alawi et al., 2002

Table 183: Toxicity of dibenz[a,h]anthracene (CASnr: 53-70-3) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg_{dw}]	Value standard soil [mg/kg_{dw}]	Ri	Notes	Reference
Insecta																
Folsomia fimetaria	23-26 d	Y	97	sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>780	>2868	2	12, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y	97	sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	>780	>2868	2	12, 21, 78	Sverdrup et al., 2002

Table 184: Acute toxicity of indeno[1,2,3-cd]pyrene (CASnr: 193-39-5) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea															
Daphnia magna	< 24 h	Y	S		am	7.8±0.2	20±2	250±30	48 h	EC50	immobility	>357	3	5	Bisson et al., 2000

Table 185: Chronic toxicity of indeno[1,2,3-cd]pyrene (CASnr: 193-39-5) to freshwater organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Algae															
Pseudokirchneriella subcapitata		Y	S		am		23±2	215	72 h	EC10	growth	1.5	2	167	Bisson et al., 2000
Crustacea															
Ceriodaphnia dubia	< 24 h	Y	R		nw	8.1±0.4	25±2	240±40	7 d	EC10	reproduction	0.27	2	168	Bisson et al., 2000

Table 186: Acute toxicity of indeno[1,2,3-cd]pyrene (CASnr: 193-39-5) to marine organisms.

Species	Species properties	A	Test type	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Crit.	Endpoint	Value [µg/L]	Ri	Notes	Reference
Bacteria															
Vibrio fischeri		Y	S	99%	am		15	20	30 min	EC10	bioluminescence	>w.s.	2	115	Loibner et al., 2004

Table 187: Toxicity of indeno[1,2,3-cd]pyrene (CASnr: 193-39-5) to terrestrial organisms

Species	Species properties	A	Purity [%]	Soil type	pH	T [°C]	Organic matter [%]	Clay [%]	Exp. time	Crit.	Endpoint	Value test soil [mg/kg_{dw}]	Value standard soil [mg/kg_{dw}]	Ri	Notes	Reference
Insecta																
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	LC50	mortality	>910	>3346	2	12, 21, 78	Sverdrup et al., 2002
Folsomia fimetaria	23-26 d	Y		sandy loam	6.2	20±1	2.7	13	21 d	EC10	reproduction	>910	>3346	2	12, 21, 78	Sverdrup et al., 2002

Notes

Notes to aquatic toxicity studies:

1: Solvent 2% ethanol, caused no significant effects; light regime: 30 min. dark
2: Solvent: see 1; light regime 30 min. light from source with UV-A+B, total irradiation 400-800 mW/cm^2 for 30 min.
3: Complex medium with yeast extract, peptone and bactopeptamin
4: Minimal medium (without carbon sources)
5: Exposure in the dark
6: Exposure in simulated solar radiation (SSR), visible light:UV-A:UV-B = 100:10:1 with an intensity of 40 μmol/m^2/s
7: Unclear dose response curve, 14% effect at 450 μg/l
8: Solvent is methanol (<0.4 mg/l); lowest oxygen conc. In test 4.9 mg/l
9: *Sarotherodon mossambicus* is the same species as *Oreochromis mossambicus*
10: SSR; light regime: two cool white fluorescent one 350-nm and one 300-nm photoreactor lamps producing UV-A+UV-B; ratio visible:UV-A:UV-B =100:10:1 based on the number of photons, total intensity 40 μmol m^{-2} s^{-1}, this is comparable with natural sunlight (spectrum+intensity)
11: Actual concentration 70% of nominal at 0 h and 50% after the renewal period of 8 h; the results are presented as the calculated average between t=0 and t=8 h after renewal according to a first order kinetics loss model; first renewal after 12 h of incubation
12: Light regime: 12 h incubation in the dark, then constant light with "white fluorescent bulbs" used with a filter to eliminate UV-A+B (<390 nm); UV-A produced by blacklights, the intensity of the UV-A in the test was 765 μW/cm^2; UV-B radiation was filtered from the blacklight spectrum.
13: No UV-radiadion; visible light by "white fluorescent lamps"; light regime:16 h light and 8 h dark
14: UV-radiation at 31 μW/cm^2; ratio UV-A:UV-B=8:1; visible light by "white fluorescent lamps"; light regime: 16 h light and 8 h dark
15: UV-radiation at 60 μW/cm^2; ratio UV-A:UV-B=8:1; visible light by "white fluorescent lamps"; light regime: 16 h light and 8 h dark
16: UV-radiation at 117 μW/cm^2; ratio UV-A:UV-B=8:1; visible light by "white fluorescent lamps"; light regime: 16 h light and 8 h dark
17: Reproduction measured as total number of neonates after 6 broods
18: 23% effect at 1.9 μg/l
19: Reproduction as number of broods per animal and number of live young per brood per animal and as total number of young
20: Exposure time is total life-time; light regime: 16 h light and 8 h dark by "cool white fluorescent bulbs" 1100 lx
21: Growth measured as length of the first brood animals
22: Actual conc. 27-76%, average 48%; highest concentration (180 μg/l) is tested in separate test
23: Actual concentrations were 36-109% of initial concentrations (average 72%)
24: 8 hours exposure in minimal medium (without carbon sources), after which 18 hours exposure in complex medium with yeast extract, peptone and bactopeptamin followed
25: Photoperiod 12:12 light:dark
26: Constant illumination: UV-A+B and visible light, spectrum 91% equal to natural sunlight; UV-A and UV-B intensities are 108 and 6.7 μW/cm^2; total

intensity approximately equal to 0.5 and 1 m depth in an eutrophic lake; 24 h pre-exposure to anthracene in dark; oxygen concentration 6.9 mg/l

27: As 26, except oxygen concentration is 8.1 mg/L

28: As 26 except oxygen concentration is 5.0 mg/L

29: Based on mean actual concentrations, which were 72-95% of nominal (on average 84%); all test concentration remained constant within 10% over 48 h, while in the lowest test concentration the concentration at the end was almost three times the initial concentration; low concentrations of other PAHs detected at t=0

30: 48 h pre-exposure to anthracene in the dark, followed by 96 h anthracene+UV exposure, light regime: 24 h light during 96 h exposure; simulated sunlight produced by white and ultraviolet fluorescent bulbs; UV-B intensity is 14.8 μW/cm^2; UV-A (365±36nm):UV-B (310±34nm)=1.42

31: As 30 except UV-B intensity is 170 μW/cm^2

32: As 30 except UV-B intensity is 70 μW/cm^2

33: 24 h pre-exposure to anthracene in the dark, followed by 24 h anthracene+UV exposure, light regime: 24 h light during 24 h exposure; simulated sunlight: UV-B intensity is 150 μW/cm^2

34: Oxygen concentration minimal 2 mg/l; photoperiod 14:10 h light:dark with approximately 1000 lux

35: Concentrations were prepared from water accomodated fraction stock solutions, which were measured and reported as ranges

36: Light regime: 12 h light and 12 h dark with mixed fluorescent and natural light

37: Light regime: 16 h light and 8 h dark, illumination with "white light"

38: Light regime: 16 h light and 8 h dark, illumination with "gold light" with an energy output of $7.5 \cdot 10^{-5}$ W/m^2 at 670, $1.4 \cdot 10^{-3}$ W/m^2 at 550 nm and $1.0 \cdot 10^{-6}$ W/m^2 at 380 nm

39: Light regime: 16 h light and 8 h dark, at 1086 lux; results expressed as 57% of the water soluble fraction, solubility in test water is 34000 μg/l

40: Exposure 1 h in the dark followed by 1 h irradiation with 13 W/m^2 of UV light (320-400 nm; maximum 350 nm)

41: Exposure ca. 12 h in the dark followed by 1 h irradiation with 13 W/m^2 of UV light (320-400 nm; maximum 350 nm); mortality recorded immediately after irradiation period

42: Exposure ca. 0.5 h in the dark followed by 0.5 h irradiation with 7.5 W/m^2 of UV light (320-400 nm; maximum 350 nm), mortality recorded the next day

43: 4 m old sexually mature fish were exposed for two weeks to 6 and 12 μg/L with a 16:8 light:dark photoperiod. Then, one male and two females per aquarium were exposed to the same concentration and photoperiod for a spawning period of 6 w and to 12 and 20 μg/L for an additional period of 3 w. Eggs were collected and percent hatching and survival were recorded in water without anthracene during 96 h.

44: LT50 study, only 1 concentration tested; actual concentration is 67% of initial concentration; light regime: 24 h light; 24 h pre-exposure with chrysene without UV radiation; light intensity during test period: UV-A 120 μW/cm^2, UV-B= 25 μW/cm^2; UV-A: UV-B ratio= 4.12:1

45: Actual concemtration 41-81% of initial concentration, average 58%

46: Light regime: 16 h light and 8 h dark, illumination with "black light" with an energy output of $3.2 \cdot 10^{-7}$ W/m^2 at 670 nm, $1.9 \cdot 10^{-5}$ W/m^2 at 550 nm and $5.7 \cdot 10^{-3}$ W/m^2 at 380 nm

47: Light regime: 16 h light and 8 h dark, illumination with "cool white fluorescent light" with an energy output of $7.0 \cdot 10^{-5}$ W/m^2 at 670 nm, $2.3 \cdot 10^{-3}$ W/m^2 at 550 nm and $1.3 \cdot 10^{-4}$ W/m^2 at 380 nm
48: LT50 study, at the end of the 96-h test period no mortality effect was found for phenanthrene and dibenz[*a,h*]anthracene and less than 20% for benzo[*ghi*]perylene; simulated UV-A at 95 µW/m^2 and UV-B at 20 µW/m^2; 24 h preincubation with toxicant without light; only 1 concentration tested
49: Light regime 13:11 h light:dark
50: Effect concentration is expressed on basis of the initial measured concentration
51: Constant artificial illumination
52: Concentration based on actual concentrations; strong decrease in test concentration: 2% recovered after 96 h; initial concentration is 85% of nominal concentration; time weighted average concentration calculated
53: Constant illumination by incandescent light at 340 ft candles; effect concentrations are based on the geometric mean between the nominal and the 24 h measured concentrations
54: Actual concentration on average over 4 days 65% of initial concentration; based on actual concentrations
55: Tidal schedule with 0% exposure to air; animals from field population acclimated for 1 month
56: Actual concentration 54% of initial concentration, in static renewal test somewhat lower
57: 11% mortality at 10 µg/L and 16% at 50 µg/L
58: Photoperiod 14:10 h light:dark; LC50 estimated with Spearman & Karber
59: Method similar to the method of Korn et al., 1979
60: Concentration based on actual concentrations; strong decrease in test concentration: 32% recovered after 96 h; initial concentration is 103% of nominal concentration; time weighted average concentration calculated
61: Exposure 2 h in the dark followed by 1 h irradiation with 13 W/m^2 of UV light (320-400 nm; maximum 350 nm); mortality recorded immediately after irradiation period
62: Photoperiod 16:8 h light:dark with an intensity of 75-80 $\mu E \cdot m^{-2} \cdot s^{-1}$ produced by "cool white fluorescent" light; renewal on days 7 and 11; test performed in screw-capped erlenmeyers with about 1/5 headspace
63: Derived from the figures with mean, standard deviation and number of replicates
64: 48 h exposure in the dark followed by 2 h exposure under UV-A (365 nm, 247 µW/cm^2)
65: Exposure under white light (2500 lux, 74-92 µW/cm^2), 16 h light/8 h dark
66: 48 h exposure in white light (see 65) followed by 2 h exposure under UV-A (365 nm, 247 µW/cm^2)
67: Exposure under ambient laboratory lighting (UV-A <2 µW/cm^2); renewal every 8 h
68: Exposure with UV-A (320-400 nm), intensity 70.0±0.5 µW/cm^2 for anthracene and 69.0±1.0 µW/cm^2 for fluoranthene; renewal every 8 h; 4 h pre-exposed under ambient laboratory lighting
69: Laboratory fluorescent light with 581±140 lux and a photoperiod of 12:12 h light:dark
70: Laboratory ultraviolet light with 359-587 µW/cm^2 UV-A and 63-80 µW/cm^2 UV-B and a photoperiod of 12:12 h light:dark
71: Laboratory ultraviolet light with 783-850 µW/cm^2 UV-A and 104 µW/cm^2 UV-B and a photoperiod of 12:12 h light:dark
72: Outdoor natural UV irradiation: midday intensities UV-A 1273-2660 µW/cm^2 and UV-B 76-182 µW/cm^2 (only measured for mysid, grass

shrimp and inland silverside); tests performed in period with generally sunny weather between June and September
73: 12 h day/night photoperiod at 100 µE/m^2/s
74: Exposure without UV light
75: After 96 h exposure and 1 h reburial, animals were transferred to uncontaminated seawater and irradiated for 1 h with UV (UV-A 167 µW/cm^2 and UV-B 58 µW/cm^2)
76: After exposure in water only, transfer to sediment with overlying water to measure reburial EC50 after 1 h
77: Reburial in sediment was measured for 1 h after the 1 h UV irradiation
78: After 48 h exposure to fluoranthene 48 h exposure to UV light (UV-A: 782-829 µW/cm^2 and UV-B: 130-153 µW/cm^2)
79: After 48 h exposure to fluoranthene 48 h exposure to UV light (UV-A: 417-475 µW/cm^2 and UV-B: 61-72 µW/cm^2)
80: Light regime 16:8 light:dark
81: After exposure for 24 h at 16:8 light:dark, 2 h exposure under UV irradiation (295-365 nm; peak 340 nm; intensity 370±20 µW/cm^2) and a recovery period of 2 h; temperature during UV-radiation and recovery 23 °C
82: Mercury light source 330-800 nm, including some UV-A
83: Test with UV filter which blocked most radiation (75±14%) below 400 nm
84: Exposure in sunlight
85: Exposure ca. 0.5 h in the dark followed by 0.5 h irradiation with sunlight, mortality recorded the next day
86: Exposure 1 h in the dark, followed by 30 min sunlight, back to dark and mortality recording after 24 h
87: Visible light:UV-A:UV-B=100:10:1; UV-A intensity 62-68 µW/cm^2 and UV-B intensity 2-5 µW/cm^2, except in second experiment with *X. Laevis* with UV-B from 0.5 to 1.5 µW/cm^2
88: Simulated solar radiation; visible light (PAR):UV-A:V-B=100:10:1 and a total fluence rate of 100 µmol/m^2/s
89: UV irradiation: UV-A: 456.2±55 µW/cm^2; UV-B: 6.3±0.1 µW/cm^2; photoperiod of 12:12 h light:dark
90: Sediment test
91: Determined from presented data and LC50 with log-logistic dose-response relationship
92: Determined from presented data with log-logistic dose-response relationship
93: Exposed to UV light for 1 h at the end of the 10-d test (UV-A: 97 µW/cm^2 and UV-B: 2225 µW/cm^2)
94: Single concentration, no dose-response curve; SSR at 100 µmol·m^{-2}·s^{-1} based on integration of 290-700 nm
95: Cool fluorescent white light (100 µmol·m^{-2}·s^{-1})
96: Simulated solar radiation (100 µmol·m^{-2}·s^{-1})
97: After pretreatment with SSR for photomodification
98: Gold light (0.17 µW/cm^2 UV-B, 0.09 µW/cm^2 UV-A, 167.72 µW/cm^2 visible); 16:8 h light:dark
99: Fluorescent light (1.32 µW/cm^2 UV-B, 13.65 µW/cm^2 UV-A, 424.69 µW/cm^2 visible); 16:8 h light:dark
100: UV enhanced light (7.54 µW/cm^2 UV-B, 102.08 µW/cm^2 UV-A, 289.24 µW/cm^2 visible); 16:8 h light:dark
101: Dim yellow light >500 nm
102: Determined from data from figures and log-logistic dose-response relationship
103: Test performed in triplicate, average value

104: Under UV: 254 nm; $2.49 \cdot 10^{18}$ quanta/L·s
105: After exposure for 24 h at 16:8 light:dark, 2 h exposure under UV irradiation (295-365 nm; peak 340 nm; intensity 370±20 μW/cm^2) and 1 h of recovery in test medium; temperature increased by less than 2 °C during UV-radiation
106: Light intensity 400 foot candles
107: UV irradiation: UV-B (peak 313 nm; range: 294-400 nm): 2.3 kJ/m^2/h for 2 times 2 h per day
108: After photomodification UV-B (290-320 nm); 40 μmol·m^{-2}·s^{-1} for 24 h (anthracene), 48 h (phenanthrene) or 96 h (benzo(a)pyrene) 25 μmol·m^{-2}·s^{-1} for 5 d (fluoranthene, naphthalene) or 7 d (pyrene)
109: Visible light; light regime: two cool white fluorescent lamps
110: SSR: ratio visible:UV-A:UV-B=100:10:1 based on the number of photons, total intensity varying from 20 to 60 μmol·m^{-2}·s^{-1}
111: SSR:total intensity 40 μmol·m^{-2}·s^{-1}; UV-B varying from 1 to 4% of visible light
112: Visible light, total intensity varying from 60 to 150 μmol·m^{-2}·s^{-1}
113: After photomodification UV:B 6 μmol·m^{-2}·s^{-1}) until less than 10% of the parent compound remained
114: After photomodification UV;B (290-320 nm; 25 μmol·m^{-2}·s^{-1}) for various time periods
115: Lumistox test
116: Microtox test with 'minimal salts medium'
117: Single concentration, no dose-response curve; natural sunlight for 16 h per day visible:UV-A:UV-B 200:10:1, 1700 μmol·m^{-2}·s^{-1}
118: After photomodification for 7 d in natural sunlight for 16 h per day visible:UV-A:UV-B 200:10:1, 1700 μmol·m^{-2}·s^{-1}
119: After photomodification for 16 d in natural sunlight for 16 h per day visible:UV-A:UV-B 200:10:1, 1700 μmol·m^{-2}·s^{-1}
120: After photomodification UV;B (290-320 nm; 20 μmol·m^{-2}·s^{-1})
121: In the third experiment no effect was observed at the highest tested concentration of 7.2 μg/L, this value is considered in the geometric mean as NOEC because it is higher than the two NOECs from the other experiments
122: Light regime: 12 h incubation in the dark, then constant light with "white fluorescent bulbs" used with a filter to eliminate UV-A+B (<390 nm); UV-A produced by blacklights, the intensity of the UV-A in the test was 410 μW/cm^2; UV-B radiation was filtered from the blacklight spectrum.
123: Light regime: 12 h incubation in the dark, then constant light with "white fluorescent bulbs" used with a filter to eliminate UV-A+B (<390 nm); UV-A produced by blacklights, the intensity of the UV-A in the test was 406 μW/cm^2; UV-B radiation was filtered from the blacklight spectrum.
124: Light regime: 12 h incubation in the dark, then constant light with "white fluorescent bulbs" used with a filter to eliminate UV-A+B (<390 nm); UV-A produced by blacklights, the intensity of the UV-A in the test was 218 μW/cm^2; UV-B radiation was filtered from the blacklight spectrum.
125: Light regime: 12 h incubation in the dark, then constant light with "white fluorescent bulbs" used with a filter to eliminate UV-A+B (<390 nm); UV-A produced by blacklights, the intensity of the UV-A in the test was 125 μW/cm^2; UV-B radiation was filtered from the blacklight spectrum.
126: Data from two separate tests combined
127: Geometric mean of three tests
128: Tidal schedule with 33% exposure to air; animals from field population acclimated for 1 month

129: Tidal schedule with 66% exposure to air; animals from field population acclimated for 1 month
130: Light regime during hatching: 16:8 light:8 fluorescent light with UV-A (67.94±9.02 μW/cm^2 at 365±36 nm) and UV-B (6.71±0.81 μW/cm^2 at 310±34 nm)
131: Light regime during hatching: 16:8 light:dark gold fluorescent light >500 nm
132: Concentrations based on actual concentrations; actual concentrations ranged from an average value of 87% after preparation of the solution to just above or below the detection limit before renewal; concentrations calculated as half the initial concentration (average recovery times the nominal concentration)
133: Concentrations based on nominal concentrations; actual concentrations ranged from 78 to 142% with an average value of 118%; lowest NOEC is the same on basis of nominal and actual concentrations
134: Concentrations based on actual concentrations; actual concentrations ranged from an average value of 83% after preparation of the solution to just above or below the detection limit before renewal; concentrations calculated as half the initial concentration (half of the average recovery times the nominal concentration)
135: Exposure ca. 12 h in the dark followed by 30 min irradiation with 13.5 W/m^2 UVA (>320, <400nm, peak 350 nm); mortality recorded immediately after irradion period
136: Only one concentration tested
137: Concentrations based on actual concentrations; strong decrease in test concentration: 7% recovered after 96 h; initial concentration is 102% of nominal concentration; time weighted average concentration calculated
138: Strong decrease in test concentration: 22% recovered after 96 h; initial concentration is 95% of nominal concentration
139: Renewal every 12 h; constant light from 1.5 meter distance
140: Photoperiod 14:10 h light:dark at 200 μE/m^2/s
141: Precipitate formed
142: 875 to 1000 ft-c from cool-white fluorescent bulbs; growth rate from 1 to 4 d seems not to be affected (possibly due to loss of compound)
143: Light regime: continuous light at 9.514-19.028 W·m^{-2}·s^{-1} (200-400 foot candles). Concentrations declined significantly in 14 d. Acenaphthene, fluorene, naphthalene, and pyrene almost completely dissappeared, benz[a]anthracene, phenanthrene, chrysene, and fluoranthene by 85, 77, 62, and 49%, respectively
144: Light regime 6:18 sunlight:dark
145: Light regime 16:8 h light:dark (10-20 μE/m^2/s; 50-100 ft-c)
146: Light regime 16:8 h light:dark (1000 lux)
147: Concentration declined to undetectable levels after 96 h; probably based on measured initial concentrations
148: Concentration declined to undetectable levels after 72 h; probably based on measured initial concentrations
149: Concentration declined to undetectable levels after 48 h; probably based on measured initial concentrations
150: Especially higher concentrations declined in 48 h, lower concentration were 0.5 μg/L; solvent control was significantly different from seawater and no information on the amount of ethanol is given
151: Irradiated throughout the experiment with UV-A light: (320-400 nm; maximum at 365 nm) at 2.5 W/m^2
152: Concentrations based on actual concentrations; renewal was every 3 days; after 2 and 3 days phenanthrene was not detected anymore;

concentrations calculated as half the initial concentration (average recovery times the nominal concentration)

153: Average concentrations over 4 days estimated to be 26% of initial concentrations, based on measured time-weighted average concentrations

154: Pre-exposure of 24 h followed by 30 min irradiation with natural sunlight on a clear day: UV intensity 4245 μW/cm^2; UV-B intensity 484 μW/cm^2

155: Pre-exposure of 24 h followed by 60 min irradiation with natural sunlight on a partly cloudy day: UV intensity 2441 μW/cm^2; UV-B intensity 278 μW/cm^2

156: Pre-exposure of 24 h followed by 60 min irradiation with natural sunlight on a complete cloudy day: UV intensity 1657 μW/cm^2; UV-B intensity 189 μW/cm^2

157: Pre-exposure of 24 h followed by 45 min irradiation with natural sunlight on a clear day covered with a filter for UV-B (70-75% reduction in 285-315 nm)

158: Pre-exposure of 24 h followed by 45 min irradiation with natural sunlight on a clear day covered with a filter for UV-A and UV-B (70-75% reduction in 285-380 nm)

159: Pre-exposure of 24 h followed by 45 min irradiation with natural sunlight on a clear day covered with a filter to reduce the total spectrum (>285 nm): UV intensity 1314 μW/cm^2

160: Artificial light with low UV emission used

161: Artificial light simulated sunlight with 30-65 μW/cm^2 UV-A (310-420 nm; peak at 350 nm) and 0.5-5 μW/cm^2 UV-B (250-400 nm; peak at 290 nm); Test result based on nominal concentrations, measured concentrations were > 80% of nominal

162: Exposure without UV light; determined from data from two ECx data and log-logistic dose-response relationship; Test result based on nominal concentrations, measured concentrations were > 80% of nominal

163: Substance dissolved in acetone, added to the bottom of the beaker and acetone was evaporated. To prepare the highest test solution, dilution water was added and series of test concentrations were prepared from this highest test concentration. For the volatile substances this may have caused substantial loss, while the nominal concentration of 1024 μg/L substantially exceeded the solubility of several substances.

164: Light regime 16:8 light:dark; mercury lamps with 150 $\mu E \cdot m^{-2} \cdot s^{-1}$

165: Fluorescent light at 4-8 klux; to some of the air-tight flasks enrichment with HCO_3^- was added in different quantities to control pH

166: From a population pre-exposed to 7.9±0.8 μg/L during breeding and 6.2±0.8 μg/L during hatching and rearing

167: 6000-8000 lux on the level of the solutions

168: Photoperiod 16:8 h light:dark at less than 500 lux

169: Constant illumination at 4000 lux; continuously aerated in open system

170: Values based on nominal concentrations; actual concentrations were decreased by 20 to 30% initially and by 32 to 52% at the end of the 96 h toxicity studies. Average values were decreased by 76% in the chronic daphnid study, 51% in the chronic chironomid study, and 66% in the bluegill sunfish study

171: Based on actual concentrations by correcting nominal concentrations for average recovery

172: In the dark for 2 h, then irradiated with fluorescent UV-lamps at 975-1000 μW/cm^2 with maximum at 312 nm for 8 h

173: In the dark for 2 h, then irradiated in sunlight at 407-1428 μW/cm^2 >290 nm for 8 h

174: In the dark for 2 h, then irradiated with fluorescent UV-lamps at 975-1000 μW/cm^2 with maximum at 375 nm for 8 h
175: Light regime: 16:8 h light:dark by fluorescent bulbs at 1100 lx; measured concentrations were 68-90% (acute) and 110-168% (chronic) of nominal; values are expressed as mean measured concentrations
176: Different from solvent control (acetone), not different from seawater control, i.e. acetone had a positive effect
177: Concentrations based on actual concentrations; actual concentrations were 45-90% of nominal by GC-FID and 55-90% by GC-MS; concentrations calculated as 70% of the nominal concentration
178: Photoperiod of 16:8 h light:dark under cool white fluorescent lamps at an intensity of 28 lx
179: Laboratory fluorescent light with UV radiation very similar to sunlight
180: Fluorescent light with 9.70±0.66 μW/cm^2 UV-A (365±36 nm) and 3.37±0.22 μW/cm^2 UV-B (310±34 nm) with a photoperiod of 16:8 h light:dark
181: Ultraviolet light with 397±35.1 μW/cm^2 UV-A (365±36 nm) and 134±22.8 μW/cm^2 UV-B (310±34 nm) with a photoperiod of 16:8 h light:dark
182: UV lacking fluorescent laboratory lighting with a photoperiod of 12:12 h light:dark
183: Continuous visible light with a total visible fluence rate of 100 μmol/m^2/s
184: Continuous simulated solar radiation with a total visible fluence rate of 100 μmol/m^2/s
185: 2 hour a day under UV exposure with UV-A at 172-180 μW/cm^2 and UV-B at 4.2-6.3 μW/cm^2; statistical analysis unclear
186: After photomodification with 20 μmol/m^2/s UV-B (comparable to sunlight) for 7 d
187: Laboratory ultraviolet light with 283 μW/cm^2 UV-A and 47 μW/cm^2 UV-B and a photoperiod of 12:12 h light:dark
188: Laboratory ultraviolet light with 612 μW/cm^2 UV-A and 82 μW/cm^2 UV-B and a photoperiod of 12:12 h light:dark
189: Laboratory fluorescent light and a photoperiod of 16:8 h light:dark
190: Laboratory ultraviolet light with 465-724 μW/cm^2 UV-A and 68-109 μW/cm^2 UV-B and a photoperiod of 16:8 h light:dark
191: Laboratory ultraviolet light with 7 μW/cm^2 UV-A and a photoperiod of 16:8 h light:dark
192: Laboratory ultraviolet light with 64 μW/cm^2 UV-A and a photoperiod of 16:8 h light:dark
193: Laboratory ultraviolet light with 360 μW/cm^2 UV-A and a photoperiod of 16:8 h light:dark
194: Laboratory ultraviolet light with 676 μW/cm^2 UV-A and a photoperiod of 16:8 h light:dark
195: Laboratory ultraviolet light with 1788 μW/cm^2 UV-A and a photoperiod of 16:8 h light:dark
196: Fluorescent light with a photoperiod of 16:8 h light:dark and intensity of 270 lux
197: Derived from the figures with mean, standard errror and number of replicates
198: Test performed outdoors in sunlight with 200-1650 μW/cm^2 UV-A and 45-320 μW/cm^2 UV-B
199: FETAX test
200: Test performed with 250 μW/cm^2 UV-A 320-400 nm (6.5 lx); peak at 365 nm

201: Test performed with continuously irradation with 2100 μW/cm^2 visible light 400-750 nm (1220 lx)
202: Exposure under normal illumination
203: Photoperiod 15:9 h light:dark by white fluorescent lamps with an intensity of 40 μE/m^2/s; based on nonexponential growth after 7 d; tested concentrations above aqueous solubility except for pyrene and the two lowest concentrations of naphthalene
204: Exposure with UV-A (320-400 nm), intensity 64.7±1.0 μW/cm^2; renewal every 8 h; 72 h pre-exposed under ambient laboratory lighting
205: 16:8 light:dark photoperiod with fluorescent light; at the end of the exposure period clams were transferred to beakers with fresh sediment
206: 16:8 light:dark photoperiod with fluorescent light, followed by 1 h of UV exposure in clean seawater with 13 W/m^2 UV-A (320-400 nm) and 2.5 W/m^2 UV-B (290-330 nm). Sunny summer day in Hamilton NZ: 35 W/m^2 UV-A and 4.3 W/m^2 UV-B; at the end of the exposure period clams were transferred to beakers with fresh sediment
207: Calculated without the highest treatment of 500 μg/L
208: Exposure ca. 12 h in the dark followed by 30 min irradiation with 13.5 W/m^2 UVA (>320, <400nm, peak 350 nm); mortality recorded after a recovery period of 24 h in water with food in the dark; data after 11 days for adult emergence are not suitable because control mortality is not well-defined
209: Time weighted concentrations from exponentially decreasing trend presented in figure used for calculations; concentrations above aqueous solubility; maximum concentration added with 0.04% acetone
210: Light regime: continuous light at 9.514-19.028 W·m^{-2}·s^{-1} (200-400 foot candles)
211: Results from second test
212: One duplicate significantly reduced, the other not
213: Photoperiod 12:12 h light:dark at 6000 lux; substance applied in 50 ppb Tween 20 acetone solution, acetone evaporated, culture medium added and autoclaved for 20 min; growth rate recalculated from generation time; condition of exponential growth phase was probably met
214: Solution contains 21 mg EDTA/L; fluorescent light used
215: Results from third test
216: Stock solution measured; results based on nominal concentration
217: Radiolabelled compound; aqueous concentrations measured; results based on nominal concentration; loss up to 50% by the end of the experiment
218: Based on measured concentrations; average measured concentrations exceeded nominal concentrations; therefore, it is estimated that reported measured concentrations may be overestimated by 25%.
219: Based on measured concentrations; before renewal average measured concentrations declined by an average of 25.4% per day
220: Based on measured concentrations; before renewal average measured concentrations declined by an average of 18.1% per day
221: Based on measured concentrations; before renewal average measured concentrations declined by an average of 17.6% per day
222: First 12 h dark, then continuous visible light at ~100 μE·m^{-2}·s^{-1}
223: First 12 h dark, then combination of visible and UV-A (~785 μW·cm^{-2}) light continuously
224: First 12 h dark, then continuous visible light at ~75 μE·m^{-2}·s^{-1}
225: First 12 h dark, then combination of visible and UV-A (~805 μW·cm^{-2}) light continuously
226: UV-A (320-400 nm) ranging from 50.5 (bottom) to 82.5 μW·cm^{-2} (top); UV-B (285-320 nm) ranging from 3.6 to 8.65 μW·cm^{-2}

227: Benthic species tested in water-only exposure
228: 96 h exposure to fluoranthene subsequently followed by expsoreure to ultraviolet light in fresh Lake Superior water at an UV-A (310-390 nm) intensity of 16.6 μW/cm^2
229: 96 h exposure to fluoranthene subsequently followed by expsoreure to ultraviolet light in fresh Lake Superior water at an UV-A (310-390 nm) intensity of 33.5 μW/cm^2
230: 96 h exposure to fluoranthene subsequently followed by expsoreure to ultraviolet light in fresh Lake Superior water at an UV-A (310-390 nm) intensity of 75.2 μW/cm^2
231: Test solutions prepared from saturated solutions in medium, which were not measured but compared with aqueous solubility data and calculated from the aqueous solubility
232: Weak dose-response relationship
233: In the presence of sand
234: Transferred to clean natural water afterwards either without treatment or followed by irradiation for 15 min by 370 kJ/m^2 UV light
235: Determined 5 to 6 months after hatching; spacing between concentrations is a factor of 10
236: Exposure to sunlight with mean fluence of $1.2 \cdot 10^{-2}$ mW/mm^2 UVA (320-400 nm) and $1 \cdot 10^{-4}$ mW/mm^2 UVB (290-320 nm)
237: Test was set up as bioconcentration experiment with fish eggs and larvae
238: *Tanytarsus dissimilis* is the same species as *Paratanytarsus parthenogeneticus*
239: Experiments are in duplicate
240: Exact values read from figure are more precise than the rounded off values in the table
241: Photoperiod 16:8 light:dark by fluorescent lamps with an intensity of 28 lm at the water surface
242: Fluorescent light with an intensity of 13-18 W/m^2 (22-33 kLux) equivalent to 350 μE·m^{-2}·s^{-1} at the surface of the test vessels
243: Algal species is from the Baltic Sea but tested at 30 °C and 0.2 psu
244: Continuous fluorescent light (PAR 380-690 nm) at 12 W·m^{-2}
245: Continuous fluorescent light (PAR 380-690 nm) at 33 W·m^{-2}
246: Continuous fluorescent light (PAR 380-690 nm) at 48 W·m^{-2}
247: Continuous fluorescent light (PAR 380-690 nm) at 64 W·m^{-2}
248: Aerated with 0.1% CO_2; pH increased to 9.5±0.4; concentrations dropped with half lifes of 2 h for anthracene and 7 h for phenanthrene at PAR of 64 W·m^{-2} although it was determined in a separate unaerated experiment that this did not influence the percentage inhibition much; TWA values are only 11% and 35% for anthracene and phenanthrene respectively
249: Results based on initial concentrations, nominal if measured concentrations were more than 80%, otherwise actual concentrations; loss in 24 h was more than 20% for anthracene, benz[a]anthracene and pyrene
250: Gold light (0.17 μW/cm^2 UV-B, 0.09 μW/cm^2 UV-A, 167.72 μW/cm^2 visible); 16:8 h light:dark
251: Test performed in proteose-peptone-yeast salts (PPYS) complex medium
252: Read from figure
253: After exposure for 1 h, transferred to filtered sea water with exposure to UV (UVA (320-400 nm) 2.095 mW/cm^2 and UVB (280-320 nm) 0.325 mW/cm^2) for 4 h and recovery in filtered sea water for 24 h in the dark
254: After exposure for 1 h, transferred to filtered sea water with exposure to sunlight (UVA (320-400 nm) 4.914 mW/cm^2 and UVB (280-320 nm)

0.581 mW/cm^2) for 4 h and recovery in filtered sea water for 24 h in the dark

255: After exposure for 1 h, transferred to filtered sea water with exposure to UV (UVA (320-400 nm) 2.098 mW/cm^2 and UVB (280-320 nm) 0.313 mW/cm^2) for 4 h and recovery in filtered sea water for 24 h in the dark

256: After exposure for 1 h, transferred to filtered sea water with exposure to UV (UVA (320-400 nm) 1.979 mW/cm^2 and UVB (280-320 nm) 0.276 mW/cm^2) for 4 h and recovery in filtered sea water for 24 h in the dark

257: After exposure for 1 h, transferred to filtered sea water with exposure to UV (UVA (320-400 nm) 1.455 mW/cm^2 and UVB (280-320 nm) 0.196 mW/cm^2) for 4 h and recovery in filtered sea water for 24 h in the dark

258: Photoperiod 16:8 h light:dark with cool-white fluorescent light (~36 μmol/m^2/s; ~400-700 nm); performed in glass bottles with Teflon lined caps

259: Visible light+UVA (320-400 nm) at 56 and 4.6 μmol/m^2/s

260: Visible light+UVA (320-400 nm)+UVB (290-320 nm) at 61, 4.4, and 0.45 μmol/m^2/s

261: Effect concentration is expressed on basis of the initial actual concentration

262: At the lowest biomass tested (50 eggs/mL). Higher biomasses lead to reduced concentration and less toxicity. Concentration decreased by 68.4% in 1 h.

263: At the second lowest biomass tested (100 eggs/mL). Higher biomasses lead to reduced concentration and less toxicity. Concentration decreased by 68.4% in 1 h.

264: At the two lowest biomasses tested (50 and 100 eggs/mL). Higher biomasses lead to reduced concentration and less toxicity. Concentrations decreased by 68.4 and 75.6% in 1 h.

265: At the all biomasses tested (0, 50, 100, 200 and 400 embryos/mL). Concentration decreased by 78.1 in control (water only) and 85.3, 89.7, 90.1, and 92.2% in the tests with embryos.

266: Based on measured concentrations

267: Value extrapolated outside the test range (40-290 μg/L)

268: 0.024 ly·min^{-1} photosynthetically active radiation (PAR)

269: Concentrations based on initial concentrations; all concentrations declined by about 25-50% in 24 h before renewal

270: Uncertainty about reported concentration (8-12 ppb; 10^{-9} mg/ml is also reported); no control with water has been incorporated, only a control containing BSA

271: Exposure period followed by a recovery period of 24 h in clean seawater

272: Photoperiod 14:10 h light:dark by cool daylight lamps (380-780 nm, PAR) with an intensity of 70 μE/m^2/s

273: Average of measured concentrations <80% of nominal, unclear if results are based on measured or nominal concentration therefore not recalculated

274: Constant light by fluorescent light with an intensity of 350 lux; renewal every 12 h

275: Based on nominal concentrations

276: Initial concentrations on average 60% of nominal, concentrations after 48 h were below detection limit; cross-contamination with other PAHs not excluded

277: Based on average measured concentration in the highest test concentration; initial concentrations varied from 72 to 81%,
278: Initial concentrations on average 50 to 60% of nominal, concentrations after 48 h were below detection limit; cross-contamination with other PAHs not excluded
279: Under fluorescent light at an intensity of 3500-4000 lux, no UV light; growth curves are presented but axis is inconclusive
280: Under fluorescent light at an intensity of 3500-4000 lux and 1 hour a day under UV exposure with UV-A at 172-180 μW/cm^2 and UV-B at 4.2-6.3 μW/cm^2
281: Under fluorescent light at an intensity of 3500-4000 lux and 2 hour a day under UV exposure with UV-A at 172-180 μW/cm^2 and UV-B at 4.2-6.3 μW/cm^2
282: Under fluorescent light at an intensity of 3500-4000 lux and 3 hour a day under UV exposure with UV-A at 172-180 μW/cm^2 and UV-B at 4.2-6.3 μW/cm^2
283: Under fluorescent light at an intensity of 3500-4000 lux and 4 hour a day under UV exposure with UV-A at 172-180 μW/cm^2 and UV-B at 4.2-6.3 μW/cm^2
284: Yellow light
285: Performed under continuous light with an intensity of 90 μE/m^2/s
286: Based on mean actual concentrations, initial concentration were 40-94% of nominal; all test concentration decreased by 30-35% over 48 h (on average 33%); low concentrations of other PAHs detected at t=0
287: Based on mean actual concentrations, initial concentration were 66% of nominal or higher; all test concentration decreased by 28-47% between renewals (2 d; on average 37%)
288: Based on mean actual concentrations, initial concentration were close to nominal (80% or higher); all test concentration decreased by 7-21% over 48 h
289: Exposure under UV light 0.08 W·m^{-2} (UVA) and 0.119 W·m^{-2} (UVB)
290: Based on mean actual concentrations, initial concentration were less than 50 to 84% of nominal; all test concentration decreased by 35-78% over 48 h (on average 53%)

Notes to terrestrial toxicity studies:

1: Route of exposure is through food (mixture of poplar-, maple-, end birch-leaves at a ratio of 3:2:1) added with 10% DOKO dogfood at a ratio of 9:1; food was renewed every week; added in acetone and acetone left to evaporate
2: LOEC, significant effect; not clear if other concentrations were tested as well; 60% of maximum water carrying capacity; spiked with acetone to quartz sand and sand added to the soil at a maximum percentage of 10% (dry weight); soil with benzo[*a*]pyrene aged for 1 month
3: Light regime: 16 h light and 8 h dark at an intensity of 400 lux; 75% moisture; 40% of maximum water carrying capacity; soil with benzo[*a*]pyrene aged for 1 week; benzo[*a*]pyrene with similar purity from a different supplier was slightly less toxic (no details) on both weight gain and cocoon production
4: Light regime: 12 h light and 12 h dark
5: Exposure through food (poplar leaves); food was renewed every week; added in acetone and acetone left to evaporate
6: Growth as post emergence of seedlings (OECD 208)
7: Photoperiod 16:8 h light:dark at an intensity of 6500 lux produced by fluorescent bulbs

8: Estimated half-lifes were 1.6 and 1.3 days for the low (0.5 mg/kg) and high (25 mg/kg) concentration, concentrations were below detection limit of 0.02 mg/kg after 20 d; no significant effect during the whole 80 day test period; CO_2 was measured on d 1.5, 3, 5, 7, 11, 17, 25, 32, 40, 52, 60, 66, 74, 80 and inorganic nitrogen on d 7, 14, 21, 28, 35, and 56.
9: Recovery only 2.4-14% of nominal after the 21 d period
10: Test performed in the dark
11: Recovery 48-89% after 14 d; average actual concentration after 14 days at the highest tested concentration of 1000 mg/kg was 885 mg/kg
12: Photoperiod 12:12 h light:dark under lighting of about 400-800 lux
13: Continuous outside illumination of about 400-800 lux
14: Light regime: 16 h light and 8 h dark; illumination with 400 W lamp emitting light with wavelength spectrum 310-780 nm with <1% UV; photo flux density 300 $\mu E \cdot m^{-2} \cdot s^{-1}$
15: Average recovery of two to three concentrations after 21 days was 6% for napthalene, 32% for acenaphtene, 33% for acenaphthylene and 85% for anthracene, relative to the initial measured concentrations
16: Soil was aged for 10 days before toxicity testing
17: Soil was aged for 40 days before toxicity testing
18: Soil was aged for 120 days before toxicity testing
19: Spiked by mixing with a known quantity of dried soil and mixed with soil to obtain the final concentration
20: Based on time weighted average concentrations; initial recovery and loss over 28 days were 84% and 4% for pyrene, 103% and 11% for fluoranthene, 99% and 96% for phenanthrene, and 80% and 84% fluorene, respectively
21: Based on initial measured concentrations
22: Values are recalculated to time weighted average concentrations
23: Average recovery of one low and high concentration after 21 days was 33% for fluorene, 72% for phenanthrene, 83% for fluoranthene and 79% for pyrene, relative to the initial measured concentrations; 10 d measured as well
24: Test result based on nominal concentrations, initial measured concentrations were on average 99% and ranged from 93% to 112% of nominal values
25: Photoperiod 16:8 light:dark at an intensity of 47.3 $\mu mol/m^2/s$
26: Exposure for 21 d in soil, 2 d counting/extraction, 6 d in drought chamber at 98.2% RH and 2 d at 100% RH
27: Solvent control performed, test performed at approximately 100% of the water holding capacity
28: Freshwater species tested in soil
29: 50 soils were tested, the one with the lowest LC50 is reported here; dichloromethane was used as carrier, evaporated for 24h; soil analysed before addition of phenanthrene; PAH contaminated soil, EC50 not corrected for background
30: 28% reduction but not significant compared with control; at 100 mg/kg no reduction was observed after 21 days exposure
31: Test result based on nominal concentrations
32: Spiked with 20 ml toluene per kg dry soil and left to volatilize for 3 h
33: According to ISO guideline 11268-2
34: According to ISO guideline 11267
35: According to ISO guideline 11269-2
36: According to ISO guideline 17155
37: According to ISO/DIS guideline 15685

38: Test result based on nominal concentrations, measured concentrations were > 75% of nominal
39: 16 h/d 130 µmol/s/m^2 PAR; at 100 mg/kg 22 to 41 % reduction
40: Spiked with chlorinated hydrocarbon (unclear which solvent and in what amount) and left to volatilize for only 2 h under a hood
41: Determined from means and standard deviation from figures and number of replicates (n=5)
42: Constant light intensity
43: Value determined with the trimmed Spearman-Karber method is considered unreliable as it clearly lies below the 50% effect level
44: Method to determine NOEC was not mentioned; EC10 value might be substantially lower but could not be determined, because weight loss occured at higher concentrations; EC10 for absolute weight is in the order of 9 mg/kg
45: Test result based on nominal concentrations, measured concentrations were > 80% of nominal
46: Time weighted average concentrations over one week were 57% for fluorene, 29% for phenanthrene, 63% for fluoranthene, 82% for benzo[a]anthracene and 101% for benzo[a]pyrene
47: Determined from data from figures and/or tables and log-logistic dose-response relationship
48: Determined from two ECx data and log-logistic dose-response relationship
49: Soil was renewed every week; average recovery of samples at the beginning and end of the week in this test system was 75% (64-84%); concentrations corrected for average recovery
50: Soil was renewed every week; average 82-93% of nominal concentration; 37% reduction but not significant compared with control
51: Soil was renewed every week; average 83-84% of nominal concentration; 36% reduction but not significant compared with control
52: Test result based on nominal concentrations, initial recovery less than 50%
53: Stimulation of growth at lower concentration up to 0.05 mg/kg$_{dw}$; subtance added in acetone, left to evaporate for 24 h
54: EC20 divided by a factor of three
55: Light regime 12:12 h light:dark at 400 lux
56: 16:8 h photoperiod (light:dark); subtance added in acetone, evaporated in a fume hood for 7 d; rehydrated to 60% of water holding capacity
57: Light regime 16:8 h light:dark
58: Soil stored at 4 ºC for one month
59: Spiked with acetone to the total amount of quartz sand and acetone left to evaporate
60: Spiked with small amount of acetone or chloroform to the dry soil, and solvent left to evaporate
61: Spiked with acetone to the dry soil, acetone left to evaporate and water added
62: Soil was renewed every week; average recovery of samples at the beginning and end of the week in this test system was 94% (84-115%)
63: Carrier acetone, evaporated for at least 24h at 28-30 °C before start experiment; natural sunlight 12h/day; unclear if OM or OC is reported; results not clear enough (no statistics performed) to lable the NOEC as reliable values
64: 12:12 h light:dark
65: Experiment performed in a system containing 30 g dry sand brought to 20±2% moisture. The test substrate was added in acetone to horse manure with a moisture content of 75% on top of the sand. It is unclear

whether the concentration indeed relate to the horse manure only and whether the concentrations are expressed on dry weight.

66: Soil contains 38% sand and 60% clay and silt
67: Subtance added in acetone, evaporated overnight
68: Exposure for 21 d in soil, 2 d counting/extraction, 7 d in drought chamber at 97.8% RH and 2 d at 100% RH
69: Spiked to quartz sand before application
70: Test according to OECD 207
71: Two days of seed germination and seedling emergence followed by 14 d exposure, photoperiod 16:8 h light:dark at least 7000 lux
72: Continuous light at 250-500 lux
73: EC10 calculated from data presented in figures; calculated EC10 is in accordance with the estimated NOEC of 192 mg/kg presented by the authors
74: Light regime 16:8 h light:dark at ca. 600 lux; 1% cow dung added
75: Cocoons observed for 35 d after test
76: Cocoon production in control is significantly higher than in the tests with fluoranthene and combined exposure
77: Cocoon production in next concentration of 100 mg/kg almost stopped, while equal at 1 and 10 mg/kg
78: Subtance added in acetone, evaporated under a fume head for 24 h
79: Exposure for 21 d in soil, 2 d counting/extraction, 7 d in drought chamber at 98.2% RH and 2 d at 100% RH
80: Light regime: 12 h light and 12 h dark at an intensity of 400-800 lux
81: According to draft OECD guideline
82: Per replicate 100 live adult springtails (*Folsomia fimetaria*) were added as food items
83: Similar to the ISO (1997) guideline
84: Based on draft ISO guideline; highest nominal concentration tested was 2800 mg/kg; results expressed as average of measured concentration at start and end of the exposure period; photoperiod 16:8 h light:dark
85: Concentrations at the end of the experiment were at least 70% of the actual initial concentrations for anthracene, benzo[a]anthracene, pyrene and benzo[a]pyrene, but only 1-10% for naphthalene and 5 to 35% for phenanthrene
86: Value is geomean of reported range
87: Results from second experiment
88: Results from third experiment

Notes to benthic toxicity studies:

1: Sediment was aged for one-and-a-half months in the dark at 4 ºC before use
2: Dark and UV-A (108.4±1.3 μW/cm^2)
3: Stored for 5 w after spiking
4: Stored for 60 d after spiking
5: Stored for 18 m after spiking
6: Stored for 3 w after spiking
7: Average loss over 10 days was 23%
8: Values are based on average measured concentrations
9: Light intensity 50 μmol quanta/m^2/s by mercuy lamps; UV filters used to minimise photodegradation
10: Stored for 7 d after spiking
11: Test according to OECD 218
12: Read from figure

13: Only initial sediment concentrations were measured, which were 71-100% of nominal
14: 12:12 h light:dark
15: Determined under normoxic conditions (DO of 5.91 mg/L, 82.1% saturation); salinity 27.2‰; placed under fluorescent lights
16: Determined under moderately hypoxic conditions (DO of 3.62 mg/L, 50.3% saturation); salinity 25.5‰; placed under fluorescent lights
17: Determined under normoxic conditions (DO of 6.86 mg/L, 95.4% saturation); salinity 29.2‰; placed under fluorescent lights
18: Determined under moderately hypoxic conditions (DO of 3.96 mg/L, 56.0% saturation); salinity 28.6‰; placed under fluorescent lights
19: Large difference between percetages organic carbon and organic matter: 0.38% oc and 2.4% om
20: Light regime 16 h light/8 h dark; mercury light source mimicking natural light; spiked with 0.3% v/v acetone
21: Effect is most pronounded with females, effect is absent (anthracene) or almost absent (phenanthrene) with males
22: Sediment (muddy sand) with overlying seawater (28 o/oo) exposure for 10 days; 1 h reburial in control sediment
23: 1 h UV radiation after 10 days exposure and 1 h reburial: UV-A (321-400 nm) 315±36 μW/cm2 and UV-B (280-320 nm) 128±12 μW/cm2 and visible light (401-700 nm) 3400±278 μW/cm2; after irradiation again 1 h reburial
24: L(E)C50 values given as μmol/g OC (2.58%) is converted to mg/kg sediment
25: 24 h exposure in sediment was followed by 3 h exposure in sediment in the presence of food (algae)
26: Sediment was aged for 10 days before toxicity testing
27: Gold light (0.17 μW/cm2 UV-B, 0.09 μW/cm2 UV-A, 167.72 μW/cm2 visible); 16:8 h light;dark
28: Fluorescent light (1.32 μW/cm2 UV-B, 13.65 μW/cm2 UV-A, 424.69 μW/cm2 visible); 16:8 h light;dark
29: UV enhanced light (7.54 μW/cm2 UV-B, 102.08 μW/cm2 UV-A, 289.24 μW/cm2 visible); 16:8 h light;dark
30: Two experiments, no clear dose response curves; high control mortality for *Diporeia* sp. and low growth rate constant for Hyalella in experiment 1; yellow light >500 nm
31: Stored for 13 d after spiking
32: Stored for 27 d after spiking
33: Stored for 41 d after spiking
34: Stored for 55 d after spiking
35: Stored for 69 d after spiking
36: Stored for 83 d after spiking
37: Stored for 121 d after spiking
38: Stored for 170 d after spiking
39: Actual concentrations were always above 65% of nominal
40: Base sediment amended with organic carbon from Zostera (macrophyta)
41: Base sediment amended with organic carbon from suspended solids
42: Base sediment amended with organic carbon from mud
43: Base sediment amended with organic carbon from oyster feces
44: Base sediment amended with organic carbon from shrimp feces
45: Based on nominal concentrations
46: Based on measured concentrations
47: Determined from data from figures and/or tables and log-logistic dose-response relationship

48: Determined from two ECx data and log-logistic dose-response relationship
49: Determined from means and standard deviation from figures and number of replicates (10)
50: No clear dose-reponse relationship, because highest concentration deviates
51: Test performed in the dark
52: Test performed under continuous light
53: Light regime 16:8 h light:dark (10-20 µE/m^2/s; 50-100 ft-c)
54: Average loss over 10 days was 5.8% for pyrene and 54.2% for phenanthrene
55: Values are based on initial measured concentrations
56: Exposure under white light (2500 lux, 74-92 µW/cm2), 16 h light/8 h dark
57: Light regime 16:8 h light:dark
58: Wet sediment spiked with substance in acetone
59: Walls of glass bottles coated with substance and mixed with sediment by rolling
60: Portion dry sediment spiked with substance in acetone and left to evaporate and mixed with rest of sediment afterwards
61: Water sediment system spiked in water with fluoranthene in acetone
62: Determined from raw data and log-logistic dose-response relationship with LC50

National Insitute for Public Health
and the Environment
P.O. Box 1 | 3720 BA Bilthoven
www.rivm.com