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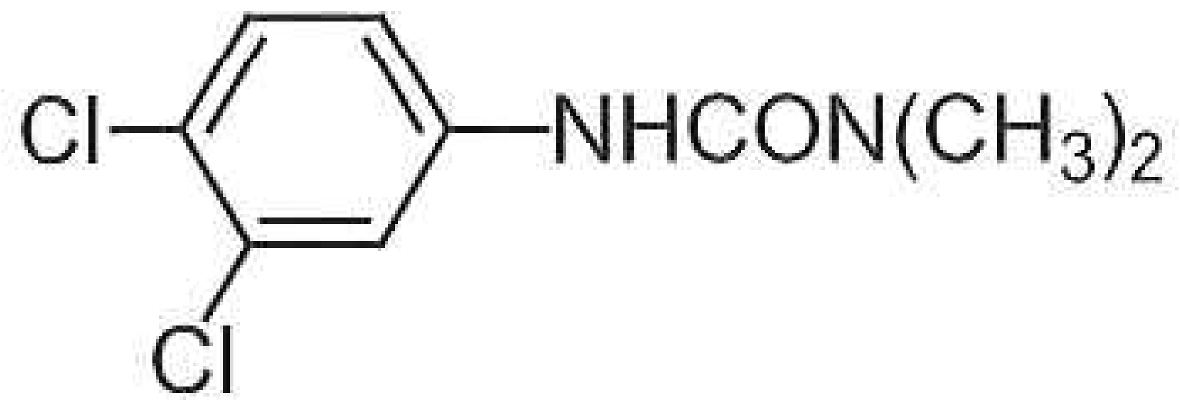

Proposed default guideline values for the protection of aquatic ecosystems: Diuron – freshwater

Water Quality and Investigations | Department of Science, Information Technology and Innovation

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Executive summary

Diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea, CAS No. 330-54-1) is a urea herbicide, or more specifically a phenylurea herbicide. Diuron is a common photosynthesis-inhibiting herbicide used for the total control of weeds and mosses as well as selective control of germinating grass and broad-leaved weeds in a variety of crops (University of Hertfordshire 2013). Non-agricultural uses include its application to urban and industrial situations (i.e. sides of roads, railroads, areas around industrial buildings), as well for aquatic weed and algae control in flood mitigation channels and as a boat anti-foulant.

The previous Australian and New Zealand guideline value (GV) (formerly referred to as a trigger value) for diuron in freshwater environments was a low reliability value (using the ANZECC and ARMCANZ 2000 reliability scheme) as it was calculated using an assessment factor of 200 applied to one chronic toxicity value for freshwater fish, *Pimephales promelas* (Warne 2000). More data on diuron toxicity are now available, including toxicity data for phototrophic species (species that photosynthesise, e.g. plants and algae), resulting in high reliability values (Warne et al. 2015).

Diuron is significantly ($p \leq 0.05$) more toxic to phototrophic species (e.g. plants and algae) than to other organisms (non-phototrophs) and a species sensitivity distribution (SSD) that used all freshwater and marine species resulted in a bimodal distribution. For this reason the default GVs were derived using only phototroph toxicity data. The lowest reported chronic toxicity value to freshwater species is 0.069 µg/L (freshwater microalgae, 96-hour EC5). The lowest reported acute toxicity value to freshwater species is 2.79 µg/L (freshwater macrophyte, 4-day EC10).

Very high reliability default GVs for diuron in freshwaters were derived based on chronic 5% effect concentration (EC5), 10% effect concentration (EC10), no observed effect concentration (NOEC) and no observed effect level (NOEL) and chronic estimated NOEC data for 26 freshwater species from four phyla and seven classes, with a good fit of the SSD to the toxicity data. It should be noted that the default GVs presented here are expressed in terms of the active ingredient (diuron) rather than commercial formulations. The default GVs for a range of protection levels are:

Default guideline value type (ANZECC and ARMCANZ 2000)	Proposed diuron (freshwater) toxicity default guideline values (µg/L)
Reliability	***Very High***
High conservation value systems (99% species protection)	0.08
Slightly to moderately disturbed systems (95% species protection)	0.23
Highly disturbed systems (90% species protection)	0.42
Highly disturbed systems (80% species protection)	0.9

Contents

List of tables

List of figures

1 Introduction

Diuron is a herbicide ($C_9H_{10}Cl_2N_2O$ and Figure 1) that at room temperature is in the form of odourless, colourless crystals. It is the active ingredient of a variety of commercial herbicide formulations. Major metabolites of diuron are subsequentially demethylated diuron compounds: N'-(3-chlorophenyl)-N,N-dimethylurea (m-CPDMU), N'-(3,4-dichlorophenyl)-N-methylurea (DCPMU) and 3,4-dichlorophenylurea (DCPU) (APVMA 2011). The ecological effects of the minor metabolite 3,4-dichloroaniline (3,4-DCA) are not well known.

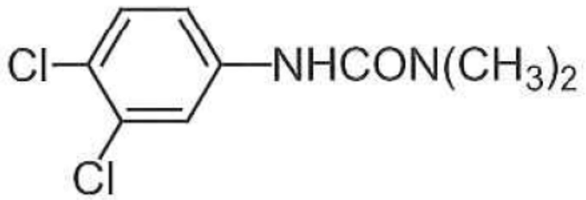


Figure 1 Structure of diuron (C = carbon, H = hydrogen, Cl = chlorine, N = nitrogen and O = oxygen).

Physicochemical properties of diuron that may affect its environmental fate and toxicity are presented in Table 1.

Table 1 Summary of selected physicochemical properties of diuron.

Physicochemical property	Value
Molecular weight	233.1 amu[1]
Aqueous solubility	37.4 mg/L @ temperature of 25°C[1] 35.6 mg/L @ temperature of 20°C[2]
Logarithm of the octanol-water partition coefficient (log Kow)	2.85 ± 0.03, temperature of 25°C[1] 2.87 @ pH 7, temperature of 20°C[2]
Logarithm of the organic carbon water partition coefficient (log Koc)	2.60 [1], 2.91[2]
Logarithm of the bioconcentration factor (log BCF)	0.975[2]
Half-life ($t_{1/2}$) in water	175 days (lagoon prediction) with majority of diuron (90%) residing in sediment[3]
Half-life ($t_{1/2}$) in soil	90 – 180 days[1] 75.5 days[2]

[1] BCPC (2012). [2] Pesticide Properties Database (University of Hertfordshire 2013). [3] Peterson and Batley (1991).

Diuron belongs to the phenylurea group within the urea class of herbicides, which also includes linuron and isoproturon. Diuron is extensively used in agriculture and forestry applications for the control of broad-spectrum weeds as selective control of germinating grass and broad-leaved weeds in a variety of crops such as pineapples, bananas, asparagus, peas, cotton, sugarcane, wheat, barley oats, and ornamentals including tulips (BCPS 2012; University of Hertfordshire 2013). Diuron is also used to control weeds and algae in and around water bodies and is a component of marine antifouling paints (APVMA 2009). In Australia, diuron is one of the most heavily used herbicides, exceeded only by glyphosate, simazine and atrazine (AATSE 2002). It is a pre-emergence, residual herbicide as well as a post-emergence knockdown (University of Hertfordshire 2013) that exhibits some solubility in water (Table 1).

Diuron is absorbed principally through the roots of plants. It is then translocated acropetally (i.e. movement upwards from the base of plants to the apex) in the xylem and accumulates in the leaves (BCPC 2012). Diuron exerts its toxicity in aquatic plants (including algae) by inhibiting electron transport in the photosystem II (PSII) complex (University of Hertfordshire 2013), a key process in photosynthesis that occurs in the thylakoid membranes of chloroplasts. Urea herbicides bind to the plastoquinone B (Q_B) protein binding site on the D1 protein in PSII. This prevents the transport of electrons to synthesise adenosine triphosphate (ATP, used for cellular metabolism) and nicotinamide adenine dinucleotide phosphate (NADPH, used in converting CO_2 to glucose), and therefore prevents CO_2 fixation (Wilson et al. 2000).

In addition to its main mode of action, PSII-inhibiting can lead to marked increases in the formation of reactive oxygen species (ROS) (Halliwell 1991). These include the synthesis of singlet oxygen (OH^-), superoxide (O_2^-) and hydrogen peroxide (H_2O_2). Reactive oxygen species are highly reactive forms of oxygen that readily react with, and bind to, biomolecules including deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Reactive oxygen species are created during normal cellular functioning particularly in biochemical processes that involve the generation of energy, e.g. photosynthesis in chloroplasts and the Krebs cycle in the mitochondria of cells. In phototrophs, ROS are formed when the absorbed light energy exceeds the ability to convert CO_2 to organic molecules, thus accumulating oxygen (Chen et al. 2012). Normal concentrations of ROS are involved in a number of cellular processes (Chen et al. 2012). However, prolonged exposure to elevated concentrations of ROS in plants, as a result of biotic (e.g. disease) and/or abiotic stressors (e.g. PSII-inhibiting herbicides), can cause irreversible cell damage and ultimately lead to cell death (apoptosis).

Diuron ultimately ends up in aquatic environments as a result of surface and/or subsurface runoff from agricultural applications following heavy or persistent rain events, as well as from antifouling paints (biocides) applied to the hull of marine vessels (APVMA 2009). Loss of diuron via volatilisation is minimal due to its solubility in water (Table 1) and low soil adsorption ability as indicated by its low log Koc value (Table 1) (Field et al. 2003). Diuron is relatively mobile and has been found to leach to groundwater and be transported in surface waters (Field et al. 2003; AVPMA 2011). A USEPA report (USEPA 1987) of surface and groundwater samples in six states of the USA did not detect diuron in any of eight surface water samples; however it was detected in approximately 2.6% of groundwater samples in California and Georgia. Australian figures from 2011–15 show that diuron has been detected in approximately 66% of surface water samples collected between 2011-15 in waterways that drain agricultural land and discharge to the Great Barrier Reef (based on data in Turner et al. 2013a, 2013b; Wallace et al. 2014, 2015, 2016; Garzon-Garcia et al. 2015).

In Australia, the APVMA suspended the registration of selected diuron products in late 2011 and enforced significant restrictions on the use of reaffirmed products. The main restriction prohibited the use of diuron during no-spray windows (from December 5, 2011 to March 31, 2012 onwards) for tropical crops including sugarcane, with restrictions being specific to the climatic and geographic conditions of each region. Other restrictions included specifying maximum application rates for different times of the year. Diuron is currently registered for use in Australia and many other countries, however, it has been reviewed in the United States (draft 2003), Canada (2007), United Kingdom (2007) and Europe (2007 and 2008) (APVMA 2009). Current restraints on diuron use in Australia can be found at http://apvma.gov.au/node/12511.

2 Aquatic Toxicology

The review of the literature revealed that there were two published studies (Kumar et al. 2010; Foster et al. 1998) that determined the toxicity of diuron to Australasian species and one unpublished study (Seery and Pradella, in prep). Foster et al. (1998) determined the toxicity of diuron to the cladoceran *Ceriodaphnia dubia* while Kumar et al. (2010) determined its toxicity to shrimp *Parataya australiensis* and Seery and Pradella (in prep.) determined its toxicity to the macroalga *Lemna aequinoctialis*. In addition, there is an honours thesis in existence by Sarah Stone (University of Wollongong) that is determining the toxicity of diuron to four algal species and to a mixture of three of the alga. As this work was not yet completed, it was not included in this review. All the other chronic data for Australasian species were included as they passed the normal quality assurance and screening processes.

A summary of the high and moderate quality raw toxicity data for freshwater species is presented in Section 5 – Toxicity Data Used in Derivation and Appendix A, Table 4 contains all the this data. The lowest reported chronic toxicity value to freshwater species is for microalgae, *Fragilaria capucina var vaucheriae*, with a 96-hour EC5 of 0.069 µg/L. The lowest reported acute toxicity value to freshwater species is for macrophyte, *Lemna aequinoctialis*, with a 4-day EC10 of 2.79 µg/L.

3 Factors Affecting Toxicity

No factors have been reported as modifying the toxicity of diuron. As with many organic chemicals it might be expected that dissolved and particulate organic matter and suspended solids would affect its bioavailability and toxicity. However, any such effect would be relatively minor given the relatively low log Koc value of diuron (Table 1).

4 Guideline Derivation

The Australian and New Zealand default Guideline Values (GVs) for diuron in freshwaters are provided in Table 2. Details of how the default GVs were calculated and the toxicity data that were used are provided below. As with all the other pesticides that have GVs, the GVs for diuron are expressed in terms of the concentration of the active ingredient.

Measured log bioconcentration factor (BCF) values for diuron are low (Table 1) and below the threshold at which secondary poisoning must be considered (i.e. threshold log BCF = 4, Warne et al. 2015). Therefore, the default GVs for diuron do not need to account for secondary poisoning.

Table 2 Default guideline values (µg/L) for diuron for the protection of freshwater ecosystems.

Diuron default guideline values (freshwater)[1]	
Percent species protection	Concentration (µg/L)
99%	0.08
95%	0.23
90%	0.42
80%	0.9

Reliability classification[2]	
Criterion	Result
Sample size	26
Type of toxicity data	Chronic EC5, EC10, NOEC and NOEL data with chronic estimated NOEC data
SSD model fit	Good
Reliability	Very High

[1] Guideline values were derived using the Burrlioz 2.0 (2016) software.

[2] See Warne et al. (2015) for definitions of guideline value "reliability".

5 Toxicity Data Used in Derivation

The previous Australian and New Zealand GV (formerly referred to as a trigger value) for diuron in freshwater environments was a low reliability value (using the ANZECC and ARMCANZ 2000 reliability scheme) as it was based on one chronic toxicity value for a fish species (Warne 2000). This value was calculated using the assessment factor (AF) method, dividing the lowest chronic toxicity value of 33.4 µg/L by an assessment factor of 200 (Warne 2000). Under the new method for deriving GVs (Warne et al. 2015) this value would be classified as having a *very low reliability*.

To obtain toxicity data for diuron to freshwater organisms, an extensive search of the scientific literature was conducted. In addition, the databases of the USEPA ECOTOX (USEPA 2015a), Office of the Pesticide Program (USEPA 2015b), the Australasian Ecotoxicology Database (Warne et al. 1998) and the ANZECC and ARMCANZ WQG toxicant databases (Sunderam et al. 2000) were searched. More data on diuron toxicity are now available, including data for phototrophic species (species that photosynthesise, e.g. plants and algae) to derive default GVs of higher reliability, using the scheme of Warne et al. (2015).

In total, there were toxicity data for 59 freshwater species (8 phyla and 14 classes) that passed the screening and quality assessment processes (Attachment A, Table 4). The represented phyla were Annelida, Arthropoda, Bacillariophyta, Chlorophyta, Chordata, Cyanobacteria, Mollusca and Tracheophyta. The 14 classes were Actinopterygii (which accounts for approximately 99% of fish), Amphibia (tetrapod vertebrates), Bacillariophyceae (a major grouping of diatoms), Branchiopoda (a grouping of crustaceans), Chlorophyceae (a major grouping of freshwater green algae), Clitellata (a class of annelid worms), Cyanophyceae (a class of cyanobacteria), Fragilariophyceae (a grouping of pennate diatoms), Gastropoda (a grouping of molluscs), Insecta (invertebrates), Liliopsida (monocots), Malacostraca (a large grouping of crustaceans), Mediophyceae (another algae grouping) and Trebouxiophyceae (another grouping of green algae).

Based on the mode of action of diuron, it would be expected that phototrophic species would be more sensitive than non-phototrophic species. The diuron ecotoxicity data for phototrophs and heterotrophs were then tested using the parametric two-sample *t* test to see if they were uni- or multi-modal. This indicated that the two groups had significantly different ($p=<0.0001$, Attachment B) sensitivities. Therefore, as recommended by Warne et al. (2015), only the ecotoxicity data for the more sensitive group of organisms (in this case, phototrophs) were used in calculating the default GVs.

There were freshwater chronic 5% effect concentration (EC5), 10% effect concentration (EC10), no observed effect concentration (NOEC) and no observed effect level (NOEL) data for 15 phototrophic species (that belonged to only three phyla and five classes), which does not meet the minimum data requirements (i.e., at least five species belonging to at least four phyla) to use a SSD to derive a GV (Warne et al. 2015). When the dataset was expanded to include chronic estimated NOEC (chronic LOEC/EC50 toxicity data that had been converted to estimates of chronic NOEC/EC10 by dividing by 5) values of freshwater phototrophic species, there were 26 species belonging to 4 phyla and 7 classes which met the minimum data requirements to use a SSD to derive default GVs (Warne et al. 2015). The number of species and taxa in the toxicity data used to derive the default GVs (Table 2) combined with the good fit of the distribution to these toxicity data (Figure 2) resulted in a very high reliability set of default GVs.

A summary of the toxicity data (one value per species) used to calculate the default GVs for diuron in freshwater environments is provided in Table 3. Further details about all the data for freshwater species that passed the screening and quality assurance schemes, including those used to derive the single species values used to calculate the default GVs are presented in Attachments A.

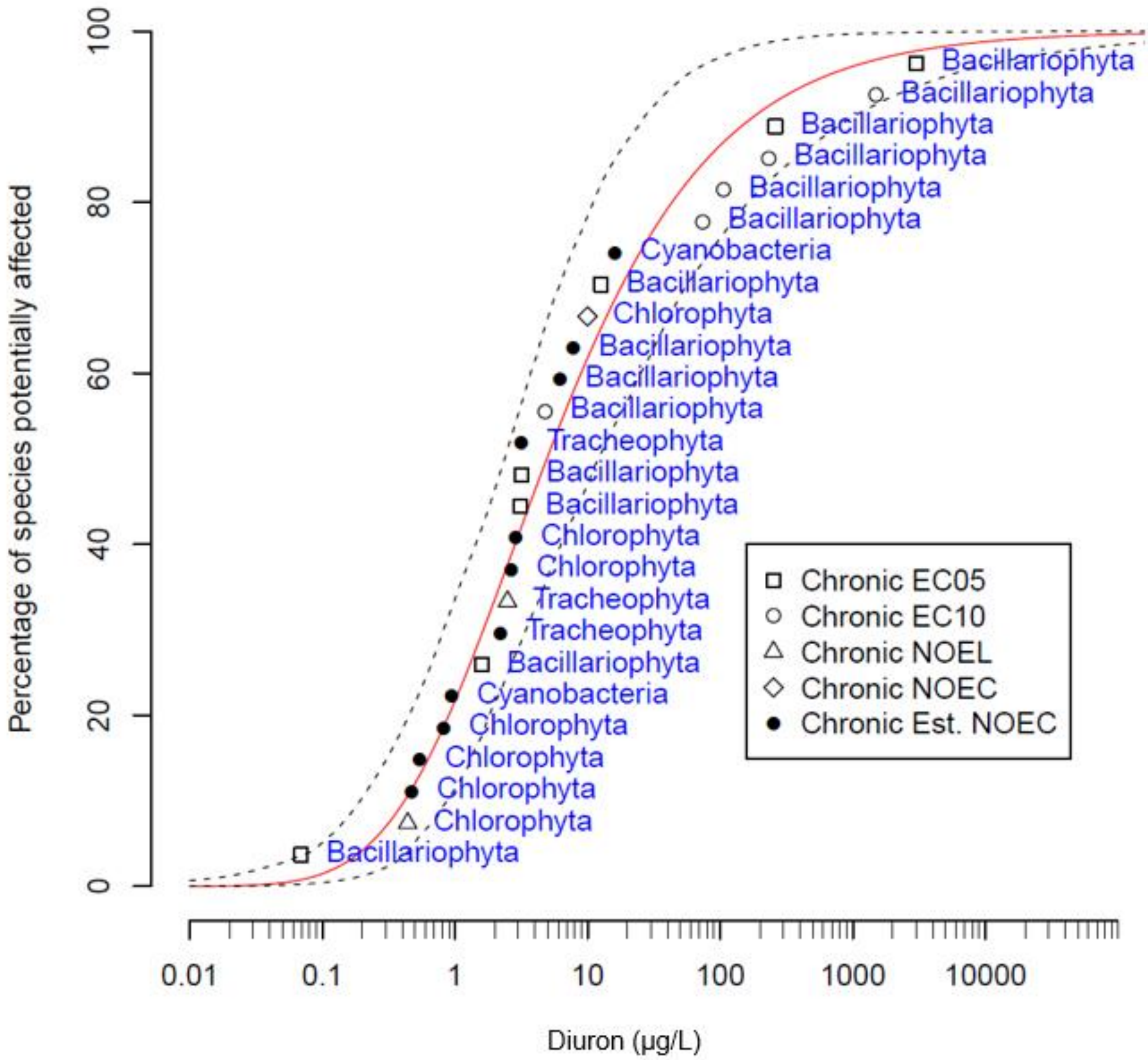
Table 3 Summary of the single toxicity value for each phototrophic species that was used to derive the default guideline values for diuron in fresh waters. Data are arranged in alphabetical order of the test species.

Taxonomic group	Species	Phyla	Class	Duration (days)	Type[1]	Toxicity endpoint	Toxicity value (µg/L)
Microalgae	*Achnanthidium minutissimum*	Bacillariophyta	Bacillariophyceae	4	Chronic EC5	Cell density	3.15
Bacteria	*Anabaena variabilis*	Cyanobacteria	Cyanophyceae	12	Chronic est. NOEC	Chlorophyll-a	16
Microalgae	*Chlorella pyrenoidosa*[2]	Chlorophyta	Trebouxiophyceae	4	Chronic est. NOEC	Cell count	0.47
Cyanobacteria	*Chroococcus minor*	Cyanobacteria	Cyanophyceae	7	Chronic est. NOEC	Cell density	0.94
Microalgae	*Craticula accomoda*	Bacillariophyta	Bacillariophyceae	4	Chronic EC5	Cell density	261
Microalgae	*Cyclotella meneghiniana*	Bacillariophyta	Mediophyceae	4	Chronic EC5	Cell density	1.59
Microalgae	*Cyclotella nana*	Bacillariophyta	Mediophyceae	3	Chronic est. NOEC	Biomass yield, Growth rate, AUC[3]	7.8
Microalgae	*Encyonema silesiacum*	Bacillariophyta	Bacillariophyceae	4	Chronic EC5	Cell density	3.11
Microalgae	*Eolimna minima*	Bacillariophyta	Bacillariophyceae	4	Chronic EC5	Cell density	3007
Microalgae	*Fragilaria capucina var vaucheriae*	Bacillariophyta	Fragilariophyceae	4	Chronic EC5	Cell density	0.069
Microalgae	*Fragilaria rumpens*	Bacillariophyta	Fragilariophyceae	4	Chronic EC10	Cell density	4.77
Microalgae	*Fragilaria ulna*[4]	Bacillariophyta	Fragilariophyceae	4	Chronic EC5	Cell density	12.6
Microalgae	*Gomphonema parvulum*	Bacillariophyta	Bacillariophyceae	4	Chronic EC10	Chlorophyll-a	232
Macrophyte	*Lemna gibba*	Tracheophyta	Liliopsida	7	Chronic NOEL	Total frond number, Growth rate, Mortality	2.49
Macrophyte	*Lemna minor*	Tracheophyta	Liliopsida	7	Chronic est. NOEC	Total chlorophyll	3.16
Macrophyte	*Lemna paucicostata*	Tracheophyta	Liliopsida	8	Chronic est. NOEC	Frond cover area	2.19
Microalgae	*Mayamaea fossalis*	Bacillariophyta	Bacillariophyceae	4	Chronic EC5	Cell density	74
Microalgae	*Nitzschia palea*	Bacillariophyta	Bacillariophyceae	3	Chronic EC5	Cell density	106
Microalgae	*Scenedesmus acutus*	Chlorophyta	Chlorophyceae	8	Chronic est. NOEC	Cell count	2.66
Microalgae	*Scenedesmus obliquus*	Chlorophyta	Chlorophyceae	4	Chronic est. NOEC	Cell count	0.82
Microalgae	*Scenedesmus quadricauda*	Chlorophyta	Chlorophyceae	4	Chronic est. NOEC	Cell count	0.54
Microalgae	*Scenedesmus subspicatus*[5]	Chlorophyta	Chlorophyceae	3	Chronic NOEC	Cell count	10
Microalgae	*Scenedesmus vacuolatus*	Chlorophyta	Chlorophyceae	2	Chronic est. NOEC	Cell density	2.86
Microalgae	*Selenastrum capricornutum*[6]	Chlorophyta	Chlorophyceae	4	Chronic NOEL	Biomass yield, Growth rate, AUC[3]	0.44
Microalgae	*Sellaphora minina*	Bacillariophyta	Bacillariophyceae	4	Chronic EC10	Chlorophyll-a	1493.3
Microalgae	*Stauroneis amphoroides*	Bacillariophyta	Bacillariophyceae	4	Chronic est. NOEC	Biomass yield, Growth rate, AUC[3]	6.2

[1] Chronic NOEC/NOEL/EC5/EC10 = no conversions applied; Chronic est. NOEC = chronic LOEC/EC50 values that were converted to chronic NOEC/NOEL/EC10 values by dividing by 5 (Warne et al. 2015). [2] This species has also been called *Chlorella vulgaris* and *Chlorella pyrenoidosa*. [3] AUC = area under the growth curve. [4] This species has also been called *Ulnaria ulna*. [5] This species has also been called *Desmodesmus subspicatus.* [6] This species has also been called *Raphidocelis subcapitata* and *Pseudokirchneriella subcapitata*.

6 Species Sensitivity Distribution

The cumulative frequency (species sensitivity) distribution (SSD) of the 26 phototrophic freshwater



species that were used to derive the default GVs is presented in Figure 2.

Figure 2 Cumulative frequency distribution generated using Burrlioz 2.0 (2016) of the sensitivity (chronic 5% effect concentration (EC5), 10% effect concentration (EC10), no observed effect concentration (NOEC) and no observed effect level (NOEL) data with chronic estimated NOEC data) values of freshwater phototrophic species to diuron. Chronic NOEC/NOEL/EC5/EC10 = no conversions applied; Chronic est. NOEC = chronic LOEC/EC50 values that were converted to chronic NOEC/NOEL/EC10 values by dividing by 5 (Warne et al. 2015).

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8 Glossary, acronyms, abbreviations

Acute toxicity	An adverse effect that occurs as the result of a short-term exposure to a chemical relative to the organism's life span. Refer to Warne et al. (2015) for examples of acute exposures.
ANZECC	Australian and New Zealand Environment and Conservation Council.
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand.
Bimodal	When the distribution of the sensitivity of species to a toxicant has two modes. This typically occurs with chemicals with specific modes of action. For example, herbicides are designed to affect plants at low concentrations but most animals are only affected at high concentrations.
CAS no.	Chemical Abstracts Service number. Each chemical has a unique identifying number that is allocated to it by the American Chemical Society.
Chronic toxicity	An adverse effect that occurs as the result of exposure to a chemical for a substantial portion of the organism's life span or an adverse sub-lethal effect on a sensitive early life stage. Refer to Warne et al. (2015) for examples of chronic exposures.
Default guideline value (Default GV)	A guideline value recommended for generic application in the absence of a more specific guideline value (e.g. site-specific), in the Australian and New Zealand Water Quality Guidelines.
ECx	The concentration of a chemical in water that is estimated to produce a x% effect on a sub-lethal endpoint. The magnitude of x can vary from 1 to 100, however values between 5 and 50 are more typical. The ECx is usually expressed as a time-dependent value (e.g. 24-hour or 96-hour ECx).
EC50 (Median effective concentration)	The concentration of a chemical in water that is estimated to produce a 50% effect on a sub-lethal endpoint. The EC50 is usually expressed as a time-dependent value (e.g. 24-hour or 96-hour EC50).
Endpoint	A measurable biological effect including, but not limited to, lethality, immobility, growth inhibition, immunological responses, organ effects, developmental and reproductive effects, behavioural effects, biochemical changes, genotoxicity, etc.
Guideline value (GV)	A measurable quantity (e.g. concentration) or condition of an indicator for a specific environmental value below which (or above which, in the case of stressors such as pH, dissolved oxygen and many biodiversity responses) there is considered to be a low risk of unacceptable effects occurring to that environmental value. Guideline values for more than one indicator should be used simultaneously in a multiple lines of

	evidence approach.
LC50 (Median lethal concentration)	The concentration of a chemical in water that is estimated to kill 50% of the test organisms. The LC50 is usually expressed as a time-dependent value (e.g. 24-hour or 96-hour LC50).
LOEC (Lowest observed effect concentration)	The lowest concentration of a chemical used in a toxicity test that has a statistically significant ($p \leq 0.05$) adverse effect on the exposed population of test organisms as compared with the controls. All higher concentrations should also cause statistically significant effects.
Mode of action	The means by which a chemical exerts its toxic effects. For example, triazine herbicides inhibit the photosystem II component of plants photosynthesis biochemical reaction.
NOEC (No observed effect concentration)	The highest concentration of a toxicant used in a toxicity test that does not have a statistically significant ($p > 0.05$) effect, compared to the controls. The statistical significance is measured at the 95% confidence level.
Phototrophs	Organisms that photosynthesize as their main means of obtaining energy e.g. plants and algae.
PSII	Photosystem II of the photosynthetic biochemical pathway.
Site-specific	Relating to something that is confined to, or valid for, a particular place. Site-specific trigger values are relevant to the location or conditions that are the focus of a given assessment.
Species	A group of organisms that resemble each other to a greater degree than members of other groups and that form a reproductively isolated group that will not produce viable offspring if bred with members of another group.
SSD	Species sensitivity distribution. A method that plots the cumulative frequency of species sensitivity and fits the best possible statistical distribution to the data. From the distribution the concentration that should theoretically protect a selected percentage of species can be determined.
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.
Toxicity test	The means by which the toxicity of a chemical or other test material is determined. A toxicity test is used to measure the degree of response produced by exposure to a concentration of chemical.

Attachment A. Summary details of all freshwater toxicity data that passed the screening and quality assessment processes

Table 4 Summary of the key characteristics of the freshwater diuron toxicity data (acute and chronic) that passed the screening and quality assurance processes. It includes both phototrophic and non-phototrophic species for freshwaters only.

Phyla	Class	Species	Life stage	Exposure duration (days)	Test type	Toxicity measure (test endpoint)	Test medium	Temp (°C)	pH	Concentration (µg/L)	Reference
Annelida	Clitellata	Blackworm *(Lumbriculus variegatus)*	Small adults	10	Acute	NOAEL (Survival)	0.45 µm filtered well water	23	6.8 ± 0.1	29,100	Nebeker and Schuytema (1998)
										29,100	*GEOMETRIC MEAN*
Annelida	Clitellata	Blackworm *(Lumbriculus variegatus)*	Small adults	10	Acute	NOAEL (Blotted wet weight)	0.45 µm filtered well water	23	6.8 ± 0.1	1,800	Nebeker and Schuytema (1998)
										1,800	*GEOMETRIC MEAN*
Annelida	Clitellata	Blackworm *(Lumbriculus variegatus)*	Small adults	10	Acute	LOAEL (Blotted wet weight)	0.45 µm filtered well water	23	6.8 ± 0.1	3,500	Nebeker and Schuytema (1998)
										3,500	*GEOMETRIC MEAN*
Arthropoda	Insecta	Yellow Fever Mosquito *(Aedes aegypti)*	Not stated	4	Acute	LC50 (Mortality)	*	*	*	1,200	Knapek and Lakota (1974)
										1,200	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Aquatic Sowbug *(Asellus brevicaudus)*	Not stated	4	Acute	LC50 (Mortality)	Well water, reconstituted water	15 ± 1	6.5 - 8.5	15,500	Johnson and Finley (1980)
										15,500	*GEOMETRIC MEAN*

Arthropoda	Branchiopoda	Cladoceran *(Ceriodaphnia dubia)*	<24 hour old neonates	1	Acute	EC50 (Immobilisation)	Soft diluted mineral water	25 ± 1	Not stated	2,300	Foster et al. (1998)
Arthropoda	Branchiopoda	Cladoceran *(Ceriodaphnia dubia)*	<24 hour old neonates	1	Acute	EC50 (Immobilisation)	Soft diluted mineral water	25 ± 1	Not stated	1,200	Foster et al. (1998)
										1,661.32	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Ceriodaphnia dubia)*	<24 hour old neonates	2	Acute	EC50 (Immobilisation)	Soft diluted mineral water	25 ± 1	Not stated	1,700	Foster et al. (1998)
Arthropoda	Branchiopoda	Cladoceran *(Ceriodaphnia dubia)*	<24 hour old neonates	2	Acute	EC50 (Immobilisation)	Soft diluted mineral water	25 ± 1	Not stated	1,000	Foster et al. (1998)
										1,303.84	*GEOMETRIC MEAN*
Arthropoda	Insecta	Midge *(Chironomus tentans)*	1st instar larvae (2 days old)	10	Chronic	NOAEL (Mortality)	0.45 µm filtered well water	24	6.9 ± 0.1	1,900	Nebeker and Schuytema (1998)
										1,900	*GEOMETRIC MEAN*
Arthropoda	Insecta	Midge *(Chironomus tentans)*	1st instar larvae (2 days old)	10	Chronic	LOAEL (Mortality)	0.45 µm filtered well water	24	6.9 ± 0.1	3,400	Nebeker and Schuytema (1998)
										3,400	*GEOMETRIC MEAN*
Arthropoda	Insecta	Midge *(Chironomus tentans)*	1st instar larvae (2 days old)	10	Chronic	NOAEL (Larval weight)	0.45 µm filtered well water	24	6.9 ± 0.1	3,400	Nebeker and Schuytema (1998)
										3,400	*GEOMETRIC MEAN*
Arthropoda	Insecta	Midge *(Chironomus tentans)*	1st instar larvae (2 days old)	10	Chronic	LOAEL (Larval weight)	0.45 µm filtered well water	24	6.9 ± 0.1	7,100	Nebeker and Schuytema (1998)
										7,100	*GEOMETRIC MEAN*
Arthropoda	Insecta	Midge *(Chironomus*	1st instar larvae	10	Chronic	LC50 (Mortality)	0.45 µm filtered well	24	6.9 ± 0.1	3,300	Nebeker and Schuytema

		tentans)	(2 days old)				water				(1998)
										3,300	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	< 24 hours	2	Acute	LOEC (Immobilisation)	Natural or reconstituted water	20 ± 1	Not stated	3,500	Fernandez-Alba et al. (2002a)
										3,500	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	< 24 hours	2	Acute	EC50 (Immobilisation)	Natural or reconstituted water	20 ± 1	Not stated	8,600	Fernandez-Alba et al. (2002a)
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	< 24 hours	2	Acute	EC50 (Immobilisation)	Natural or reconstituted water	20 ± 1	Not stated	8,600	Fernandez-Alba et al. (2002b)
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	<24 hour old neonates	2	Acute	EC50 (Immobilisation)	Non-chlorinated tap water and spring water (1:1 ratio)	20 ± 1	Not stated	8,600	Hernando et al. (2003)
										8,600	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	Not stated	4	Acute	LC50 (Mortality)	*	*	*	400	Knapek and Lakota (1974)
										400	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	Life cycle	21	Chronic	LOEC (Body length/Dry weight)	Surface or ground, reconstituted or dechlorinated tap water	20 ± 1	Not stated	113	US EPA (2015a)
										113	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	Life cycle	21	Chronic	NOEL (Body length/Dry weight)	Surface or ground, reconstituted or dechlorinated	20 ± 1	Not stated	57	US EPA (2015a)

							tap water				
										57	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	Life cycle	28	Chronic	LOEC (Body length/Dry weight)	Surface or ground, reconstituted or dechlorinated tap water	20 ± 1	Not stated	200	US EPA (2015a)
										200	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia magna)*	Life cycle	28	Chronic	NOEL (Body length/Dry weight)	Surface or ground, reconstituted or dechlorinated tap water	20 ± 1	Not stated	200	US EPA (2015a)
										200	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	1st instar larvae	2	Acute	EC50 (Body length/Dry weight)	Surface or ground, reconstituted or dechlorinated tap water	20 ± 2	Not stated	1,400	US EPA (2015a)
										1,400	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	Not stated	2	Acute	EC50 (Immobilisation)	Reconstituted de-ionised water	18	6.5 - 8.5	1,400	Sanders and Cope (1966)
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	Not stated	2	Acute	EC50 (Immobilisation)	Well water, reconstituted water	15 ± 1	7.4 - 7.8	1,400	Johnson and Finley (1980)
										1,400	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	Adults (5 days old)	4	Acute	LC50 (Mortality)	0.45 µm filtered well water	Not stated	6.9 ± 0.1	17,900	Nebeker and Schuytema (1998)

										17,900	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	Adults (5 days old)	7	Chronic	NOAEL (Mortality)	0.45 µm filtered well water	Not stated	6.9 ± 0.1	4,000	Nebeker and Schuytema (1998)
										4,000	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	Adults (5 days old)	7	Chronic	LOAEL (Mortality)	0.45 µm filtered well water	Not stated	6.9 ± 0.1	7,700	Nebeker and Schuytema (1998)
										7,700	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	Adults (5 days old)	7	Chronic	NOAEL (Progeny)	0.45 µm filtered well water	Not stated	6.9 ± 0.1	4,000	Nebeker and Schuytema (1998)
										4,000	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	Adults (5 days old)	7	Chronic	LOAEL (Progeny)	0.45 µm filtered well water	Not stated	6.9 ± 0.1	7,700	Nebeker and Schuytema (1998)
										7,700	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Daphnia pulex)*	Adults (5 days old)	7	Chronic	LC50 (Mortality)	0.45 µm filtered well water	Not stated	6.9 ± 0.1	7,100	Nebeker and Schuytema (1998)
										7,100	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Shrimp *(Gammarus fasciatus)*	Not stated	2	Acute	LC50 (Mortality)	Untreated well water	15.5 ± 0.5	7.4	1,800	Sanders (1970)
										1,800	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Shrimp *(Gammarus fasciatus)*	Not stated	4	Acute	LC50 (Mortality)	Well water, reconstituted water	21 ± 1	6.5 - 8.5	160	Johnson and Finley (1980)
Arthropoda	Malacostraca	Shrimp *(Gammarus fasciatus)*	Not stated	4	Acute	LC50 (Mortality)	Untreated well water	15.5 ± 0.5	7.4	700	Sanders (1970)

										335	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Amphipod *(Gammarus lacustris)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	380	Sanders (1969)
										380	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Amphipod *(Gammarus lacustris)*	Not stated	4	Acute	LC50 (Mortality)	*	*	*	160	Sanders (1969)
										160	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Amphipod *(Hyalella azteca)*	2 day old young	4	Acute	LC50 (Mortality)	0.45 µm filtered well water	22	6.9 ± 0.1	19,400	Nebeker and Schuytema (1998)
										19,400	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Amphipod *(Hyalella azteca)*	2 day old young	10	Acute	NOAEL (Mortality)	0.45 µm filtered well water	22	6.9 ± 0.1	7,900	Nebeker and Schuytema (1998)
										7,900	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Amphipod *(Hyalella azteca)*	2 day old young	10	Acute	LOAEL (Mortality)	0.45 µm filtered well water	22	6.9 ± 0.1	15,700	Nebeker and Schuytema (1998)
										15,700	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Amphipod *(Hyalella azteca)*	2 day old young	10	Acute	NOAEL (Length)	0.45 µm filtered well water	22	6.9 ± 0.1	22,900	Nebeker and Schuytema (1998)
										22,900	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Amphipod *(Hyalella azteca)*	2 day old young	10	Acute	NOAEL (Blotted wet weight)	0.45 µm filtered well water	22	6.9 ± 0.1	22,900	Nebeker and Schuytema (1998)
										22,900	*GEOMETRIC MEAN*

Arthropoda	Malacostraca	Amphipod *(Hyalella azteca)*	2 day old young	10	Acute	LC50 (Mortality)	0.45 µm filtered well water	22	6.9 ± 0.1	18400	Nebeker and Schuytema (1998)
										18,400	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Australian Glass Shrimp *(Paratya australiensis)*	Not stated	4	Acute	LC50 (Mortality)	Not stated	23 ± 1	7 - 8.5	8,800	Kumar et al. (2010)
										8,800	*GEOMETRIC MEAN*
Arthropoda	Malacostraca	Australian Glass Shrimp *(Paratya australiensis)*	Not stated	4	Acute	LC10 (Mortality)	Not stated	23 ± 1	7 - 8.5	4,700	Kumar et al. (2010)
Arthropoda	Malacostraca	Australian Glass Shrimp *(Paratya australiensis)*	Not stated	4	Acute	NOEC (Mortality)	Not stated	23 ± 1	7 - 8.5	5,000	Kumar et al. (2010)
										4,847.68	*GEOMETRIC MEAN*
Arthropoda	Insecta	Stonefly *(Pteronarcys californica)*	Not stated	2	Acute	LC50 (Mortality)	Reconstituted water	15.5 ± 0.5	7.1	2,800	Sanders and Cope (1968)
										2,800	*GEOMETRIC MEAN*
Arthropoda	Insecta	Stonefly *(Pteronarcys californica)*	Not stated	4	Acute	LC50 (Mortality)	Reconstituted water	15.5 ± 0.5	7.1	1,200	Sanders and Cope (1968)
Arthropoda	Insecta	Stonefly *(Pteronarcys californica)*	Not stated	4	Acute	LC50 (Mortality)	Reconstituted water	15.5 ± 0.5	7.1	1,200	Sanders and Cope (1968)
										1,200	*GEOMETRIC MEAN*
Arthropoda	Branchiopoda	Cladoceran *(Simocephalus serrulatus)*	Not stated	2	Acute	EC50 (Immobilisation)	Reconstituted water	10.0 - 26.66	7.4 - 7.8	2,000	Sanders and Cope (1966)
Arthropoda	Branchiopoda	Cladoceran *(Simocephalus*	Not stated	2	Acute	EC50 (Immobilisation)	Well water, reconstituted	15 ± 1	6.5 - 8.5	2,000	Johnson and Finley (1980)

		serrulatus)					water				
										2,000	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Achnanthidium minutissimum)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	3.15	Larras et al. (2012)
										3.15	*GEOMETRIC MEAN*
										3.15	***VALUE USED IN SSD***
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Achnanthidium minutissimum)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	45	Larras et al. (2013)
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Achnanthidium minutissimum)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	7.67	Larras et al. (2013)
										18.6	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Achnanthidium minutissimum)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	108	Larras et al. (2012)
										108	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Achnanthidium minutissimum)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	56	Larras et al. (2013)
										56	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Craticula accomoda)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	261	Larras et al. (2012)
										261	*GEOMETRIC MEAN*
										261	***VALUE USED***

											IN SSD
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Craticula accomoda)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	185	Larras et al. (2013)
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Craticula accomoda)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	644	Larras et al. (2013)
										345	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Craticula accomoda)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	1,734	Larras et al. (2012)
										1,734	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Craticula accomoda)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	1,426	Larras et al. (2013)
										1,426	*GEOMETRIC MEAN*
Bacillariophyta	Mediophyceae	Microalgae *(Cyclotella meneghiniana)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	1.59	Larras et al. (2012)
										1.59	*GEOMETRIC MEAN*
										1.59	***VALUE USED IN SSD***
Bacillariophyta	Mediophyceae	Microalgae *(Cyclotella meneghiniana)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	27	Larras et al. (2013)
Bacillariophyta	Mediophyceae	Microalgae *(Cyclotella meneghiniana)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	2.74	Larras et al. (2013)
										8.6	*GEOMETRIC*

											MEAN
Bacillariophyta	Mediophyceae	Microalgae *(Cyclotella meneghiniana)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	23	Larras et al. (2012)
										23	*GEOMETRIC MEAN*
Bacillariophyta	Mediophyceae	Microalgae *(Cyclotella meneghiniana)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	49	Larras et al. (2013)
										49	*GEOMETRIC MEAN*
Bacillariophyta	Mediophyceae	Microalgae *(Cyclotella nana)*	Not stated	3	Chronic	EC50 (Biomass Yield, Growth Rate, AUC)	ASTM Type 1 water	24 ± 2	7.5 ± 0.1	39	US EPA (2015a)
										39	*GEOMETRIC MEAN*
										7.8[@]	***VALUE USED IN SSD***
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Encyonema silesiacum)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	3.11	Larras et al. (2012)
										3.11	*GEOMETRIC MEAN*
										3.11	***VALUE USED IN SSD***
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Encyonema silesiacum)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	90	Larras et al. (2013)
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Encyonema silesiacum)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	3.98	Larras et al. (2013)
										18.93	*GEOMETRIC MEAN*

Bacillariophyta	Bacillariophyc-eae	Microalgae *(Encyonema silesiacum)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	8.79	Larras et al. (2012)
										8.79	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Encyonema silesiacum)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	286	Larras et al. (2013)
										286	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Eolimna minima)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	3,007	Larras et al. (2012)
										3,007	*GEOMETRIC MEAN*
										3,007	***VALUE USED IN SSD***
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Eolimna minima)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	4,236	Larras et al. (2012)
										4,236	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria capucina var vaucheriae)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	0.069	Larras et al. (2012)
										0.069	*GEOMETRIC MEAN*
										0.069	***VALUE USED IN SSD***
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria capucina var vaucheriae)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	21	Larras et al. (2013)
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria capucina var vaucheriae)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	0.11	Larras et al. (2013)

										1.52	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria capucina var vaucheriae)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	4.03	Larras et al. (2012)
										4.03	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria capucina var vaucheriae)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	44	Larras et al. (2013)
										44	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria rumpens)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	18	Larras et al. (2012)
										18	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria rumpens)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	0.76	Larras et al. (2013)
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria rumpens)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	30	Larras et al. (2013)
										4.77	*GEOMETRIC MEAN*
										4.77	***VALUE USED IN SSD***
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria rumpens)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	122	Larras et al. (2012)
										122	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria rumpens)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll	DV culture medium	Not stated	Not stated	8.89	Larras et al. (2013)

						-a fluorescence)					
										8.89	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria ulna*[1]*)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	12.6	Larras et al. (2012)
										12.6	*GEOMETRIC MEAN*
										12.6	***VALUE USED IN SSD***
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Ulnaria ulna)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	24	Larras et al. (2013)
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Ulnaria ulna)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	18	Larras et al. (2013)
										20.78	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Fragilaria ulna*[1]*)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	51	Larras et al. (2012)
										51	*GEOMETRIC MEAN*
Bacillariophyta	Fragilariophyc-eae	Microalgae *(Ulnaria ulna)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	42	Larras et al. (2013)
										42	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Gomphonema parvulum)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	904	Larras et al. (2012)
										904	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-	Microalgae	Not stated	4	Chronic	EC10	DV culture	Not	Not	53	Larras et al.

	eae	*(Gomphonema parvulum)*				(Growth Rate/Chlorophyll -a fluorescence)	medium	stated	stated		(2013)
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Gomphonema parvulum)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	1016	Larras et al. (2013)
										232.05	*GEOMETRIC MEAN*
										232.05	***VALUE USED IN SSD***
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Gomphonema parvulum)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	2,255	Larras et al. (2012)
										2,255	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Gomphonema parvulum)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	1,423	Larras et al. (2013)
										1,423	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Mayamaea fossalis)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	74	Larras et al. (2012)
										74	*GEOMETRIC MEAN*
										74	***VALUE USED IN SSD***
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Mayamaea fossalis)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	91	Larras et al. (2013)
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Mayamaea fossalis)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	96	Larras et al. (2013)
										93.5	*GEOMETRIC MEAN*

Bacillariophyta	Bacillariophyc-eae	Microalgae *(Mayamaea fossalis)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	463	Larras et al. (2012)
										463	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Mayamaea fossalis)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	139	Larras et al. (2013)
										139	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Nitzschia palea)*	Exponential growth phase	4	Chronic	EC5 (Cell density)	DV culture medium	21 ± 2	Not stated	106	Larras et al. (2012)
										106	*GEOMETRIC MEAN*
										106	***VALUE USED IN SSD***
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Nitzschia palea)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	380	Larras et al. (2013)
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Nitzschia palea)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	196	Larras et al. (2013)
										272.9	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Nitzschia palea)*	Exponential growth phase	4	Chronic	EC50 (Cell density)	DV culture medium	21 ± 2	Not stated	1,539	Larras et al. (2012)
										1,539	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Nitzschia palea)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll -a fluorescence)	DV culture medium	Not stated	Not stated	1,667	Larras et al. (2013)
										1,667	*GEOMETRIC MEAN*

Bacillariophyta	Bacillariophyc-eae	Microalgae *(Sellaphora minina)*	Not stated	4	Chronic	EC10 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	693	Larras et al. (2013)
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Sellaphora minina)*	Exponential growth phase	4	Chronic	EC10 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	3218	Larras et al. (2013)
										1493.34	*GEOMETRIC MEAN*
										1493.34	***VALUE USED IN SSD***
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Sellaphora minina)*	Not stated	4	Chronic	EC50 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	2606	Larras et al. (2013)
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Sellaphora minina)*	Exponential growth phase	4	Chronic	EC50 (Growth Rate/Chlorophyll-a fluorescence)	DV culture medium	Not stated	Not stated	4236	Larras et al. (2013)
										3322.5	*GEOMETRIC MEAN*
Bacillariophyta	Bacillariophyc-eae	Microalgae *(Stauroneis amphoroides)*	Not stated	3	Chronic	EC50 (Biomass Yield, Growth Rate, AUC)	ASTM Type 1 water	24 ± 2	7.5 ± 0.1	31	US EPA (2015a)
										31	*GEOMETRIC MEAN*
										6.2[@]	***VALUE USED IN SSD***
Chlorophyta	Trebouxiophyc-eae	Microalgae *(Chlorella pyrenoidosa*[2]*)*	Not stated	4	Chronic	EC50 (Cell count)	HB-4 media	25	Not stated	2.3	Ma et al. (2002)
Chlorophyta	Trebouxiophyc-eae	Microalgae *(Chlorella pyrenoidosa*[2]*)*	Not stated	4	Chronic	EC50 (Cell count)	HB-4 media	25	Not stated	1.3	Ma et al. (2001)
Chlorophyta	Trebouxiophyc-eae	Microalgae *(Chlorella vulgaris*[2]*)*	Not stated	4	Chronic	EC50 (Cell count)	HB-4 media	25	Not stated	4.3	Ma et al. (2002)

										2.34	*GEOMETRIC MEAN*
										0.47@	***VALUE USED IN SSD***
Chlorophyta	Chlorophyceae	Microalgae *(Scenedesmus acutus)*	Not stated	8	Chronic	EC50 (Cell count)	Inorganic medium	23	Not stated	13.29	Grossmann et al. (1992)
										13.29	*GEOMETRIC MEAN*
										2.67@	***VALUE USED IN SSD***
Chlorophyta	Chlorophyceae	Microalgae *(Scenedesmus obliquus)*	Not stated	4	Chronic	EC50 (Cell count)	HB-4 media	25	Not stated	4.09	Ma (2002)
										4.09	*GEOMETRIC MEAN*
										0.82@	***VALUE USED IN SSD***
Chlorophyta	Chlorophyceae	Microalgae *(Scenedesmus quadricauda)*	Not stated	4	Chronic	EC50 (Cell count)	HB-4 media	Not stated	Not stated	2.7	Ma et al. (2003)
										2.7	*GEOMETRIC MEAN*
										0.54@	***VALUE USED IN SSD***
Chlorophyta	Chlorophyceae	Microalgae *(Scenedesmus vacuolatus)*	Exponential growth phase	2	Chronic	EC50 (Cell density)	Not stated	25	Not stated	14.3	Copin and Chevre (2015)
										14.3	*GEOMETRIC MEAN*
										2.86@	***VALUE USED IN SSD***

Chlorophyta	Chlorophyceae	Microalgae *(Scenedesmus subspicatus[3])*	Not stated	1	Acute	NOEC (Cell count)	Inorganic medium containing sucrose	20 ± 2	Not stated	7	Schafer et al. (1994)
										7	*GEOMETRIC MEAN*
Chlorophyta	Chlorophyceae	Microalgae *(Scenedesmus subspicatus[3])*	Not stated	3	Chronic	NOEC (Cell count)	Inorganic medium containing sucrose	20 ± 2	Not stated	10	Schafer et al. (1994)
										10	*GEOMETRIC MEAN*
										10	***VALUE USED IN SSD***
Chlorophyta	Chlorophyceae	Microalgae *(Scenedesmus subspicatus[3])*	Not stated	3	Chronic	EC50 (Cell count)	Inorganic medium containing sucrose	20 ± 2	Not stated	36	Schafer et al. (1994)
										36	*GEOMETRIC MEAN*
Chlorophyta	Chlorophyceae	Microalgae *(Desmodesmus subspicatus)*	Not stated	3	Chronic	EC50 (Cell density)	Inorganic medium containing sucrose	23 ± 2	8 ± 1	46.3	Masojidek et al. (2011)
										46.3	*GEOMETRIC MEAN*
Chlorophyta	Chlorophyceae	Microalgae *(Pseudokirchner -iella subcapitata[4])*	Not stated	3	Chronic	EC50 (Cell density)	De-ionised water and growth medium (algaltoxkit)	23 ± 2	8.1 ± 0.2	45	Mezcua et al. (2002)
Chlorophyta	Chlorophyceae	Microalgae *(Selenastrum capricornutum[4])*	Exponential growth phase	3	Chronic	EC50 (Cell density)	Distilled water and algal growth medium (algaltoxkit)	23 ± 2	8 ± 1	23,000	Fernandez-Alba et al. (2002a)
										149	*GEOMETRIC MEAN*
Chlorophyta	Chlorophyceae	Microalgae	Not stated	3	Chronic	LOEC	De-ionised	23 ± 2	8.1 ±	15	Mezcua et al.

		(Pseudokirchner-iella subcapitata[4])				(Cell density)	water and growth medium (algaltoxkit)		0.2		(2002)
Chlorophyta	Chlorophyceae	Microalgae *(Selenastrum capricornutum[4])*	Exponential growth phase	3	Chronic	LOEC (Cell density)	Distilled water and algal growth medium (algaltoxkit)	23 ± 2	8 ± 1	45	Fernandez-Alba et al. (2002b)
										26	*GEOMETRIC MEAN*
Chlorophyta	Chlorophyceae	Microalgae *(Pseudokirchner-iella subcapitata[4])*	Not stated	4	Chronic	EC50 (Cell count)	Not stated	25 - 27	7.6 - 9.0	36.4	Schrader et al. (1998)
Chlorophyta	Chlorophyceae	Microalgae *(Raphidocelis subcapitata[4])*	Not stated	4	Chronic	EC50 (Cell count)	HB-4 media	25	Not stated	0.7	Ma et al. (2006)
										5.05	*GEOMETRIC MEAN*
Chlorophyta	Chlorophyceae	Microalgae *(Selenastrum capricornutum[4])*	Not stated	4	Chronic	EC50 (Biomass Yield, Growth Rate, AUC)	ASTM Type 1 water	24 ± 2	7.5 ± 0.1	2.4	US EPA (2015a)
										2.4	*GEOMETRIC MEAN*
Chlorophyta	Chlorophyceae	Microalgae *(Selenastrum capricornutum[4])*	Not stated	4	Chronic	NOEL (Biomass Yield, Growth Rate, AUC)	ASTM Type 1 water	24 ± 2	7.5 ± 0.1	0.44	US EPA (2015a)
										0.44	*GEOMETRIC MEAN*
										0.44	***VALUE USED IN SSD***
Chordata	Actinopterygii	Goldfish *(Carassius auratus)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	5,800	Nishiuchi and Hashimoto (1967)
										5,800	*GEOMETRIC MEAN*

Chordata	Actinopterygii	Grass Carp *(Ctenopharyngo -don idella)*	1+ years	1	Acute	LC50 (Mortality)	Dechlorinated tap water	13.5 ± 0.5	8.1	47,000	Tooby et al. (1980)
										47,000	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Grass Carp *(Ctenopharyngo -don idella)*	1+ years	2	Acute	LC50 (Mortality)	Dechlorinated tap water	13.5 ± 0.5	8.1	44,000	Tooby et al. (1980)
										44,000	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Grass Carp *(Ctenopharyngo -don idella)*	1+ years	4	Acute	LC50 (Mortality)	Dechlorinated tap water	13.5 ± 0.5	8.1	31,000	Tooby et al. (1980)
										31,000	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Common Carp *(Cyprinus carpio)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	3,200	Nishiuchi and Hashimoto (1967)
										3,200	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Common Carp *(Cyprinus carpio)*	Not stated	4	Acute	LC50 (Mortality)	*	*	*	2,900	Knapek and Lakota (1974)
										2,900	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	7,400	Cope (1965)
										7,400	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	22 ± 2	6.0 - 8.0	3,200	US EPA (2015a)
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted	22 ± 2	6.0 - 8.0	2,800	US EPA (2015a)

							water				
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Reconstituted water	23.8	7.1	8,900	Macek et al. (1969)
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Reconstituted water	23.8	7.1	5,900	Macek et al. (1969)
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Reconstituted water	23.8	7.1	7,600	Macek et al. (1969)
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	22 ± 2	6.0 - 8.0	84,000	US EPA (2015b)
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	*	*	*	4,000	Cope (1965)
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Well water, reconstituted water	18 ± 1	6.5 - 8.5	8,200	Johnson and Finley (1980)
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	22 ± 2	6.0 - 8.0	3,200	US EPA (2015b)
Chordata	Actinopterygii	Bluegill Sunfish *(Lepomis macrochirus)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	22 ± 2	6.0 - 8.0	2,800	US EPA (2015b)
										6,231.35	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Striped Bass *(Morone saxatilis)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	8,000	Hughes (1973)
Chordata	Actinopterygii	Striped Bass *(Morone saxatilis)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	500	Hughes (1973)

										2,000	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Striped Bass *(Morone saxatilis)*	Not stated	3	Acute	LC50 (Mortality)	*	*	*	500	Hughes (1973)
Chordata	Actinopterygii	Striped Bass *(Morone saxatilis)*	Not stated	3	Acute	LC50 (Mortality)	*	*	*	6,000	Hughes (1973)
										1,732.05	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Striped Bass *(Morone saxatilis)*	Not stated	4	Acute	LC50 (Mortality)	*	*	*	6,000	Hughes (1973)
Chordata	Actinopterygii	Striped Bass *(Morone saxatilis)*	Not stated	4	Acute	LC50 (Mortality)	Distilled water	21	8.2	3,100	Wellborn (1969)
Chordata	Actinopterygii	Striped Bass (*Morone saxatilis)*	Not stated	4	Acute	LC50 (Mortality)	*	*	*	500	Hughes (1973)
										2,102.94	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Cutthroat Trout *(Oncorhynchus clarkii)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	12 ± 2	6.0 - 8.0	1,400	US EPA (2015a)
Chordata	Actinopterygii	Cutthroat Trout *(Oncorhynchus clarkii)*	Not stated	4	Acute	LC50 (Mortality)	Well water, reconstituted water	10 ± 1	6.5 - 8.5	1,400	Johnson and Finley (1980)
Chordata	Actinopterygii	Cutthroat Trout *(Oncorhynchus clarkii)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	12 ± 2	6.0 - 8.0	710	US EPA (2015a)
										1,116.45	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Coho Salmon *(Oncorhynchus kisutch)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	16,000	Hughes and Davis (1962)

											16,000	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Coho Salmon *(Oncorhynchus kisutch)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	12 ± 2	6.0 - 8.0	2,400	US EPA (2015a)
										2,400	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	12 ± 2	6.0 - 8.0	1,950	US EPA (2015a)
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Not stated	4	Acute	LC50 (Mortality)	Well water, reconstituted water	13 ± 1	6.5 - 8.5	4,900	Johnson and Finley (1980)
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	12 ± 2	6.0 - 8.0	19,600	US EPA (2015b)
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	12 ± 2	6.0 - 8.0	23,800	US EPA (2015b)
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Not stated	4	Acute	LC50 (Mortality)	Well water, reconstituted water	13 ± 1	6.5 - 8.5	16,000	Johnson and Finley (1980)
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	12 ± 2	6.0 - 8.0	16,000	US EPA (2015b)
										10,222.35	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Juveniles (<24 hours after	7	Acute	LC50 (Mortality)	Dechlorinated tap water	20	Not measured	74,000	Okamura et al. (2002)

			hatching)								
										74,000	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Juveniles (<24 hours after hatching)	14	Acute	LC50 (Mortality)	Dechlorinated tap water	20	Not measured	15,000	Okamura et al. (2002)
										15,000	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Juveniles (<24 hours after hatching)	21	Chronic	LC50 (Mortality)	Dechlorinated tap water	20	Not measured	5,900	Okamura et al. (2002)
										5,900	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Rainbow Trout *(Oncorhynchus mykiss)*	Juveniles (<24 hours after hatching)	28	Chronic	LC50 (Mortality)	Dechlorinated tap water	20	Not measured	230	Okamura et al. (2002)
										230	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Japanese Rice Fish *(Oryzias latipes)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	3,500	Nishiuchi and Hashimoto (1967)
										3,500	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Rice Fish *(Oryzias melastigma)*	Larvae	4	Acute	LC50 (Mortality)	Culture medium prepared with filtered artificial seawater (FAS)	25 ± 1	8.1 - 8.4	7,800	Bao et al. (2011)
										7,800	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Adult	1	Acute	LC50 (Mortality)	Lake Superior water	24.3 ± 0.8	Not stated	23,300	Call et al. (1987)

										23,300	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Adult	2	Acute	LC50 (Mortality)	Lake Superior water	24.3 ± 0.8	Not stated	19,900	Call et al. (1987)
										19,900	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Not stated	4	Acute	LC50 (Mortality)	Lake water	25 ± 1	6.5 - 8.0	14,200	Geiger et al. (1986)
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Adult	4	Acute	LC50 (Mortality)	Lake Superior water	24.3 ± 0.8	Not stated	14,200	Call et al. (1987)
										14,200	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Embryo/ larval	7	Chronic	NOAEL (Mortality)	0.45 µm filtered well water	24	6.8 ± 0.1	8,300	Nebeker and Schuytema (1998)
										8,300	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Embryo/ larval	7	Chronic	LOAEL (Mortality)	0.45 µm filtered well water	24	6.8 ± 0.1	15,100	Nebeker and Schuytema (1998)
										15,100	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Embryo/ larval	7	Chronic	LC50 (Mortality)	0.45 µm filtered well water	24	6.8 ± 0.1	11,700	Nebeker and Schuytema (1998)
										11,700	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales*	Embryo/ larval	7	Chronic	NOAEL (Number of eggs hatched)	0.45 µm filtered well water	24	6.8 ± 0.1	31,200	Nebeker and Schuytema (1998)

		promelas)									
										31,200	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Embryo/ larval	7	Chronic	NOAEL (Blotted wet weight)	0.45 µm filtered well water	24	6.8 ± 0.1	15,100	Nebeker and Schuytema (1998)
										15,100	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Embryo/ larval	7	Chronic	NOAEL (Length)	0.45 µm filtered well water	24	6.8 ± 0.1	4,200	Nebeker and Schuytema (1998)
										4,200	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Embryo/ larval	7	Chronic	LOAEL (Length)	0.45 µm filtered well water	24	6.8 ± 0.1	8,300	Nebeker and Schuytema (1998)
										8,300	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Adult	8	Acute	LC50 (Mortality)	Lake Superior water	24.3 ± 0.8	Not stated	7,700	Call et al. (1987)
										7,700	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles (1.5 months)	10	Acute	NOAEL (Mortality)	0.45 µm filtered well water	24	6.8 ± 0.1	20,000	Nebeker and Schuytema (1998)
										20,000	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles (1.5 months)	10	Acute	LOAEL (Mortality)	0.45 µm filtered well water	24	6.8 ± 0.1	27,100	Nebeker and Schuytema (1998)
										27,100	*GEOMETRIC*

											MEAN
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles (1.5 months)	10	Acute	LC50 (Mortality)	0.45 µm filtered well water	24	6.8 ± 0.1	27,100	Nebeker and Schuytema (1998)
										27,100	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles (1.5 months)	10	Acute	NOAEL (Weight)	0.45 µm filtered well water	24	6.8 ± 0.1	3,400	Nebeker and Schuytema (1998)
										3,400	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles (1.5 months)	10	Acute	LOAEL (Weight)	0.45 µm filtered well water	24	6.8 ± 0.1	3,400	Nebeker and Schuytema (1998)
										3,400	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles (1.5 months)	10	Acute	NOAEL (Length)	0.45 µm filtered well water	24	6.8 ± 0.1	3,400	Nebeker and Schuytema (1998)
										3,400	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles (1.5 months)	10	Acute	LOAEL (Length)	0.45 µm filtered well water	24	6.8 ± 0.1	3,400	Nebeker and Schuytema (1998)
										3,400	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Early life	60	Chronic	LOEC (Mortality)	Dilution water	25 ± 2	Not stated	61.8	US EPA (2015a)
										61.8	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead	Life cycle	64	Chronic	NOEL	Dilution water	25 ± 2	Not	26.4	US EPA

		Minnow *(Pimephales promelas)*				(Mortality)			stated		(2015a)
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles	64	Chronic	NOEC (Mortality)	Lake Superior water	24.3 ± 0.8	Not stated	33.4	Call et al. (1987)
										29.69	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles	64	Chronic	LOEC (Mortality)	Lake Superior water	24.3 ± 0.8	Not stated	78	Call et al. (1987)
										78	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles	64	Chronic	NOEC (Hatchlings)	Lake Superior water	24.3 ± 0.8	Not stated	29	Call et al. (1987)
										29	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles	64	Chronic	NOEC (Length)	Lake Superior water	24.3 ± 0.8	Not stated	29	Call et al. (1987)
										29	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Fathead Minnow *(Pimephales promelas)*	Juveniles	64	Chronic	NOEC (Wet weight)	Lake Superior water	24.3 ± 0.8	Not stated	29	Call et al. (1987)
										29	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Harlequin Rasbora *(Rasbora heteromorpha)*	Not stated	2	Acute	LC50 (Mortality)	*	*	*	190,000	Tooby et al. (1975)
										190,000	*GEOMETRIC MEAN*

Chordata	Actinopterygii	Lake Trout *(Salvelinus namaycush)*	Not stated	4	Acute	LC50 (Mortality)	Clean surface or ground water, reconstituted water	12 ± 2	6.0 - 8.0	1,200	US EPA (2015b)
Chordata	Actinopterygii	Lake Trout *(Salvelinus namaycush)*	Not stated	4	Acute	LC50 (Mortality)	Well water, reconstituted water	10 ± 1	7.2-7.5	2,700	Johnson and Finley (1980)
										1,800	*GEOMETRIC MEAN*
Chordata	Actinopterygii	Tench *(Tinca tinca)*	Not stated	4	Acute	LC50 (Mortality)	*	*	*	15,500	Knapek and Lakota (1974)
										15,000	*GEOMETRIC MEAN*
Chordata	Amphibia	Pacific Tree Frog *(Pseudacris regilla)*	Embryo	10	Chronic	NOEC (Mortality)	Natural high-quality, chlorine-free freshwater	20	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	Pacific Tree Frog *(Pseudacris regilla)*	Embryo	14	Chronic	NOEC (Length)	Natural high-quality, chlorine-free freshwater	20	7.4	29100	Schuytema and Nebeker (1998)
Chordata	Amphibia	Pacific Tree Frog *(Pseudacris regilla)*	Larvae	14	Chronic	NOEC (Length)	Natural high-quality, chlorine-free freshwater	20	7.4	14,500	Schuytema and Nebeker (1998)
										20,541.42	*GEOMETRIC MEAN*
Chordata	Amphibia	Pacific Tree Frog *(Pseudacris regilla)*	Larvae	14	Chronic	NOEC (Wet weight)	Natural high-quality, chlorine-free freshwater	20	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	Pacific Tree Frog *(Pseudacris*	Larvae	14	Chronic	NOEC (Dry weight)	Natural high-quality, chlorine-free	20	7.4	21,000	Schuytema and Nebeker (1998)

		regilla)					freshwater				
										21,000	*GEOMETRIC MEAN*
Chordata	Amphibia	Pacific Tree Frog *(Pseudacris regilla)*	Larvae	14	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	20	7.4	10,800	Schuytema and Nebeker (1998)
Chordata	Amphibia	Pacific Tree Frog *(Pseudacris regilla)*	Larvae	14	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	20	7.4	19,600	Schuytema and Nebeker (1998)
										14,549.23	*GEOMETRIC MEAN*
Chordata	Amphibia	Northern Red-legged Frog *(Rana aurora)*	Larvae	14	Chronic	NOEC (Wet weight)	Natural high-quality, chlorine-free freshwater	20	7.4	7,600	Schuytema and Nebeker (1998)
										7,600	*GEOMETRIC MEAN*
Chordata	Amphibia	Northern Red-legged Frog *(Rana aurora)*	Larvae	14	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	20	7.4	22,200	Schuytema and Nebeker (1998)
										22,200	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	10	Chronic	NOEC (Dry weight)	Natural high-quality, chlorine-free freshwater	24	7.4	7,600	Schuytema and Nebeker (1998)
										7,600	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	10	Chronic	NOEC (Wet weight)	Natural high-quality, chlorine-free freshwater	24	7.4	14,500	Schuytema and Nebeker (1998)
										14,500	*GEOMETRIC MEAN*
Chordata	Amphibia	American	Larvae	10	Chronic	NOEC	Natural high-	24	7.4	14,500	Schuytema

		Bullfrog *(Rana catesbeiana)*				(Length)	quality, chlorine-free freshwater				and Nebeker (1998)
										14,500	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	10	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	24	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	14	Chronic	NOEC (Dry weight)	Natural high-quality, chlorine-free freshwater	24	7.4	14,500	Schuytema and Nebeker (1998)
										14,500	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	14	Chronic	NOEC (Length)	Natural high-quality, chlorine-free freshwater	24	7.4	14,500	Schuytema and Nebeker (1998)
										14,500	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	14	Chronic	NOEC (Wet weight)	Natural high-quality, chlorine-free freshwater	24	7.4	21,100	Schuytema and Nebeker (1998)
										21,100	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	14	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	24	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	21	Chronic	NOEC (Dry weight)	Natural high-quality, chlorine-free freshwater	24	7.4	7,600	Schuytema and Nebeker (1998)

										7,600	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	21	Chronic	NOEC (Wet weight)	Natural high-quality, chlorine-free freshwater	24	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	21	Chronic	NOEC (Length)	Natural high-quality, chlorine-free freshwater	24	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	American Bullfrog *(Rana catesbeiana)*	Larvae	21	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	24	7.4	12,700	Schuytema and Nebeker (1998)
										12,700	*GEOMETRIC MEAN*
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Embryo	4	Acute	NOEC (Dry Weight)	Natural high-quality, chlorine-free freshwater	24	7.4	21,100	Schuytema and Nebeker (1998)
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Embryo	4	Acute	NOEC (Dry Weight)	Natural high-quality, chlorine-free freshwater	24	7.4	14,500	Schuytema and Nebeker (1998)
										17,491.43	*GEOMETRIC MEAN*
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Embryo	4	Acute	NOEC (Length)	Natural high-quality, chlorine-free freshwater	24	7.4	7,600	Schuytema and Nebeker (1998)
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Embryo	4	Acute	NOEC (Length)	Natural high-quality, chlorine-free freshwater	24	7.4	14,500	Schuytema and Nebeker (1998)
										10,497.62	*GEOMETRIC*

											MEAN
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Larvae	4	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	24	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Embryo	14	Chronic	NOEC (Dry Weight)	Natural high-quality, chlorine-free freshwater	24	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Embryo	14	Chronic	NOEC (Length)	Natural high-quality, chlorine-free freshwater	24	7.4	29,100	Schuytema and Nebeker (1998)
										29,100	*GEOMETRIC MEAN*
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Larvae	14	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	24	7.4	8,100	Schuytema and Nebeker (1998)
Chordata	Amphibia	African Clawed Frog *(Xenopus laevis)*	Larvae	14	Chronic	LC50 (Mortality)	Natural high-quality, chlorine-free freshwater	24	7.4	14,500	Schuytema and Nebeker (1998)
										10,837.44	*GEOMETRIC MEAN*
Cyanobacteria	Cyanophyceae	Cyanobacteria *(Anabaena variabilis)*	Not stated	12	Chronic	EC50 (Growth Rate/Chlorophyll -a fluorescence)	BG11 medium	25 ± 1	Not stated	80	Singh et al. (2011)
										80	*GEOMETRIC MEAN*
										16[@]	***VALUE USED IN SSD***
Cyanobacteria	Cyanophyceae	Cyanobacteria	<10 days	7	Chronic	EC50	MN medium	25 ± 1	8.1 -	4.7	Bao et al.

		(Chroococcus minor)				(Cell density)	without inoculants, 0.45 µm filtered		8.4		(2011)
										4.7	*GEOMETRIC MEAN*
										0.94[@]	***VALUE USED IN SSD***
Mollusca	Gastropoda	Freshwater Snail *(Physa gyrina)*	15 day old young	10	Acute	NOAEL (Mortality)	0.45 µm filtered well water	23	6.8 ± 0.1	29,100	Nebeker and Schuytema (1998)
										29,100	*GEOMETRIC MEAN*
Mollusca	Gastropoda	Freshwater Snail *(Physa gyrina)*	15 day old young	10	Acute	NOAEL (Blotted wet weight)	0.45 µm filtered well water	23	6.8 ± 0.1	13,400	Nebeker and Schuytema (1998)
										13,400	*GEOMETRIC MEAN*
Mollusca	Gastropoda	Freshwater Snail *(Physa gyrina)*	15 day old young	10	Acute	LOAEL (Blotted wet weight)	0.45 µm filtered well water	23	6.8 ± 0.1	22,800	Nebeker and Schuytema (1998)
										22,800	*GEOMETRIC MEAN*
Tracheophyta	Liliopsida	Macrophyte *(Lemna aequinoctialis)*	Not stated	4	Acute	EC10 (Frond count)	0.45 mm filtered distilled water, autoclaved and Hoagland No. 2 Basal Salt Mixture	30 ± 1	6 ± 0.2	2.79	Seery et al. (in prep.)
										2.79	*GEOMETRIC MEAN*
Tracheophyta	Liliopsida	Macrophyte *(Lemna aequinoctialis)*	Not stated	4	Acute	EC50 (Frond count)	0.45 mm filtered distilled water, autoclaved and Hoagland No. 2 Basal Salt Mixture	30 ± 1	6 ± 0.2	5.55	Seery et al. (in prep.)

										5.55	*GEOMETRIC MEAN*
Tracheophyta	Liliopsida	Macrophyte *(Lemna gibba)*	Not stated	7	Chronic	NOEL (Total frond number/Growth rate/Mortality)	M-Hoaglands or 20X-AAP nutrient media. ASTM type 1 water	25 ± 2	4.8 - 5.2 (M-Hoagl-ands) and 7.5 ± 0.1 20X-AAP).	2.49	USEPA (2015)
										2.49	*GEOMETRIC MEAN*
										2.49	***VALUE USED IN SSD***
Tracheophyta	Liliopsida	Macrophyte *(Lemna gibba)*	Not stated	7	Chronic	EC50 (Total frond number/Growth rate/Mortality)	M-Hoaglands or 20X-AAP nutrient media. ASTM type 1 water	25 ± 2	4.8 - 5.2 (M-Hoagl-ands) and 7.5 ± 0.1 20X-AAP).	13	USEPA (2015)
										13	*GEOMETRIC MEAN*
Tracheophyta	Liliopsida	Macrophyte *(Lemna minor)*	Not stated	7	Chronic	LOEC (Total chlorophyll)	Mineral medium	25 ± 1	Not stated	5	Teisseire et al. (1999)
										5	*GEOMETRIC MEAN*
Tracheophyta	Liliopsida	Macrophyte *(Lemna minor)*	Not stated	7	Chronic	EC50 (Total chlorophyll)	Mineral medium	25 ± 1	Not stated	25	Teisseire et al. (1999)
										25	*GEOMETRIC MEAN*

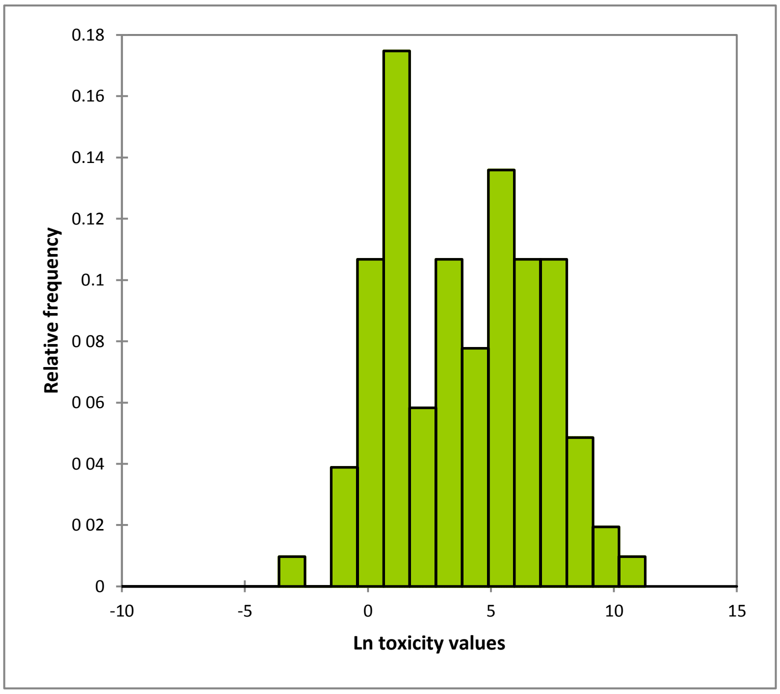
										3.16[&]	***VALUE USED IN SSD***
Tracheophyta	Liliopsida	Macrophyte *(Lemna minor)*	Not stated	7	Chronic	EC50 (Frond count)	Not stated	24 ± 1	6.5 ± 0.2	28.3	Gatidou et al. (2015)
										26.6	*GEOMETRIC MEAN*
Tracheophyta	Liliopsida	Macrophyte *(Lemna paucicostata)*	Not stated	8	Chronic	EC50 (Frond cover area)	Inorganic medium containing sucrose	25	Not stated	10.96	Grossmann et al. (1992)
										10.96	*GEOMETRIC MEAN*
										2.19[@]	***VALUE USED IN SSD***

* Data were obtained from the USEPA (2015) Office of Pesticide Programs Database, with methods originating from various published studies which were unattainable, therefore detail of media, temperature and pH for those entries were unavailable. It is important to note that the USEPA (2015) follows strict quality assurance and quality check procedures within their organisation to ensure only high quality ecotoxicology data are reported. It was therefore assumed the data were the equivalent of either high or acceptable quality and were therefore usable in the derivation of guideline values for diuron.

[1] This species has also been called *Ulnaria ulna*. [2] This species has also been called *Chlorella vulgaris* and *Chlorella pyrenoidosa*. [3] This species has also been called Desmodesmus subspicatus. [4] This species has also been called *Raphidocelis subcapitata* and *Pseudokirchneriella subcapitata*. [@] Values were chronic EC/LC50 values that were converted to chronic NOEC/EC10 values by dividing by 5 (Warne et al. 2015). [&] Value was the geometric mean of chronic LOEC and EC50 values that were converted to chronic NOEC/EC10 values by 2.5 and 5, respectively (Warne et al. 2015).

Attachment B. Distribution of sensitivities for aquatic species used in SSD

The toxicity data for diuron to all freshwater and marine species that passed the screening and quality assessment schemes were combined to create a larger dataset to determine the modality of the data. All the data that were not chronic NOEC or EC10 values were first converted to this type of data using the methods recommended by Warne et al. (2015). A natural logarithmic (ln) transformation was then applied to normalise the data. Visual examination of the histogram of the transformed data indicated that the distribution of the diuron ecotoxicity data may be bimodal



(Figure 3).

Figure 3 Histogram of the natural logarithm (ln) of all diuron (freshwater and marine) toxicity data for phototrophic and non-phototrophic species (*n* = 103).

The diuron ecotoxicity data for phototrophic and non-phototrophic species were tested to see if they came from the same population. To test for significant differences (i.e. p-value ≤ 0.05) between the two groups, the parametric two-sample *t* test was used as the transformed diuron toxicity data had equal variances (Fisher's F-Test; p = 0.551) but did not follow a normal distribution (Anderson-Darling; p < 0.000). Results from the two-sample *t* test indicated that the two groups were significantly different (p = <0.0001), therefore it can be concluded that the distribution of the diuron concentration data is bi- or multi-modal.

References for attachments

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