

Water Quality Criteria Report for Bifenthrin

Appendix B

Data summary sheets

Appendix B1: Acceptable data rated RR (p. B2-B29)

Appendix B2: Supplemental data rated RL, LR, or LL (p. B30-B53)

Appendix B3: Unused data rated N (p. B54-B64)

Abbreviations used in this appendix:

n/a = Not Applicable

NC = Non Calculable

NR = Not Reported

Unused lines were deleted from tables

Within each section, studies are listed in alphabetical order by species name, when there are multiple summaries for one species, they are listed in alphabetical order by author.

Appendix B1

Studies rated RR

Appendix B1: Studies rated RR

Toxicity Data Summary

Ceriodaphnia dubia

Study: Guy D. 2000a. Aquatic Toxicology laboratory Report P-2161-2. Bifenthrin with cladoceran *Ceriodaphnia dubia* in an acute definitive test. California Department of Fish and Game, Aquatic Toxicology Lab, Elk Grove, CA.

Relevance

Score: 100

Rating: R

Reliability

Score: 86.5

Rating: R

Reference	Guy 2000a	<i>C. dubia</i>
Parameter	Value	Comment
Test method cited	ASTM /EPA	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Ceriodaphnia</i>	
Species	<i>dubia</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	In house culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	100% survival in solvent and dilution water controls	
Temperature	24.0 -24.7 °C	
Test type	Static w/ 48 h renewal	
Photoperiod/light intensity	16:8 light:dark	
Dilution water	NR	
pH	8.04-8.38	
Hardness	138-168 mg/L	
Alkalinity	152-184 mg/L	
Conductivity	328-447 µs/cm	
Dissolved Oxygen	7.74-8.36 mg/L	

Appendix B1: Studies rated RR

Reference	Guy 2000a	<i>C. dubia</i>
Parameter	Value	Comment
Feeding	No	
Purity of test substance	97.8 %	
Concentrations measured?	No - estimated	
Measured is what % of nominal?	85% estimated from spikes	
Chemical method documented?	No	
Concentration of carrier (if any) in test solutions	0.0016 mL/L (acetone)	
Nominal and estimated (Est) concentrations (divided by a factor derived from recovery of spiked water samples on day 0 and day 2		
Concentration 1 Nom/Est (µg/L)	0.05/0.036	4 reps and 5 neonates per rep
Concentration 2 Nom/Est (µg/L)	0.1/0.036	4 reps and 5 neonates per rep
Concentration 3 Nom/Est (µg/L)	0.2/0.091	4 reps and 5 neonates per rep
Concentration 4 Nom/Est (µg/L)	0.4/0.153	4 reps and 5 neonates per rep
Concentration 5 Nom/Est (µg/L)	0.8/0.392	4 reps and 5 neonates per rep
Concentration 6 Nom/Est (µg/L)	1.6/0.861	4 reps and 5 neonates per rep
Controls	Water only and a solvent (acetone) control	4 reps and 5 neonates per rep
LC ₅₀ (95% Confidence interval) (µg/L)	0.078 (0.056-0.13)	Linear interpolation

Reliability points taken off for:

Documentation: Analytical method (4), Measured concentrations (3), Dilution water source (3), Hypothesis tests (8)

Acceptability: Meas. Concentrations 20% Nom (4), Dilution water source acceptable (2), Hypothesis tests (3)

Appendix B1: Studies rated RR

Toxicity Data Summary

Ceriodaphnia dubia

Study: Wheelock CE, Miller JL, Miller MJ, Gee SJ, Shan G, Hammock BD. 2004. Development of toxicity identification evaluation procedures for pyrethroid detection using esterase activity. *Environmental Toxicology and Chemistry* 23(11): 2699-2708.

Relevance

Score: 100

Rating: R

Reliability

Score: 77.5

Rating: R

Reference	Wheelock <i>et al.</i> 2004	<i>C. dubia</i>
Parameter	Value	Comment
Test method cited	EPA	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Ceriodaphnia</i>	
Species	<i>dubia</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	AQUA-Science, Davis, CA	
Have organisms been exposed to contaminants?	Probably not	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	48 h	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	> 90%	
Temperature	25 ± 1 °C	
Test type	Static	
Photoperiod/light intensity	16:8, light:dark	
Dilution water	EPA moderately hard	
pH	7.4-7.8	
Hardness	80-100 mg/L	
Alkalinity	60-70 mg/L	
Conductivity	Measured but NR	
Dissolved Oxygen	Measured but NR	
Feeding	None during test	
Purity of test substance	> 97%	

Appendix B1: Studies rated RR

Reference	Wheelock <i>et al.</i> 2004	<i>C. dubia</i>
Parameter	Value	Comment
Concentrations measured?	No	
Measured is what % of nominal?	NR	
Chemical method documented?	NR	
Concentration of carrier (if any) in test solutions	< 1 %	
Concentration 1 Nom/Meas ($\mu\text{g/L}$)	5-7 concentrations	2-4 reps w/ 5 neonates each
Control	Water and methanol control	2-4 reps w/ 5 neonates each
LC ₅₀ ($\mu\text{g/L}$)	48 h: 0.142 ± 0.122	ToxCAL software, but no stat method reported

Reliability points taken off for:

Documentation: Analytical method (4), Measured concentrations (3), Dissolved Oxygen (4), Conductivity (2), Statistical methods identified (5), Hypothesis tests (8)

Acceptability: Measured concentrations within 20% Nom (4), Concentrations do not exceed 2x water solubility (4), Carrier solvent ≤ 0.5 mL/L (4), Appropriate spacing between concentrations (2), Appropriate statistical method (2), Hypothesis tests (3)

Appendix B1: Studies rated RR

Toxicity Data Summary

Chironomus dilutus (formerly *Chironomus tentans*)

Study: Anderson BS, Phillips BM, Hunt JW, Connor V, Richard N, Tjeerdema RS. 2006. Identifying primary stressors impacting macroinvertebrates in the Salinas River (CA, USA): Relative effects of pesticides and suspended particles. *Environmental Pollution* 141:402-408.

Relevance
Score: 90 (No standard method)
Rating: R

Reliability
Score: 79
Rating: R

Reference	Anderson <i>et al.</i> 2006	<i>C. dilutus</i>
Parameter	Value	Comment
Test method cited	NR	
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Chironomidae	
Genus	<i>Chironomus</i>	
Species	<i>dilutus</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	3 rd instar	
Source of organisms	Chesapeake Culture, Hayes, VA.	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	NR	
Animals randomized?	NR	
Test vessels randomized?	No	
Test duration	96 hr	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	90% survival*	
Temperature	23 ± 1 °C*	
Test type	Static	
Photoperiod/light intensity	16 light:8 dark*	
Dilution water	Well Water	
pH	NR	
Hardness	91.6 mg/L*	
Alkalinity	122.4 mg/L as CaCO ₃ *	
Conductivity	NR	

Appendix B1: Studies rated RR

Reference	Anderson <i>et al.</i> 2006	<i>C. dilutus</i>
Parameter	Value	Comment
Dissolved Oxygen	NR	
Feeding	Not fed	
Purity of test substance	100%	
Concentrations measured?	Some were, but not used in toxicity value calculations	
Measured is what % of nominal?	36-65%	Meas. 2 reps of only some conc's
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	Used 100 mg/L methanol stock	
Concentration 1 Nom/Meas ($\mu\text{g/L}$)	0.560/ 200, 364	10 reps, 1 per rep
Concentration 2 Nom/Meas ($\mu\text{g/L}$)	1.8/ 0.964, 1.110	10 reps, 1 per rep
Concentration 3 Nom/Meas ($\mu\text{g/L}$)	5/ NR	10 reps, 1 per rep
Concentration 4 Nom/Meas ($\mu\text{g/L}$)	10/ NR	10 reps, 1 per rep
Concentration 5 Nom/Meas ($\mu\text{g/L}$)	20/ NR	10 reps, 1 per rep
Control	0/ NR	10 reps, 1 per rep
LC ₅₀ ($\mu\text{g/L}$)	2.615	Method: Spearman-Kärber

Other notes:

*Control survival, temp. variation photoperiod, and water chemistry obtained by personal communication with the testing laboratory.

Emailing author revealed typo in the article. The LC₅₀ of 26 $\mu\text{g/L}$ in the paper SHOULD READ 2.6 $\mu\text{g/L}$.

Reliability points taken off for:

Documentation: Dissolved Oxygen (4), Conductivity (2), pH (3), Hypothesis tests (8)

Acceptability: Standard method (5), Meas. Concentrations 20% Nom (4), Organisms randomly assigned to containers (1), Organisms properly acclimated (1), Dissolved oxygen (6), Conductivity (1), pH (2), Random design (2), Hypothesis tests (3)

Appendix B1: Studies rated RR

Toxicity Data Summary

Daphnia magna

Study: Surprenant DC. 1983. Acute toxicity of FMC 54800 technical to *Daphnia magna*.
Bionomics Study. FMC Study No: A83 / 986. MRID 00132537.

Relevance
Score: 100
Rating: R

Reliability
Score: 89
Rating: R

Reference	Surprenant 1983	<i>D. magna</i>
Parameter	Value	Comment
Test method cited	USEPA	
Phylum/subphylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Daphnia</i>	
Species	<i>magna</i>	
Native to	Northeastern United States	
Age/size at start of test/growth phase	< 24 hours	
Source of organisms	Laboratory culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	48 hr	
Data for multiple times?	Yes	
Effect 1	Mortality	
Control response 1	0 %	
Temperature	20-21 °C	
Test type	Flow-through	
Photoperiod/light intensity	16 light: 8 dark	
Dilution water	EPA hard water (fortified well water)	Warham Mass. well water
pH	7.9-8.3	
Hardness	160-190 mg/L	
Alkalinity	110-130 mg/L	
Conductivity	400-600 uMhos/cm	
Dissolved Oxygen	> 5.6 mg/L	
Feeding	None	

Appendix B1: Studies rated RR

Reference	Surprenant 1983	<i>D. magna</i>
Parameter	Value	Comment
Purity of test substance	88.35 %	
Concentrations measured?	No	
Measured is what % of nominal?	NR	
Chemical method documented?	No	
Concentration of carrier (if any) in test solutions	< 0.47 µL/mL	DMF
Concentration 1 Nom (µg/L)	10	4 reps, 20 org/rep
Concentration 2 Nom (µg/L)	5	4 reps, 20 org/rep
Concentration 3 Nom (µg/L)	2.5	4 reps, 20 org/rep
Concentration 4 Nom (µg/L)	1.2	4 reps, 20 org/rep
Concentration 5 Nom (µg/L)	0.60	4 reps, 20 org/rep
Control	Solvent control and dilution water	4 reps, 20 org/rep
LC ₅₀ (95% confidence limit) (µg/L)	48 hr: 1.6 (1.2-2.0)	Method: Moving angle average analysis

Reliability points taken off for:

Documentation: Analytical method (4), Measured concentrations (3), Hypothesis tests (8)

Acceptability: Measured concentrations within 20% Nom (4), Hypothesis tests (3)

Appendix B1: Studies rated RR

Toxicity Data Summary

Daphnia magna

Study: Burgess D. 1989. Chronic Toxicity of 14C-FMC 54800 to *Daphnia magna* Under Flow-Through Test Conditions. ABC Labs. FMC #A88-2649. MRID 411565-01.

Relevance
Score: 100
Rating: R

Reliability
Score: 93.5
Rating: R

Reference	Burgess 1989	<i>D. magna</i>
Parameter	Value	Comment
Test method cited	USEPA/ASTM/ Organization for Economic Cooperation and Development	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Daphnia</i>	
Species	<i>magna</i>	
Family in North America?	Yes	
Age/size at start of test	< 24 hours	
Source of organisms	Lab Culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated / disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Not Reported	
Test duration	21 Days	
Data for multiple times?	Raw data, but no toxicity values	
Effect 1	Survival	
Control response 1	97.5 %	
Effect 2	Length	
Control response 2	4.1 mm	
Effect 3	Time to 1 st Brood	
Control response 3	8 days	
Effect 4	Reproduction	
Control response 4	4.7 young/day/adult	
Temperature	19 – 20 °C	
Test type	Flow-Through	
Photoperiod/light intensity	16 light:8 dark, 30-70 Foot Candles	
Dilution water	Blended R.O. and well water to achieve hardness	Missouri well water

Appendix B1: Studies rated RR

Reference	Burgess 1989	<i>D. magna</i>
Parameter	Value	Comment
pH	7.4-7.7	
Hardness	160-180 mg/L	
Alkalinity	174-192 mg/L	
Conductivity	350-360 µmhos/cm	
Dissolved Oxygen	7.4-8.4 mg/L	
Feeding	Senastrum suspension 3x daily + Yeast, Vitamin, Tetramin 1x daily	
Purity of test substance	97%	purified in lab
Concentrations measured?	Yes	
Measured is what % of nominal?	50-76%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	Not Reported	
Concentration 1 Nom/Meas (ng/L)	0.6/0.296	4 rep/10 per rep
Concentration 2 Nom/Meas (ng/L)	1.2/0.76	4 rep/10 per rep
Concentration 3 Nom/Meas (ng/L)	2.5/1.3	4 rep/10 per rep
Concentration 4 Nom/Meas (ng/L)	5/2.9	4 rep/10 per rep
Concentration 5 Nom/Meas (ng/L)	10/7.6	4 rep/10 per rep
Control/Solvent Control	0/Unreported	4 rep/10 per rep
Reproduction		
NOEC	1.3 ng/L (reproduction)	Method: ANOVA w/Dunnett's test p: 0.05, MSD: NR
LOEC	2.9 ng/L	
MATC (GeoMean NOEC,LOEC)	1.9 ng/L	
% control at NOEC	4.5/4.7 - 96%	
% of control LOEC	2.1/4.7 - 44%	
Length		
NOEC	2.9 ng/L (length)	Method: ANOVA w/Dunnett's test p: 0.05, MSD: NR
LOEC	7.6 ng/L	
MATC (GeoMean NOEC,LOEC)	4.7 ng/L	
% control at NOEC	3.6/4.1 - 88%	
% of control LOEC	3.2/4.1 - 78%	
Time to 1st brood		
NOEC	2.9 ng/L (time to 1 st brood)	Method: ANOVA w/Dunnett's test p: 0.05, MSD: NR
LOEC	7.6 ng/L	
MATC (GeoMean NOEC,LOEC)	4.7 ng/L	
% control at NOEC	NR	
% of control LOEC	NR	

Reliability points taken off for:

Documentation: Minimum significant difference (2)

Appendix B1: Studies rated RR

Acceptability: Measured concentrations within 20% Nom (4), Carrier solvent ≤ 0.1 mL/L (4), Random or block design (2), Minimum significant difference (1)

Appendix B1: Studies rated RR

Toxicity Data Summary

Hyalella azteca

Study: Anderson BS, Phillips BM, Hunt JW, Connor V, Richard N, Tjeerdema RS. 2006. Identifying primary stressors impacting macroinvertebrates in the Salinas River (CA, USA): Relative effects of pesticides and suspended particles. Environmental Pollution 141:402-408.

Relevance
Score: 90 (no Standard method)
Rating: R

Reliability
Score: 79
Rating: R

Reference	Anderson <i>et al.</i> 2006	<i>H. azteca</i>
Parameter	Value	Comment
Test method cited	NR	
Phylum	Arthropoda	
Class	Crustacea	
Order	Malacostraca	
Family	Hyalellidae	
Genus	<i>Hyalella</i>	
Species	<i>azteca</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	7-14 days	
Source of organisms	Aquatic Biosystems, FT. Collins, CO.	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	NR	
Animals randomized?	NR	
Test vessels randomized?	No	
Test duration	96 hours	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	97% survival*	
Temperature	23 ± 1°C*	
Test type	Static	
Photoperiod/light intensity	16 light: 8 dark*	
Dilution water	Well Water	
pH	NR	
Hardness	91.6 mg/L*	
Alkalinity	122.4 mg/L as CaCO ₃ *	
Conductivity	NR	

Appendix B1: Studies rated RR

Reference	Anderson <i>et al.</i> 2006	<i>H. azteca</i>
Parameter	Value	Comment
Dissolved Oxygen	NR	
Feeding	Not fed	
Purity of test substance	100%	
Concentrations measured?	Yes	
Measured is what % of nominal?	19-56%	Meas. 2 reps of only some conc's
Chemical method documented?	Some were, but not used in toxicity value calculations	
Concentration of carrier (if any) in test solutions	Used 100 mg/L methanol stock	
Concentration 1 Nom ($\mu\text{g/L}$)	0.0056	3 reps, 5 org/rep
Concentration 2 Nom/Meas ($\mu\text{g/L}$)	0.010/ 0.002, 0.005	3 reps, 5 org/rep
Concentration 3 Nom ($\mu\text{g/L}$)	0.018	3 reps, 5 org/rep
Concentration 4 Nom/Meas ($\mu\text{g/L}$)	0.032/ 0.006,0.018	3 reps, 5 org/rep
Concentration 5 Nom ($\mu\text{g/L}$)	0.056	3 reps, 5 org/rep
Control	0	3 reps, 5 org/rep
LC ₅₀ ($\mu\text{g/L}$)	0.0093	Method: Spearman-Karber

Other notes:

*Control survival, temp. variation and water chemistry obtained by personal communication with the testing laboratory.

Reliability points taken off for:

Documentation: Dissolved Oxygen (4), Conductivity (2), pH (3), Hypothesis tests (8)

Acceptability: Standard method (5), Measured concentrations within 20% Nom (4), Organisms randomly assigned to containers (1), Organisms properly acclimated (1), Dissolved oxygen (6), Conductivity (1), pH (2), Random / block design (2), Hypothesis tests (3)

Appendix B1: Studies rated RR

Toxicity Data Summary

Hyalella azteca

Study: Weston DP, Jackson CJ. 2009. Use of Engineered Enzymes to Identify Organophosphate and Pyrethroid-Related Toxicity in Toxicity Identification Evaluations. Environmental Science and Technology 43:5514-5520.

Relevance
Score: 100
Rating: R

Reliability
Score: 88
Rating: R

Reference	Weston & Jackson 2009	<i>H. azteca</i>
Parameter	Value	Comment
Test method cited	USEPA	Modified for <i>H. azteca</i>
Phylum	Arthropoda	
Class	Crustacea	
Order	Malacostraca	
Family	Hyalellidae	
Genus	<i>Hyalella</i>	
Species	<i>azteca</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	7- 14 d [†]	
Source of organisms	Lab Culture [†]	Weston lab
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes [†]	
Animals randomized?	Yes [†]	
Test vessels randomized?	Yes [†]	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	Median control survival was 95% (range 84-100%). Median solvent control survival for the acetone carrier was 98% (84-100%)	
Effect 2	Impaired swimming*	
Control response 2	Survivors never had impaired control response	
Temperature	23 °C	
Test type	Static renewal (48 h)	
Photoperiod/light intensity	16:8 (light:dark)	
Dilution water	EPA moderately hard water,	

Appendix B1: Studies rated RR

Reference	Weston & Jackson 2009	<i>H. azteca</i>
Parameter	Value	Comment
	from purified water	
pH	7.5 [†]	
Hardness	90 mg/L as CaCO ₃ [†]	
Alkalinity	60 mg/L as CaCO ₃ [†]	
Conductivity	335 umhos/cm [†]	
Dissolved Oxygen	7.4 mg/L [†]	
Feeding	Yes, but appropriate	DO depletion & sorption minimized by feeding 6h prior to renewal
Purity of test substance	> 98% [†]	
Concentrations measured?	Yes, but not all, used recovery of some to estimate “actual” conc.	
Measured is what % of nominal?	median 114% of nominal; range 64-189%	pyrethroid conc. declined to a median of 34% of initial nominal concentration within 48 h (range <12-72%, n = 9).
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	Acetone, < 32 µL/L	
Concentration 1 Nom (µg/L)	5-8 conc. separated by a factor of 0.5 (e.g., 20, 10, 5, 2.5, 1.3 ng/L)	3 reps, 10 org /rep [†]
Control	Solvent	3 reps, 10 org/rep
LC ₅₀ (95% confidence interval) (ng/L)	2.7 (2.1-3.3) 7.3 (6.1-8.6) 8.0 (6.8-9.4) 8.2 (7.0-9.6)	Method: Probit
EC ₅₀ (95% confidence interval) (ng/L)	1.9 (1.5-2.3) 3.1 (2.7-3.7) 3.5 (3.1-3.9) 3.5 (2.9-4.1)	Method: Probit

Other notes:

[†]Indicates information was gathered or clarified via email communication with the author Dr. Donald Weston (dweston@berkeley.edu).

*From the study: “Most impaired organisms were lying on their sides, able only to twitch one or more appendages. For those few individuals still able to swim, movement was poorly coordinated and swimming limited to only a few body lengths. Therefore, we also recorded the proportion of animals able to swim normally, with results reported as the median effective concentration (EC₅₀).”

Appendix B1: Studies rated RR

When spiking water or sediment with pesticides, samples to determine the actual pesticide concentration were taken from one concentration step in the midpoint of the range used. For the water tests, the initial water concentration was determined at time 0 and again when fresh solutions were prepared at 48 h. The two samples were either analyzed separately or as a composite. Samples were also taken of water that had been in the beakers for the maximum period (at the end of the first and second 48 h intervals, combined as a composite).

The average pyrethroid concentrations to which *H. azteca* were exposed were approximated as the nominal concentration minus one-half of the 66% nonenzymatic loss over 48 h (i.e., average actual concentration equal to 33% less than nominal). All reported water concentrations are actual values, derived from nominal concentrations adjusted by this factor.

Reliability points taken off for:

Documentation: Nominal concentrations (3), Measured concentrations (3), Hypothesis tests (8)

Acceptability: Meas. conc. w/in 20% of nom. (4), Conc. not > 2x water solubility (4), Hypothesis tests (3)

Appendix B1: Studies rated RR

Toxicity Data Summary

Lepomis macrochirus

Study: Hoberg JR. 1983a. Acute toxicity of FMC 54800 technical to bluegill (*Lepomis macrochirus*). FMC Study No: A83/987. MRID 00132536.

Relevance
Score: 100
Rating: R

Reliability
Score: 84.5
Rating: R

Reference	Hoberg 1983a	<i>L. macrochirus</i>
Parameter	Value	Comment
Test method cited	USEPA	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Perciformes	
Family	Centrarchidae	
Genus	<i>Lepomis</i>	
Species	<i>macrochirus</i>	
Native to	St. Lawrence River, Great Lakes, Mississippi River	Introduced worldwide
Age/size at start of test/growth phase	2.5 (1.3-3.6) g 58 (49-64) mm	mean (range)
Source of organisms	Commercial supplier	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	14 day acclimation period
Animals randomized?	No	
Test vessels randomized?	No	
Test duration	144 hr	
Data for multiple times?	Yes	
Effect 1	Mortality	
Control response 1	0 % at all time points	
Temperature	21-22 °C	
Test type	Flow though	
Photoperiod/light intensity	16 light:8 dark (2-20 hectolux)	
Dilution water	Well water	
pH	7.0-7.5	
Hardness	28-30 mg/L	
Alkalinity	24-28 mg/L	
Conductivity	100-140 µMhos/cm	
Dissolved Oxygen	87-94% saturation	

Appendix B1: Studies rated RR

Reference	Hoberg 1983a	<i>L. macrochirus</i>
Parameter	Value	Comment
Feeding	Dry pelleted food @ 120 hr	ad libitum
Purity of test substance	88.35 %	
Concentrations measured?	No	
Measured is what % of nominal?	n/a	
Chemical method documented?	No	
Concentration of carrier (if any) in test solutions	NR	DMF
Concentration 1 Nom ($\mu\text{g/L}$)	1	2 reps /10 fish each
Concentration 2 Nom ($\mu\text{g/L}$)	0.65	2 reps /10 fish each
Concentration 3 Nom ($\mu\text{g/L}$)	0.42	2 reps /10 fish each
Concentration 4 Nom ($\mu\text{g/L}$)	0.27	2 reps /10 fish each
Concentration 5 Nom ($\mu\text{g/L}$)	0.18	2 reps /10 fish each
Control	Control and solvent control	
LC ₅₀ (95% confidence interval) ($\mu\text{g/L}$)	48 hr: 0.65 (0.42-1.0)	Method: Binomial probability
LC ₅₀ (95% confidence interval) ($\mu\text{g/L}$)	72 hr: 0.44 (0.39-0.50) 96 hr: 0.35 (0.30-0.40) 144 hr: 0.30 (0.28-0.35)	Method: Moving angle average

Reliability points taken off for:

Documentation: Analytical method (4), Measured concentrations (3), Hypothesis tests (8)

Acceptability: Measured concentrations within 20% Nom (4), Carrier solvent ≤ 0.5 mL/L (4), Organisms randomly assigned to containers (1), Random or block design (2),

Appropriate spacing between concentrations (2), Hypothesis tests (3)

Appendix B1: Studies rated RR

Toxicity Data Summary

Oncorhynchus mykiss (formerly *Salmo gairdneri*)Study: Hoberg JR. 1983b. Acute toxicity of FMC 54800 technical to rainbow trout (*Salmo gairdneri*). FMC Study No: A83/967. MRID 00132539.

Relevance
Score: 100
Rating: R

Reliability
Score: 86
Rating: R

Reference	Hoberg 1983b	<i>O. mykiss</i>
Parameter	Value	Comment
Test method cited	USEPA	
Phylum/subphylum	Vertebrae	
Class	Actinopterygii	
Order	Salmoniformes	
Family	Salmonidae	
Genus	<i>Oncorhynchus</i>	
Species	<i>mykiss</i>	
Native to	Canada, Alaska	
Age/size at start of test/growth phase	1.0 (0.57-1.6) g 46 (40-54) mm	mean (range)
Source of organisms	Commercial supplier	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Not reported	
Test vessels randomized?	Not reported	
Test duration	120 hr	
Data for multiple times?	Yes	
Effect 1	Mortality	
Control response 1	0% (at all times)	
Temperature	11 - 12 °C	
Test type	Flow-through	
Photoperiod/light intensity	16 light :8 dark	
Dilution water	Well water	
pH	7.0 - 7.3	
Hardness	28-30 mg/L	
Alkalinity	24 mg/L as CaCO ₃	
Conductivity	130-140 µMhos/cm	
Dissolved Oxygen	9.0 - 9.8 mg/L	
Feeding	None	
Purity of test substance	88.35 %	

Appendix B1: Studies rated RR

Reference	Hoberg 1983b	<i>O. mykiss</i>
Parameter	Value	Comment
Concentrations measured?	No	
Measured is what % of nominal?	Not applicable	
Chemical method documented?	Not applicable	
Concentration of carrier (if any) in test solutions	Not reported	Dimethyl formamide (DMF)
Concentration 1 Nom ($\mu\text{g/L}$)	1.5	2 reps /10 fish each
Concentration 2 Nom ($\mu\text{g/L}$)	0.75	2 reps /10 fish each
Concentration 3 Nom ($\mu\text{g/L}$)	0.38	2 reps /10 fish each
Concentration 4 Nom ($\mu\text{g/L}$)	0.19	2 reps /10 fish each
Concentration 5 Nom ($\mu\text{g/L}$)	0.094	2 reps /10 fish each
Control	Control and solvent control	2 reps /10 fish each
LC ₅₀	24 h: 6.2 $\mu\text{g/L}$	Method: probit analysis
LC ₅₀ (95% confidence interval) ($\mu\text{g/L}$)	48 h: 0.34 (0.27-0.42) 72 h: 0.20 (0.15-0.26) 96 h: 0.15 (0.15-0.26) 120 h: 0.10 (0.15-0.26)	Method: moving angle average analysis

Other notes:

- Increased mortalities prevented calculation of an LC₅₀ after 120hrs
- Moving angle average analysis:
Peltier, W.H., and Weber, C.I. (1985). *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms*. EPA-600/4-85-013, U.S. Environmental Protection Agency, Cincinnati, OH.

Reliability points taken off for:

Documentation: Analytical method (4), Measured concentrations (3), Hypothesis tests (8)
Acceptability: Measured concentrations within 20% Nom (4), Carrier solvent ≤ 0.5 mL/L (4), Random or block design (2), Hypothesis tests (3)

Appendix B1: Studies rated RR

Toxicity Data Summary

Pimephales promelas

Study: Guy D. 2000b. Aquatic Toxicology laboratory Report P-2161-2. Bifenthrin with *Pimephales promelas* in an acute definitive test. California Department of Fish and Game, Aquatic Toxicology Lab, Elk Grove, CA.

Relevance
Score: 100
Rating: R

Reliability
Score: 85
Rating: R

Reference	Guy 2000b	<i>P. promelas</i>
Parameter	Value	Comment
Test method cited	ASTM /EPA	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	<i>Pimephales</i>	
Species	<i>promelas</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	8 d, dry wt: 0.0039-0.0052 g	
Source of organisms	Aquatic Resources Lab	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	100% in solvent control; 98% in dilution water cont	
Temperature	24.0 - 24.5 °C	
Test type	Static w/ 48 h renewal	
Photoperiod/light intensity	16:8 light:dark	
Dilution water	NR	
pH	8.02-8.41	
Hardness	150-162 mg/L	
Alkalinity	170-182 mg/L	
Conductivity	328-447 µs/cm	
Dissolved Oxygen	6.65-8.33 mg/L	

Appendix B1: Studies rated RR

Reference	Guy 2000b	<i>P. promelas</i>
Parameter	Value	Comment
Feeding	Yes, can not determine if during test or just acclimation period	
Purity of test substance	97.8%	
Concentrations measured?	Not directly: estimated	
Measured is what % of nominal?	184 - 204% estimated from spikes	
Chemical method documented?	No (would be helpful to know since recovery abnormally high)	
Concentration of carrier (if any) in test solutions	0.0055 mL/L (acetone)	
Nominal and estimated (Est) concentrations (divided by a factor derived from recovery of spiked water samples on day 0 and day 2		
Concentration 1 Nom/Est (µg/L)	0.3/0.56	4 reps; 10 fish per rep
Concentration 2 Nom/Est (µg/L)	0.6/1.09	4 reps; 10 fish per rep
Concentration 3 Nom/Est (µg/L)	1.25/2.4	4 reps; 10 fish per rep
Concentration 4 Nom/Est (µg/L)	2.5/5.1	4 reps; 10 fish per rep
Concentration 5 Nom/Est (µg/L)	3.75/7.40	4 reps; 10 fish per rep
Concentration 6 Nom/Est (µg/L)	5 /9.18	4 reps; 10 fish per rep
Controls	Water only and a solvent (acetone) control	4 reps; 10 fish per rep
LC ₅₀ (95% confidence interval) (µg/L)	0.78 (0.526-0.853)	Method: Linear interpolation

Reliability points taken off for:

Documentation: Analytical method (4), Measured concentrations (3), Dilution water source (3), Hypothesis tests (8)

Acceptability: Measured concentrations within 20% nominal (4), Organism fed in acute tests (3), Dilution water source acceptable (2), Hypothesis tests (3)

Toxicity Data Summary

Pimephales promelas

Study: McAllister WA. 1988. Full life cycle toxicity of ¹⁴C-FMC 54800 to the fathead minnow (*Pimephales promelas*) in a flow-through system. FMC Study No: A86/2100. MRID 40791301.

Relevance

Score: 100

Rating: R

Reliability

Score: chronic 93.5, acute 87.5

Rating: R

Reference	McAllister 1988	<i>P. promelas</i>
Parameter	Value	Comment
Test method cited	USEPA	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	<i>Pimephales</i>	
Species	<i>promelas</i>	
Native to	North America	
Age/size at start of test/growth phase	Chronic: < 48 hr eggs Acute: 14 d old	
Source of organisms	In-house laboratory culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	Chronic: 368 days Acute: 96 h	F ₀ and F ₁ gen - entire life cycle
Data for multiple times?	Yes	
Acute effect 1	96 h Mortality	
Acute control response 1	0%	
Chronic effect 1	92 d F ₀ Survival	
Control response 1	100%	
Effect 2-6	Number eggs / female, Number of spawns, Number of eggs, Number spawns / female, Number eggs / female, Percent egg hatch	No statistically significant responses, but trend - High variability, See Fig. 10
Other effects measured	F ₀ wet weight, F ₀ Hatchability, F ₀ Standard length, F ₁ Hatchability, F ₁	No statistically significant responses found

Appendix B1: Studies rated RR

Reference	McAllister 1988	<i>P. promelas</i>
Parameter	Value	Comment
	Standard length, F ₁ wet weight, F ₁ wet weight, F ₁ Survival	
Other Effect/ info in study	Bioconcentration factor	
	> 48 hr old 83-4900X	
	96 hr old 530-10,000X	
	14 day old 6000X	0.019 µg/L conc.
	Whole body residue Adults (F ₀) 21-28,000X	
Temperature	25 ± 1 °C	
Test type	Acute: static Chronic: flow-through	
Photoperiod/light intensity	Chronic: 16 light: 8 dark Acute: NR	
Dilution water	Aerated well water	
pH	Chronic: 7.8 - 8.2 Acute: 8.1-8.2	
Hardness	Chronic: 246 - 346 mg/L Acute: 270-280 mg/L	
Alkalinity	Chronic: 302 - 522 mg/L Acute: NR	
Conductivity	Chronic: 530 – 840 uMhos/cm Acute: NR	
Dissolved Oxygen	Chronic: 3.9 - 8.7 mg/L Acute: 5.2-8.7 mg/L	
Feeding	Acute - none Chronic - daily artemia	
Purity of test substance	Technical- 96.2%	¹⁴ C labeled
Concentrations measured? (ug/L)	Yes	
Measured is what % of nominal?	Acute: 73-88% Chronic: 53 - 146 %	
Chemical method documented?	Liquid scintillation counting	
Concentration of carrier (if any) in test solutions	max. 0.013 mL/L	Acetone
Acute test		
Concentration 1 Nom/Meas (µg/L)	0.051/0.042	10 fish per aquaria
Concentration 2 Nom/Meas (µg/L)	0.10/0.083	10 fish per aquaria
Concentration 3 Nom/Meas (µg/L)	0.20/0.17	10 fish per aquaria
Concentration 4 Nom/Meas (µg/L)	0.40/0.35	10 fish per aquaria
Concentration 5 Nom/Meas (µg/L)	0.80/0.58	10 fish per aquaria
Control	Water only + solvent	10 fish per aquaria
LC ₅₀ (95% confidence interval)	96 hr: 0.21 (0.16-0.28) µg/L	Method: Moving

Appendix B1: Studies rated RR

Reference	McAllister 1988	<i>P. promelas</i>
Parameter	Value	Comment
		average
Chronic		
Concentration 1 Nom/Meas (µg/L)	0.0050/0.0037 ± 0.0013	Started w/ 35 eggs in 4 replicate chambers at each conc. (was F ₀)
Concentration 2 Nom/Meas (µg/L)	0.0090/0.0090 ± 0.0034	
Concentration 3 Nom/Meas (µg/L)	0.019/0.019 ± 0.0062	
Concentration 4 Nom/Meas (µg/L)	0.038/0.040 ± 0.017	
Concentration 5 Nom/Meas (µg/L)	0.075/0.090 ± 0.042	
Control	Water only + solvent (acetone)	
Chronic 92 d F₀ Survival		
NOEC	0.040 µg/L	Method: ANOVA w/ Tukey's HSD p: 0.05 MSD: NR
LOEC	0.090 µg/L	
MATC (GeoMean NOEC,LOEC)	0.060 µg/L	
% of control at NOEC	Day 92: 100%	
% of control LOEC	Day 92: 54%	

Static acute tests are not good for calculating ACR for fish

Acute and chronic test run separately. Acute test is static, and is documented separately at starting on pg 168.

Reliability points taken off CHRONIC test for:

Documentation: Minimum significant difference (MSD)(2).

Acceptability: Measured concentrations within 20% Nom (4), Dissolved oxygen ≥ 60 % (6), MSD (1).

Reliability points taken off ACUTE test for:

Documentation: Alkalinity (2), Conductivity (2), Photoperiod (3), Minimum significant difference (MSD)(2).

Acceptability: Measured concentrations within 20% Nom (4), Carrier solvent ≤ 0.5 mL/L (4), Alkalinity (2), Conductivity (1), Photoperiod (2), Adequate replication (2), MSD (1).

Appendix B1: Studies rated RR

Toxicity Data Summary

Procloeon sp.

Study: Anderson BS, Phillips BM, Hunt JW, Connor V, Richard N, Tjeerdema RS. 2006. Identifying primary stressors impacting macroinvertebrates in the Salinas River (CA, USA): Relative effects of pesticides and suspended particles. Environmental Pollution 141:402-408.

Relevance
Score: 90 (no Std method)
Rating: R

Reliability
Score: 77
Rating: R

Reference	Anderson <i>et al.</i> 2006	<i>Procloeon sp.</i>
Parameter	Value	Comment
Test method cited	NR	
Phylum	Arthropoda	
Class	Insecta	
Order	Ephemeroptera	
Family	Baetidae	
Genus	<i>Procloeon</i>	
Species	NR	
Family in North America?	Yes	
Age/size at start of test/growth phase	0.5-1.0 cm	
Source of organisms	Reference station, Salinas River	
Have organisms been exposed to contaminants?	Maybe	
Animals acclimated and disease-free?	NR	
Animals randomized?	NR	
Test vessels randomized?	No	
Test duration	48 hours	
Data for multiple times?	No	
Effect 1	Survival	
Control response 1	87% survival*	
Temperature	23 ± 1°C *	
Test type	Static	
Photoperiod/light intensity	16 light: 8 dark*	
Dilution water	Well Water	
pH	NR	
Hardness	91.6 mg/L*	
Alkalinity	122.4 mg/L as CaCO ₃ *	
Conductivity	NR	

Appendix B1: Studies rated RR

Reference	Anderson <i>et al.</i> 2006	<i>Procloeon sp.</i>
Parameter	Value	Comment
Dissolved Oxygen	NR	
Feeding	Not fed	
Purity of test substance	100%	
Concentrations measured?	Some were, but not used in toxicity value calculations	
Measured is what % of nominal?	55-77%	Meas. 2 reps of only some conc's
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	Used 100 mg/L methanol stock	
Concentration 1 Nom ($\mu\text{g/L}$)	0.018	3 reps, 5 org/rep
Concentration 2 Nom ($\mu\text{g/L}$)	0.032	3 reps, 5 org/rep
Concentration 3 Nom/Meas ($\mu\text{g/L}$)	0.056/0.031, 0.043	3 reps, 5 org/rep
Concentration 4 Nom ($\mu\text{g/L}$)	0.100	3 reps, 5 org/rep
Concentration 5 Nom ($\mu\text{g/L}$)	0.180	3 reps, 5 org/rep
Concentration 6 Nom/Meas ($\mu\text{g/L}$)	0.320/0.206, 0.202	3 reps, 5 org/rep
Concentration 7 Nom ($\mu\text{g/L}$)	0.560	3 reps, 5 org/rep
Control	0	3 reps, 5 org/rep
LC ₅₀ ($\mu\text{g/L}$)	0.084	Method: Spearman-Karber

Other notes:

*Control survival, temp. variation and water chemistry obtained by personal communication with the testing laboratory.

Reliability points taken off for:

Documentation: Dissolved Oxygen (4), Conductivity (2), pH (3), Hypothesis tests (8)
Acceptability: Standard method (5), Measured concentrations within 20% nominal (4), Organisms randomly assigned to containers (1), Organisms properly acclimated (1), Dissolved oxygen (6), Conductivity (1), pH (2), Random / block design (2), Hypothesis tests (3), prior contaminant exposure? (4)

Appendix B2
Studies rated RL, LR, LL

Toxicity Data Summary

Americamysis bahia (formerly *Mysidopsis bahia*)

Study: Barrows ME. 1986b. Acute toxicity of FMC 54800 to mysid shrimp *Mysidopsis bahia*. FMC Study No: A85-1875. EPA MRID: 00163102, or 470271-039

Relevance

Score: 85 (saltwater)

Rating: L

Reliability

Score: 89.5

Rating: R

Reference	Barrows 1986b	<i>A. bahia</i>
Parameter	Value	Comment
Test method cited	USEPA	
Phylum/subphylum	Arthropoda	
Class	Malacostraca	
Order	Mysida	
Family	Mysidae	
Genus	<i>Americamysis</i>	Formerly <i>Mysidopsis</i>
Species	<i>bahia</i>	<i>bahia</i>
Found in North America?	Yes, Gulf of Mexico, FL coast	15-30 ppt waters
Age/size at start of test/growth phase	<24 hours	
Source of organisms	Laboratory culture	
Have organisms been exposed to contaminants?	no	
Animals acclimated and disease-free?	yes	
Animals randomized?	yes	
Test vessels randomized?	yes	
Test duration	96 hours	
Data for multiple times?	yes	
Effect 1	mortality 96 hrs	
Control response 1	0%, 5% mortality	Control, solvent control
Temperature	21.5-21.6 °C	
Test type	Flow-through	
Photoperiod/light intensity	16:8	
Dilution water	Duxbury Bay (Mass) seawater	30.5-31.0 ppt
pH	7.82-7.86	
Hardness	(30.5-31.0 ppt)	
Alkalinity	NR	
Conductivity	(30.5-31.0 ppt)	

Appendix B2: Studies rated RL, LR, LL

Reference	Barrows 1986b	<i>A. bahia</i>
Parameter	Value	Comment
Dissolved Oxygen	5.6-6.6 mg/L, $\geq 74\%$	
Feeding	None	
Purity of test substance	88.35% (stated in appendix)	
Concentrations measured?	no	
Measured is what % of nominal?	77-117 %	
Chemical method documented?	Liquid scintillation counting	
Concentration of carrier (if any) in test solutions	0.27 mL/L	acetone
Concentration 1 Nom/Meas ($\mu\text{g/mL}$)	0.050/ 439	2 reps, 10 per rep
Concentration 2 Nom/Meas ($\mu\text{g/mL}$)	0.025/ 0.0192	2 reps, 10 per rep
Concentration 3 Nom/Meas ($\mu\text{g/mL}$)	0.0125/ 0.0115	2 reps, 10 per rep
Concentration 4 Nom/Meas ($\mu\text{g/mL}$)	0.00625/ 0.00731	2 reps, 10 per rep
Concentration 5 Nom/Meas ($\mu\text{g/mL}$)	0.00312/ 0.00248	2 reps, 10 per rep
Control	Solvent and water only	2 reps, 10 per rep
LC ₅₀	3.97 ng/L (3.09-4.97) (0.00397 $\mu\text{g/L}$)	Method not specified

Reliability points taken off for:

Documentation: Alkalinity (2), Minimum significant difference (2), % of control at NOEC and/or LOEC (2), point estimates (8)

Acceptability: Measured concentrations within 20% Nom (4), Alkalinity (2), Minimum significant difference (1)

Toxicity Data Summary

Americamysis bahia (Formerly *Mysidopsis bahia*)

Study: Boeri RL, Ward TJ. 1991. Life Cycle Toxicity of Bifenthrin to the mysid, *Mysidopsis bahia*. FMC # A90-3318. MRID 42338801

Relevance

Score: 85 (saltwater Species)

Rating: L

Reliability

Score: 87.5

Rating: R

Reference	Boeri & Ward 1991	<i>A. bahia</i>
Parameter	Value	Comment
Test method cited	USEPA, 1985,1988	
Phylum	Arthropoda	
Class	Crustacea	
Order	Mysida	
Family	Mysidae	
Genus	<i>Americamysis</i>	Formerly <i>Mysidopsis</i>
Species	<i>bahia</i>	<i>bahia</i>
Family in North America?	Yes	
Age/size at start of test/growth phase	<24 hours	
Source of organisms	Aquatic Research Organisms Division of Resource Analysts, Inc.	Hampton, NH.
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	28 Days	
Data for multiple times?	Raw Data Only	
Effect 1	Survival, F1	
Control response 1	Pooled Control: 92.5%	
Effect 2	Reproduction, young per female	
Control response 2	7.0, 7.5 young /day	For Control, Solvent Control
Effect 3	Growth: F1 length	
Control response 3	8.6 ± 0.1 mm	
Temperature	23.5-25.7°C	
Test type	Chronic Flow Through	

Appendix B2: Studies rated RL, LR, LL

Reference	Boeri & Ward 1991	<i>A. bahia</i>
Parameter	Value	Comment
Photoperiod/light intensity	16:8 l/d, 12 μ Es ⁻¹ m ⁻²	
Dilution water	20% seawater	
pH	7.2-9.5	
Hardness	NR	
Alkalinity	NR	
Conductivity	20-21 ppt	
Dissolved Oxygen	>6.8 mg/L	
Feeding	Artemia salina nauplii, 2x daily	
Purity of test substance	96.5 %	
Concentrations measured?	yes	
Measured is what % of nominal?	42-152%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	0.1 ml/L Acetone	
Concentration 1 Nom/Meas (ng/L)	0.79/1.2	8 rep/40 per
Concentration 2 Nom/Meas (ng/L)	1.4/1.3	8 rep/40 per
Concentration 3 Nom/Meas (ng/L)	2.8/1.6	8 rep/40 per
Concentration 4 Nom/Meas (ng/L)	5.6/2.5	8 rep/40 per
Concentration 5 Nom/Meas (ng/L)	11.3/4.7	8 rep/40 per
Control	0/0.98	8 rep/40 per
Solvent Control	0/0.98	8 rep/40 per
NOEC (ng/L)	Survival of F1 gen.: 1.2 Length: 1.2 Reproduction: 2.5	Method:ANOVA w/Dunnett's test p:0.05 MSD: NR
LOEC (ng/L)	Survival of F1 gen.: 1.3 Length: 1.3 Reproduction: 4.7	Same as above
MATC (GeoMean NOEC,LOEC) (ng/L)	Survival of F1 gen.: 1.25 Length: 1.25 Reproduction: 3.43	
% control at NOEC	NR	
% of control LOEC	NR	

Other notes: There is a trend of decreased reproduction starting at 1.3 ng/L (similar to other endpoints), but it is not statistically significant until higher concentrations (see Tables 3 and 6)

Sublethal effects MATC = 4.7ng/L (lethargy, erratic swimming)

Number of young per female MATC = 4.7ng/L

Reliability points taken off for:

Documentation: Alkalinity (2), Statistical methods identified (5), Hypothesis tests (8)

Appendix B2: Studies rated RL, LR, LL

Acceptability: Measured concentrations within 20% Nom (4), Alkalinity (2), Appropriate statistical method (2), Hypothesis tests (3)

Toxicity Data Summary

Ceriodaphnia dubia

Study: Liu W, Gan J, Lee S, Werner I. 2005a. Isomer selectivity in aquatic toxicity and biodegradation of bifenthrin and permethrin. *Environmental Toxicology & Chemistry* 24: 1861-1866.

Same data as reported in Liu *et al.* 2005b.

Relevance

Score: 92.5 (control response not reported)

Rating: R

Reliability

Score: 60

Rating: L

Reference	Liu <i>et al.</i> 2005a	<i>C. dubia</i>
Parameter	Value	Comment
Test method cited	USEPA	
Phylum/subphylum	Arthropoda / Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Ceriodaphnia</i>	
Species	<i>dubia</i>	
In North America	Yes	
Age/size at start of test/growth phase	<20 hrs old	
Source of organisms	Commercial supplier*	*info obtained from Liu <i>et al.</i> 2005b
Have organisms been exposed to contaminants?	Probably not	
Animals acclimated and disease-free?	NR	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 hr	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	NR	
Temperature	NR	
Test type	Static	
Photoperiod/light intensity	NR	
Dilution water	USEPA Moderately hard water	
pH	NR	

Appendix B2: Studies rated RL, LR, LL

Reference	Liu <i>et al.</i> 2005a	<i>C. dubia</i>
Parameter	Value	Comment
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	Not during exposure	
Purity of test substance	96%	
Concentrations measured?	NR	
Measured is what % of nominal?	NR	
Chemical method documented?	Yes, but it was not used to measure concentrations in the toxicity tests.	
Concentration of carrier (if any) in test solutions	0.08%	Acetone
Concentrations (nominal) (µg/L)	0-0.6	4 rep /5 org ea.
Control	Solvent control	4 rep /5 org ea.
LC50 (µg/L)	0.144	Method: probit

Notes:

*info obtained from Liu *et al.* 2005b

Liu W, Gan J, Schlenk D, Jury WA. 2005b. Enantioselectivity in environmental safety of current chiral insecticides. *Proceedings of the National Academy of Sciences*, 102:701-706.

Reliability points taken off for:

Documentation: Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Temperature (4), Conductivity (2), pH (3), Photoperiod (3), Hypothesis tests (8).

Acceptability: Control response (9), Measured concentrations within 20% Nom (4), Organisms randomly assigned to containers (1), Organisms properly acclimated/disease free (1), Hardness (2), Alkalinity (2), Dissolved Oxygen (6), Temperature acceptable (3), Temperature not held to $\pm 1^{\circ}\text{C}$ (3), Conductivity (1), pH (2), Photoperiod (2), Number of concentrations (3), Random or block design (2), Appropriate spacing between concentrations (2), Hypothesis tests (3).

Toxicity Data Summary

Ceriodaphnia dubia

Study: Liu W, Gan J, Schlenk D, Jury WA. 2005b. Enantioselectivity in environmental safety of current chiral insecticides. Proceedings of the National Academy of Sciences, 102:701-706.

Same data as reported in Liu *et al.* 2005a.

Relevance

Score: 92.5 (control response not reported)

Rating: R

Reliability

Score: 60

Rating: L

Reference	Liu <i>et al.</i> 2005b	<i>C. dubia</i>
Parameter	Value	Comment
Test method cited	USEPA	
Phylum/subphylum	Arthropoda / Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	Ceriodaphnia	
Species	dubia	
In North America	Yes	
Age/size at start of test/growth phase	<20 hrs old	
Source of organisms	Commercial supplier	Aquatic Biosystems (Fort Collins, CO)
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	NR	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 hr	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	NR	
Temperature	NR	
Test type	Static	
Photoperiod/light intensity	NR	
Dilution water	USEPA Moderately hard water*	*info. From Liu <i>et al.</i> 2005a
pH	NR	
Hardness	NR	

Appendix B2: Studies rated RL, LR, LL

Reference	Liu <i>et al.</i> 2005b	<i>C. dubia</i>
Parameter	Value	Comment
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	None during test*	*info. From Liu <i>et al.</i> 2005a
Purity of test substance	96%	
Concentrations measured?	NR	
Measured is what % of nominal?	NR	
Chemical method documented?	Yes, but not used for the toxicity tests.	
Concentration of carrier (if any) in test solutions	0.08%	Acetone
Concentrations (nominal) (µg/L)	0-0.6*	4 rep /5 org ea.
Control	Solvent control*	4 rep /5 org ea.
LC ₅₀ (µg/L)	0.144 ± 0.017	Method: probit

Notes:

*info. From Liu *et al.* 2005a

Liu W, Gan J, Lee S, Werner I. 2005a. Isomer selectivity in aquatic toxicity and biodegradation of bifenthrin and permethrin. *Environmental Toxicology & Chemistry* 24: 1861-1866.

Reliability points taken off for:

Documentation: Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Temperature (4), Conductivity (2), pH (3), Photoperiod (3), Hypothesis tests (8).

Acceptability: Control response (9), Measured concentrations within 20% Nom (4), Organisms randomly assigned to containers (1), Organisms properly acclimated/disease free (1), Hardness (2), Alkalinity (2), Dissolved Oxygen (6), Temperature acceptable (3), Temperature not held to ± 1°C (3), Conductivity (1), pH (2), Photoperiod (2), Number of concentrations (3), Random or block design (2), Appropriate spacing between concentrations (2), Hypothesis tests (3).

Toxicity Data Summary

Ceriodaphnia dubia

Study: Yang WC, Spurlock F, Liu WP, Gan JY. 2006b. Inhibition of aquatic toxicity of pyrethroid insecticides by suspended sediment. *Environ Toxicol Chem* 25:1913-1919.

Relevance

Score: 92.5 (control type not described)

Rating: R

Reliability

Score: 66

Rating: L

Data summarized for only for treatment of added suspended solids

Reference	Yang <i>et al.</i> 2006b	<i>C. dubia</i>
Parameter	Value	Comment
Test method cited	EPA	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Ceriodaphnia</i>	
Species	<i>dubia</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	<24 h	
Source of organisms	Aquatic Biosystems	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	no	
Effect 1	mortality	
Control response 1	= or > 90% survival	
Temperature	21 +/- 1 C	
Test type	Static	
Photoperiod/light intensity	16: 8 light: dark	
Dilution water	EPA moderately hard water	
pH	NR	
Hardness	Recipe given-can calculate	96 mg NaHCO ₃ /L
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	None during test	
Purity of test substance	98%	

Appendix B2: Studies rated RL, LR, LL

Reference	Yang <i>et al.</i> 2006b	<i>C. dubia</i>
Parameter	Value	Comment
Concentrations measured?	Not for this test	
Measured is what % of nominal?	NR	
Chemical method documented?	Yes, but not used for this test	
Concentration of carrier (if any) in test solutions	About 0.4mL /L acetone	
Concentration 1 Nom ($\mu\text{g/L}$)	0.4	4 Reps, 5 per rep
Concentration 2 Nom ($\mu\text{g/L}$)	0.2	4 Reps, 5 per rep
Concentration 3 Nom ($\mu\text{g/L}$)	0.1	4 Reps, 5 per rep
Concentration 4 Nom ($\mu\text{g/L}$)	0.05	4 Reps, 5 per rep
Concentration 5 Nom ($\mu\text{g/L}$)	0.02	4 Reps, 5 per rep
Concentration 6 Nom ($\mu\text{g/L}$)	0.01	4 Reps, 5 per rep
Control	Not described	4 Reps, 5 per rep
LC ₅₀ ($\mu\text{g/L}$)	0.05 (0.043 -0.057)	Method not stated, only that ToxCalc soft ware was used

Reliability points taken off for:

Documentation: Control type (8), Analytical method (4), Measured concentrations (3), Alkalinity (2), Dissolved oxygen (4), Conductivity (2), pH (3), Statistical methods identified (5), Hypothesis tests (8).

Acceptability: Control appropriate (6), Measured concentrations within 20% Nom (4), Organisms randomly assigned to test containers (1), Alkalinity (2), Dissolved oxygen (6), Conductivity (1), pH (2), Random or block design (2), Appropriate statistical method (2), Hypothesis tests (3).

Appendix B2: Studies rated RL, LR, LL

Toxicity Data Summary

Crassostrea virginica

Study: Ward GS. 1986a. Acute toxicity of FMC 54800 technical on new shell growth of the eastern oyster (*Crassostrea virginica*). FMC Study No: A86-2083. MRID 470271-040. or EPA no:00136103

Relevance
Score: 70 (saltwater, no toxicity values)
Rating: L

Reliability
Score: 81.5
Score: R

Reference	Ward 1986a	<i>C. virginica</i>
Parameter	Value	Comment
Test method cited	EPA and in house protocol	
Phylum/subphylum	Mollusca	
Class	Bivalvia	
Order	Ostreoida	
Family	Ostreidae	
Genus	Crassostrea	
Species	virginica	
Native to	North America (east coast)	
Age/size at start of test/growth phase	31-50 mm height	
Source of organisms	commercial supplier	
Have organisms been exposed to contaminants?	no	
Animals acclimated and disease-free?	yes	
Animals randomized?	yes	
Test vessels randomized?	yes	
Test duration	96 hours	
Data for multiple times?	no	
Effect 1	Reduced shell growth	
Control response 1	3.15mm, 3.68mm for control. Solvent control	Shell growth
Temperature	24 °C	
Test type	Flow-trough	
Photoperiod/light intensity	16:8	
Dilution water	unfiltered seawater, from Marineland, FL	34-35 ppt
pH	7.5 - 8.0	
Hardness	34-35 ppt salinity	
Alkalinity	NR	
Conductivity	34-35 ppt salinity	
Dissolved Oxygen	> 5.5 mg/L	
Feeding	Plankton available in unfiltered water	

Appendix B2: Studies rated RL, LR, LL

Reference	Ward 1986a	<i>C. virginica</i>
Parameter	Value	Comment
Exposure	aqueous	
Purity of test substance	88.35%	technical grade
Concentrations measured?	Yes	
Measured is what % of nominal?	26-122%	
Chemical method documented?	HPLC	
Concentration of carrier (if any) in test solutions	0.05 mL/L	acetone
Concentration 1 Nom/Meas (µg/L)	0.30 / 0.0781	20 per concentration, (assume 1 rep)
Concentration 2 Nom/Meas (µg/L)	0.59 / 0.721	
Concentration 3 Nom/Meas (µg/L)	1.18 / 0.393	
Concentration 4 Nom/Meas (µg/L)	2.37 / 1.09	
Concentration 5 Nom/Meas (µg/L)	4.74 / 2.15	
Control	Seawater and solvent control	
EC ₅₀	Cannot calculate, authors suggest >2.15 µg/L	
NOEC	NR	
LOEC	NR	
MATC (GeoMean NOEC,LOEC)	NR	96 h test
% control at NOEC	NR	
% of control LOEC	NR	

See also Ward 1986b for rating sheet

Problems:

Concentrations decreased over the 4 day test, even though test was flow-thru (w/ diluter system)

Only the highest (2.15 ug/L) and the lowest (0.078 ug/L) concentrations were statistically different than the control, so interrupted dose-response

Reliability points taken off for:

Documentation: Alkalinity (2), Hypothesis tests (8), Point estimates (8)

Acceptability: Measured concentrations within 20% Nom (4), Organism fed (3), Alkalinity (2), random or block design (2), Adequate replication (2), Hypothesis tests (3), Point estimates (3)

Appendix B2: Studies rated RL, LR, LL

Toxicity Data Summary

Crassostrea virginica

Study: Ward GS. 1986b. Acute toxicity of FMC 54800 technical on new shell growth of the eastern oyster (*Crassostrea virginica*). FMC Study No: A86-2203. MRID 40266501

Relevance

Score: 70 (Saltwater, no toxicity values)

Rating: L

Reliability

Score: 79.5

Rating: R

Reference	Ward 1986b	<i>C. virginica</i>
Parameter	Value	Comment
Test method cited	In house protocol and USEPA	
Phylum/subphylum	Mollusca	
Class	Bivalvia	
Order	Ostreoida	
Family	Ostreidae	
Genus	Crassostrea	
Species	virginica	
Native to	North America (east coast)	
Age/size at start of test/growth phase	36-50 mm height	
Source of organisms	commercial supplier	
Have organisms been exposed to contaminants?	no	
Animals acclimated and disease-free?	yes	
Animals randomized?	yes	
Test vessels randomized?	yes	
Test duration	96 hours	
Data for multiple times?	no	
Effect 1	Reduced shell growth	
Control response 1	2.77, 2.26 mm, in control and solvent control	shell growth
Temperature	26 ± 1 °C	
Test type	Flow Thru	
Photoperiod/light intensity	16:8	
Dilution water	unfiltered seawater	35-36 ppt, from Marineland, FL,
pH	7.0 - 7.8	
Hardness	35-36 ppt salinity	
Alkalinity	NR	
Conductivity	35-36 ppt salinity	
Dissolved Oxygen	> 3.4 mg/L	

Appendix B2: Studies rated RL, LR, LL

Reference	Ward 1986b	<i>C. virginica</i>
Parameter	Value	Comment
Feeding	Phytoplankton in unfiltered sea water, also water supplemented with corn starch to maximize growth	
Exposure	aqueous	
Purity of test substance	88.35%	technical grade
Concentrations measured?	Yes	
Measured is what % of nominal?	7.4-44%	dramatically decreased over the 4 days, but flow thru
Chemical method documented?	HPLC	
Concentration of carrier (if any) in test solutions	0.06 mL/L	acetone
Concentration 1 Nom/Meas (µg/L)	130/32.1	20 per concentration, (assume 1 rep)
Concentration 2 Nom/Meas (µg/L)	216/95.7	
Concentration 3 Nom/Meas (µg/L)	360/71.5	
Concentration 4 Nom/Meas (µg/L)	600/99.7	
Concentration 5 Nom/Meas (µg/L)	1000/73.9	
Control	Water only and solvent	
EC ₅₀ (µg/L)	96 hr: > 99.7 estimated, actual EC ₅₀ could not be determined, no clear dose-response relationship	
NOEC (µg/L)	96 hr Meas: 71.5 96 hr Nom: 600	
LOEC; indicate calculation method	96 hr Meas: 73.9 96 hr Nom: 360	
MATC (GeoMean NOEC,LOEC)	NR	ACUTE Data only (96 hr values)
% control at NOEC	+16 @ 71.5 ug/L +& @ 95.7 ug/L	
% of control LOEC	24% reduction @ 99.7ug/L 13% reduction @ 73.9ug/L	

Problem with study:

Concentrations (measured every 2 days) dramatically decreased over the 4 days, some problem with diluted described that slowed flow, resulting in lower concentrations. No clear dose-response relationship, control has 23% more growth than solvent control

Reliability points taken off for:

Documentation: Alkalinity (2), Hypothesis tests (8), Point estimates (8)

Acceptability: Measured concentrations within 20% Nom (4), Concentrations do not exceed 2x water solubility (4), Organism fed (3), Alkalinity (2), random or block design (2), Adequate replication (2), Hypothesis tests (3), Point estimates (3)

Appendix B2: Studies rated RL, LR, LL

Toxicity Data Summary

Cyprinodon variegatus

Study: Barrows ME. 1986a. Acute toxicity of FMC 54800 to sheepshead minnow (*Cyprinodon variegatus*). FMC Study No: A85-1874. EPA no: 00163101, or MRID 470 271-038

Relevance

Score: 85 (saltwater)

Rating: L

Reliability

Score: 88

Rating: R

Reference	Barrows 1986a	<i>C. variegatus</i>
Parameter	Value	Comment
Test method cited	ASTM	
Phylum/subphylum	Chordata	
Class	Actinopterygii	
Order	Cyprinodontiformes	
Family	Cyprinodontidae	
Genus	Cyprinodon	
Species	variegatus	
Native to	North & South America	
Age/size at start of test/growth phase	9 weeks, juveniles	
Source of organisms	laboratory culture	
Have organisms been exposed to contaminants?	no	
Animals acclimated and disease-free?	yes	
Animals randomized?	yes	
Test vessels randomized?	yes	
Test duration	96 hr	
Data for multiple times?	Yes- raw data in appendix	
Effect 1	96 hr mortality	
Control response 1	0 % mortality	In both solvent control and control
Temperature	32.5-33 °C	
Test type	Flow-through	
Photoperiod/light intensity	16:8	
Dilution water	Duxbury Bay seawater (Mass)	in raw data says filtered seawater
pH	7.80 - 7.97	
Hardness	30.5-31.0 ppt salinity	
Alkalinity	NR	
Conductivity	30.5-31.0 ppt salinity	
Dissolved Oxygen	>72% saturation	
Feeding	None	

Appendix B2: Studies rated RL, LR, LL

Reference	Barrows 1986a	<i>C. variegatus</i>
Parameter	Value	Comment
Purity of test substance	88.35 % technical	
Concentrations measured? ($\mu\text{g/L}$)	yes	
Measured is what % of nominal?	106 - 145 %	
Chemical method documented?	liquid scintillation count	
Concentration of carrier (if any) in test solutions	0.28 mL/L	acetone
Concentration 1 Nom/Meas ($\mu\text{g/L}$)	60/ 63.4	2 reps, 10 per rep
Concentration 2 Nom/Meas ($\mu\text{g/L}$)	30/ 31.7	2 reps, 10 per rep
Concentration 3 Nom/Meas ($\mu\text{g/L}$)	15/ 17.2	2 reps, 10 per rep
Concentration 4 Nom/Meas ($\mu\text{g/L}$)	7.5/ 10.9	2 reps, 10 per rep
Concentration 5 Nom/Meas ($\mu\text{g/L}$)	3.8/ 5.24	2 reps, 10 per rep
Control	Control and solvent control	2 reps, 10 per rep
LC50 96h	17.8 (14.7-21.8) $\mu\text{g/L}$	Moving average
NOEC;	(Not applicable- 96 hr values)	
LOEC; indicate calculation method	NR	
MATC (GeoMean NOEC,LOEC)	NR	
% control at NOEC	NR	
% of control LOEC	NR	

Reliability points taken off for:

Documentation: Alkalinity (2), Hypothesis tests (8)

Acceptability: Measured concentrations within 20% Nom (4), Alkalinity (2), Temperature not held to $\pm 1^\circ\text{C}$ (3), Random or block design (2), Hypothesis tests (3)

Appendix B2: Studies rated RL, LR, LL

Toxicity Data Summary

Daphnia magna

Study: Hoberg, J., Nicholson, R.B., Grandy, K., Surprenant, D.C. 1985. The Chronic Toxicity of 14C-FMC 54800 to *Daphnia magna* Under Flow-Through Conditions. FMC # 84-1256. MRID 40275401 (Raw data in MRID 470286-025/00163139)

Relevance

Score: 85 (low chemical purity)

Rating: L

Reliability

Score: 89, both acute & chronic

Rating: R

Reference	Hoberg <i>et al.</i> 1985	<i>D. magna</i>
Parameter	Value	Comment
Test method cited	EPA 1975, Lab Established protocol	
Phylum	Arthropoda	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Daphnia</i>	
Species	<i>magna</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	≤24 Hours	
Source of organisms	Lab Culture	
Have organisms been exposed to contaminants?	Probably not	
Animals acclimated and disease-free?	Not Specified	
Animals randomized?	Yes	
Test vessels randomized?	Not Reported	
Test duration	21 Days	
Data for multiple times?	Raw Data	
Effect 1	Survival	
Control response 1	100% Control and Solvent Control	
Effect 4	Reproduction	
Control response 4	Control: 58 young/ adult Solvent C.: 60 young/ adult	
Temperature	19 – 21 °C	
Test type	Chronic Flow-Through	
Photoperiod/light intensity	3-6 Hectolux 16:8 l/d	
Dilution water	Fortified Well Water	
pH	7.8-8.3	
Hardness	160-180	
Alkalinity	110-130	
Conductivity	400-600 µmhos/cm	

Appendix B2: Studies rated RL, LR, LL

Reference	Hoberg <i>et al.</i> 1985	<i>D. magna</i>
Parameter	Value	Comment
Dissolved Oxygen	> 60 %	
Feeding	5 ml Yeast, 2 ml Ankistrodesmus 3x daily, 2x daily weekends	
Purity of test substance	10.36%	
Concentrations measured?	Yes	
Measured is what % of nominal?	54%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	20 mL/L	
ACUTE		
Concentration 1 Nom/Meas (µg/L)	0.58 /0.48	4 rep/5 per rep
Concentration 2 Nom/Meas (µg/L)	0.29 /0.20	4 rep/5 per rep
Concentration 3 Nom/Meas (µg/L)	0.14/ 0.12	4 rep/5 per rep
Concentration 4 Nom/Meas (µg/L)	0.072/ 0.064	4 rep/5 per rep
Concentration 5 Nom/Meas (µg/L)	0.036/ 0.025	4 rep/5 per rep
Control	Solvent and dilution water	4 rep/5 per rep both
CHRONIC		
Concentration 1 Nom/Meas (µg/L)	0.0025/0.00095	4 rep/20 per
Concentration 2 Nom/Meas (µg/L)	0.0050/0.0022	4 rep/20 per
Concentration 3 Nom/Meas (µg/L)	0.010/0.0051	4 rep/20 per
Concentration 4 Nom/Meas (µg/L)	0.020/0.012	4 rep/20 per
Concentration 5 Nom/Meas (µg/L)	0.040/0.031	4 rep/20 per
Control	Solvent and dilution water	4 rep/20 per both
LC ₅₀ (95% confidence interval) (µg/L)	0.11 (0.094-0.13)	Method: Moving average angle analysis
NOEC (µg/L)	Reproduction: 0.00095 Survival: 0.012	Method: ANOVA w/Dunnett's test p: 0.05 MSD: NR
LOEC (µg/L)	Reproduction: 0.0022 Survival: 0.031	Interrupted dose-response -repro
MATC (GeoMean NOEC,LOEC) (µg/L)	Reproduction: 0.0014 Survival: 0.019	
% control at NOEC/LOEC	NR	

Acute Test run first, the results were used to determine the concentrations for the chronic test run after.

Reliability points taken off for:

Documentation: Minimum significant difference (2), % of control at NOEC/ LOEC (2).

Acceptability: Purity (10), Measured concentrations within 20% Nom (4), Carrier solvent too high (4), Organisms acclimated and disease free (1), Random or block design (2), Minimum significant difference (2).

Toxicity Data Summary

Daphnia magna

Study: Wang C, Chen F, Zhang Q, Fang Z. 2009. Chronic toxicity and cytotoxicity of synthetic pyrethroid cis-bifenthrin. Journal of Environmental Science-China, 21, 1710-1715.

Relevance

Score: 92.3 (Control not described)

Rating: R

Reliability

Score: 69

Rating: L

Reference	Wang <i>et al.</i> 2009	<i>D. magna</i>
Parameter	Value	Comment
Test method cited	OECD 1998	
Phylum	Arthropoda	
Class	Crustacea	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Daphnia</i>	
Species	<i>magna</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Laboratory culture	Institute of Environmental Science, Zhejiang University
Have organisms been exposed to contaminants?	Probably not	
Animals acclimated and disease-free?	NR	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	21 d	
Data for multiple times?	No	
Effect 1	Number of young/female	
Control response 1	91.6 (SD=16.61)	
Effect 2	Average brood size	
Control response 2	7.5 (SD=1.65)	
Effect 3	Number of first brood/female	
Control response 3	12.4 (SD=3.6)	
Effect 4	Days to first brood	
Control response 4	6.2 (SD=0.63)	
Effect 5	Longevity (d)	
Control response 5	20.5 (SD=1.33)	
Effect 6	Length (cm)	
Control response 6	5.1 (SD=0.29)	

Appendix B2: Studies rated RL, LR, LL

Reference	Wang <i>et al.</i> 2009	<i>D. magna</i>
Parameter	Value	Comment
Temperature	22 ±1 °C	
Test type	Static renewal, 48 h renewal	
Photoperiod/light intensity	12L:12D	
Dilution water	M4 medium (OECD 1998)	
pH	NR	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	Feeding in tests NR	
Purity of test substance	99.5%	
Concentrations measured?	No	
Measured is what % of nominal?	n/a	
Toxicity values calculated based on nominal or measured concentrations?	Nominal	
Chemical method documented?	n/a	
Concentration of carrier (if any) in test solutions	Ethanol, ≤0.008%	
Concentration 1 Nom/Meas (µg/L)	0.005	10 reps, #/rep NR
Concentration 2 Nom/Meas (µg/L)	0.01	10 reps, #/rep NR
Concentration 3 Nom/Meas (µg/L)	0.02	10 reps, #/rep NR
Concentration 4 Nom/Meas (µg/L)	0.04	10 reps, #/rep NR
Concentration 5 Nom/Meas (µg/L)	0.08	10 reps, #/rep NR
Control	Not described	10 reps, #/rep NR
EC ₅₀ (µg/L)	Longevity: 0.031 Reproduction: 0.019	Method: non-linear regression
NOEC (µg/L)	Longevity: 0.01 # of 1 st brood/female: 0.01 Average brood size: 0.01 # of young/female: 0.01 Days to 1 st brood: 0.02 Length: 0.04	Method: one-way ANOVA p: < 0.05 MSD: NR
LOEC(µg/L)	Longevity: 0.02 # of 1 st brood/female: 0.02 Average brood size: 0.02 # of young/female: 0.02 Days to 1 st brood: 0.04 Length: > 0.04	Same as above
MATC (GeoMean NOEC,LOEC) (µg/L)	Longevity: 0.014 # of 1 st brood/female: 0.014 Average brood size: 0.014 # of young/female: 0.014	
% of control at NOEC	Longevity: 94%	

Appendix B2: Studies rated RL, LR, LL

Reference	Wang <i>et al.</i> 2009	<i>D. magna</i>
Parameter	Value	Comment
	# of 1 st brood/female: 90% Average brood size: 95% # of young/female: 92% Days to 1 st brood: 98% Length: 75%	
% of control at LOEC	Longevity: 81% # of 1 st brood/female: 72% Average brood size: 69% # of young/female: 52% Days to 1 st brood: 126%	

Notes:

Reliability points taken off for:

Documentation: Control type (8), Analytical method (4), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved oxygen (4), Conductivity (2), pH (3), Minimum significant difference (2).

Acceptability: Control description (6), Measured concentrations within 20% of nominal (4), Organisms randomized (1), Organisms/rep (2), Feeding (3), Hardness (2), Alkalinity (2), Dissolved oxygen (6), Conductivity (1), pH (2), Random design (2), Minimum significant difference (1).

Toxicity Data Summary

Simulium vitattum - Blackfly*Cheumatopsyche* spp. & *Hydropsyche* spp. - Caddisfly*Heptageniidae* spp. - Mayfly*Enallagma* spp. & *Ishnura* spp. - Damselfly*Hydrophilus* spp. - Water scavenger beetle

Siegfried BD. 1993. Comparative toxicity of pyrethroid insecticides to terrestrial and aquatic insects. *Environmental Toxicology and Chemistry* 12: 1683-1689.

AQUATIC exposures only, TOPICAL exposures not summarized here

Relevance

Score: 90 (no std method)

Rating: R

Reliability

Score: 63.5

Rating: L

Reference	Siegfried 1993	Various insects
Parameter	Value	Comment
Test method cited	No standard method cited	
Phylum/subphylum	Arthropoda	
Class	Insecta	
Order	Diptera, Trichoptera, Ephemeroptera, Odonata, Coleoptera	
Family	various	
Genus	<i>Simulium</i> , <i>Hydropsyche</i> , <i>Ishnura</i> , <i>Enallagma</i> , <i>Hydrophilus</i> , <i>Cheumatopsyche</i> , <i>Heptageniidae</i>	Terrestrial insects tested in this study were not included here.
Species	<i>vitattum</i> , others unidentified	
Native to	Nebraska, USA	
Age/size at start of test/growth phase	Larva (Black fly & Caddisfly), nymph (Mayfly & Damselfly), adult (beetles)	
Source of organisms	Collected from field, Lancaster County, NE	Various ponds and lakes
Have organisms been exposed to contaminants?	Yes-probably	Collected from environment
Animals acclimated and disease-free?	Acclimated-72 h	Health status not determined
Animals randomized?	NR	
Test vessels randomized?	NR	

Appendix B2: Studies rated RL, LR, LL

Reference	Siegfried 1993	Various insects
Parameter	Value	Comment
Test duration	24 hours	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	< 10 mortality, except black flies 14%, mayflies 16%	
Temperature	20 °C	
Test type	Acute Static	
Photoperiod/light intensity	24 hr dark	
Dilution water	states only 'distilled'	
pH	NR	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	None	
Purity of test substance	94%	
Concentrations measured?	NR	
Measured is what % of nominal?	NR	
Chemical method documented?	NR	
Concentration of carrier (if any) in test solutions	states diluted in water	
Concentrations (µg/L)	NR, at least three concentrations used	3 reps, 5-10 insects per rep
Control	Acetone	
LC ₅₀ (µg/L)	Black fly 1.3 Caddisfly 7.2 Mayfly 2.3 Damselyfly 1.1 Diving beetle 5.4	Method: probit

Reliability points taken off for:

Documentation: Analytical method (4), Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Conductivity (2), pH (3), Hypothesis tests (8)

Acceptability: Acceptable standard method (5), Measured concentrations within 20% Nom (4), No prior contaminant exposure (4), Organisms randomly assigned to containers (1), Dilution water source (2), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Temperature not held to $\pm 1^{\circ}\text{C}$ (3), Conductivity (2), pH (3), Adequate number of concentrations (3), Random or block design (2), Appropriate spacing between concentrations (2), Hypothesis tests (3).

Appendix B3

Studies rated RN, LN, N

Toxicity Data Summary

Aedes albopictus

Study: Arshad AJK, Xue R-D. 1995. Comparative toxicity of selected larvicides and insect growth regulators to a Florida laboratory population of *Aedes albopictus*. Journal of the American Mosquito Control Association, 11:72-76.

Relevance

Score: 82.5 (No std method, Control response)

Rating: L

Reliability

Score: 55.5

Rating: N

Reference	Ali & Xue 1995	<i>A. albopictus</i>
Parameter	Value	Comment
Test method cited	Ref to Mulla <i>et al.</i> 1982	
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Culicidae	
Genus	<i>Aedes</i>	
Species	<i>albopictus</i>	
Family in North America?	Yes (non native? Pest/invasive?)	
Age/size at start of test/growth phase	Late 4 th instar	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	no	
Animals acclimated and disease-free?	yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	24 h	
Data for multiple times?	NR	
Effect 1	mortality	
Control response 1	NR	
Temperature	26 ± 2 °C	
Test type	static	
Photoperiod/light intensity	14 h L: 10 h D	
Dilution water	tap	
pH	NR	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	once	

Appendix B3: Studies rated RN, LN, N

Reference	Ali & Xue 1995	<i>A. albopictus</i>
Parameter	Value	Comment
Purity of test substance	93.7%	
Concentrations measured?	No	
Measured is what % of nominal?	NR	
Chemical method documented?	NR	
Concentration of carrier (if any) in test solutions	1mL/100mL	
Concentration 1 Nom/Meas ($\mu\text{g/L}$)	4-9 conc	3 Reps and 20 organisms per rep, test repeated 3x
Control	solvent	3 Reps and 20 organisms per rep, test repeated 3x
LC ₅₀ (95% confidence interval) ($\mu\text{g/L}$)	5.2 (4.5-6.0)	Method: Log-dose-probit
LC ₉₀ (95% confidence interval) ($\mu\text{g/L}$)	17.5 (14.3-22.4)	Method: Log-dose-probit

Reliability points taken off for:

Documentation: Analytical method (4), Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Conductivity (2), pH (3), Hypothesis tests (8)

Acceptability: Acceptable standard method (5), Control response (9), Measured concentrations within 20% Nom (4), Concentrations do not exceed 2x water solubility (4), Carrier solvent ≤ 0.5 mL/L (4), Appropriate age/size (3), Organisms randomly assigned to containers (1), Feeding (3), Dilution water source (2), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Temperature not held to $\pm 1^\circ\text{C}$ (3), Conductivity (2), pH (3), Random or block design (2), Appropriate spacing between concentrations (2), Hypothesis tests (3)

Toxicity Data Summary

Ceriodaphnia dubia

Daphnia magna

Study: Mokry, LE & Hoagland KD. 1990. Acute toxicities of five synthetic pyrethroid insecticides to *Daphnia magna* and *Ceriodaphnia dubia*. Environmental Toxicology & Chemistry 9 (8): 1045-1051.

Relevance

Score: 67.5 (purity-25.4 %, no std method, control response NR)

Rating: N

Appendix B3: Studies rated RN, LN, N

Toxicity Data Summary

Crassostrea virginica

Study: Ward GS. 1987. Acute toxicity of FMC 54800 technical to embryos and larvae of the eastern oyster (*Crassostrea virginica*). FMC Study No: A87-2264. MRID 40383501

Relevance

Score: 85 (saltwater)

Rating: N – all concentrations tested > 2x water solubility

Toxicity Data Summary

Culex pipiens quinquefasciatus

Hardstone MC, Leichter C, Harrington LC, Kasai S, Tomita T, Scott JG. 2008. Corrigendum to “Cytochrome P450 monooxygenase-mediated permethrin resistance confers limited and larval specific cross-resistance in the southern house mosquito, *Culex pipiens quinquefasciatus*.” *Pest Biochem Physiol* 91:191-191.

and

Original article:

Hardstone MC, Leichter C, Harrington LC, Kasai S, Tomita T, Scott JG. 2007. Cytochrome P450 monooxygenase-mediated permethrin resistance confers limited and larval specific cross-resistance in the southern house mosquito, *Culex pipiens quinquefasciatus*. *Pest Biochem Physiol* 89:175.

Relevance

Rating: N → not aqueous exposures

Study reports LC_{50s} of 3.5 and 5.2 µg/L for susceptible and resistant strains but these were not aqueous exposures.

From the methods section:

"Adult mosquito bioassays were conducted in glass jars (230 ml, internal surface area of 180 cm²) treated with 1 ml of insecticide solution (or 1 ml of acetone for controls), which was evenly coated on the inner walls."

Toxicity Data Summary

Culex quinquefasciatus

Study: Halliday WR Georghiou GP. 1985. Cross-resistance and dominance relationships of pyrethroids in a permethrin-selected strain of *Culex quinquefasciatus* (Diptera: Culicidae). Journal of Economic Entomology, 78:127-1232.

Relevance

Score: 82.5 (No std method, Control not described)

Rating: L

Reliability

Score: 47

Rating: N

Reference	Halliday & Georghiou 1985	<i>C. quinquefasciatus</i>
Parameter	Value	Comment
Test method cited	Ref Georghiou 1966	
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Culicidae	
Genus	<i>Culex</i>	
Species	<i>quinquefasciatus</i>	
Family in North America?	Yes	
Age/size at start of test/growth phase	4 th instar	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	24 h	
Data for multiple times?	no	
Effect 1	mortality	Susceptible and resistant strains tested
Control response 1	≤ 15%	
Temperature	NR	
Test type	static	
Photoperiod/light intensity	NR	
Dilution water	tap	
pH	NR	
Hardness	NR	
Alkalinity	NR	

Appendix B3: Studies rated RN, LN, N

Reference	Halliday & Georghiou 1985	<i>C. quinquefasciatus</i>
Parameter	Value	Comment
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	NR	
Purity of test substance	'Technical' no%	
Concentrations measured?	NR	
Measured is what % of nominal?	NR	
Chemical method documented?	NR	
Concentration of carrier (if any) in test solutions	10mL/L	
Concentration 1 Nom/Meas (µg/L)	4 levels, but concentrations not reported	4 reps and 20 organisms per rep
Control	yes	
LC ₅₀ (µg/L)	Susceptible: 2.1 Resistant: 39.0	Method: probit

Reliability points taken off for:

Documentation: Control Type (8), Analytical method (4), Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Temperature (4), Conductivity (2), pH (3), Photoperiod (3) Hypothesis tests (8)

Acceptability: Standard method (5), Control appropriate type (6), Meas. Concentrations 20% Nom (4), Concentrations do not exceed 2x water solubility (4), Carrier solvent ≤ 0.5 mL/L (4), Appropriate age/ size (3), Organisms randomly assigned to containers (1), Dilution water (2), Hardness (2), Alkalinity (2), Dissolved Oxygen (6), Temperature (6), Conductivity (1), pH (2), Photoperiod (2), Adequate number of concentrations (3), Appropriate spacing between concentrations (2), Random / block design (2), Hypothesis tests (3)

Toxicity Data Summary

Cyprinodon variegatus

Palaemonetes pugio

Harper, HE, Pennington, PL, Hoguet, J and Fulton, MH. 2008. Lethal and sublethal effects of the pyrethroid, bifenthrin, on grass shrimp (*Palaemonetes pugio*) and sheepshead minnow (*Cyprinodon variegatus*). *Journal of Environmental Science and Health, Part B*, 43:6, 476 - 483.

Relevance - Mortality

Score: 67.5 (saltwater, no std method, Control response NR)

Rating: N

Relevance - Sublethal effects (not summarized)

Score: 52.5 (saltwater, no std method, Control response NR, endpoint not relevant)

Rating: N

Toxicity Data Summary

Daphnia magna

Study: Liu W, Gan J, Schlenk D, Jury WA. 2005b. Enantioselectivity in environmental safety of current chiral insecticides. Proceedings of the National Academy of Sciences, 102:701-706.

Relevance

Score: 85 (control not described, response not reported)

Rating: L

Reliability

Score: 50.5

Rating: N

Reference	Liu <i>et al.</i> 2005b	<i>D. magna</i>
Parameter	Value	Comment
Test method cited	USEPA	
Phylum/subphylum	Arthropoda / Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	<i>Daphnia</i>	
Species	<i>magna</i>	
In North America	Yes	
Age/size at start of test/growth phase	adults	
Source of organisms	Commercial supplier	Aquatic Biosystems (Fort Collins, CO)
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	NR	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 hr	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	NR	
Temperature	NR	
Test type	Static	
Photoperiod/light intensity	NR	
Dilution water	NR	
pH	NR	
Hardness	NR	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	NR	

Appendix B3: Studies rated RN, LN, N

Reference	Liu <i>et al.</i> 2005b	<i>D. magna</i>
Parameter	Value	Comment
Feeding	NR	
Purity of test substance	96%	
Concentrations measured?	NR	
Measured is what % of nominal?	NR	
Chemical method documented?	Yes, but not used for the toxicity tests.	
Concentration of carrier (if any) in test solutions	0.08%	Acetone
Concentrations (nominal) (µg/L)	NR	4 rep /5 org ea.
Control	Not described	4 rep /5 org ea.
LC ₅₀ (µg/L)	0.175 ± 0.030	Method: probit

Notes:

Reliability points taken off for:

Documentation: Control type (8), Nominal concentrations (3), Measured concentrations (3), Dilution water (3), Hardness (2), Alkalinity (2), Dissolved Oxygen (4), Temperature (4), Conductivity (2), pH (3), Photoperiod (3), Hypothesis tests (8).

Acceptability: Control description (6), Control response (9), Measured concentrations within 20% Nom (4), Organisms randomly assigned to containers (1), Organisms properly acclimated/disease free (1), Dilution water (2), Hardness (2), Alkalinity (2), Dissolved Oxygen (6), Temperature acceptable (3), Temperature not held to ± 1°C (3), Conductivity (1), pH (2), Photoperiod (2), Number of concentrations (3), Random or block design (2), Appropriate spacing between concentrations (2), Hypothesis tests (3).