

Table 2a. Chronic Toxicity of Copper to Freshwater Animals

Species	Test ^a	Chemical	Endpoint	Hardness (mg/L as CaCO ₃)	Chronic Limits (µg/L)	Chronic Values		Species Mean Chronic Value (Total µg/L)	Genus Mean Chronic Value (Total µg/L)	ACR	Reference
						Chronic Value ^b (µg/L)	EC20 ^b (µg/L)				
Rotifer, <i>Brachionus calyciflorus</i>	LC,T	Copper sulfate	Intrinsic growth rate	85	2.5-5.0	3.54	-	3.54	3.54		Janssen et al. 1994
Snail, <i>Campeloma decisum</i> (Test 1)	LC,T	Copper sulfate	Survival	35-55	8-14.8	10.88	8.73	9.77	9.77	191.6	Arthur and Leonard 1970
Snail, <i>Campeloma decisum</i> (Test 2)	LC,T	Copper sulfate	Survival	35-55	8-14.8	10.88	10.94			153.0	Arthur and Leonard 1970
Cladoceran, <i>Ceriodaphnia dubia</i> (New River)	LC,D	-	Reproduction	179	6.3-9.9	7.90 ^c (8.23)	-	19.3	19.3	3.599	Belanger et al. 1989
Cladoceran, <i>Ceriodaphnia dubia</i> (Cinch River)	LC,D	-	Reproduction	94.1	<19.3-19.3	<19.3	19.36 ^c (20.17)			3.271	Belanger et al. 1989
Cladoceran, <i>Ceriodaphnia dubia</i>	LC,T	Copper sulfate	Survival and reproduction	57	-	24.50	-			0.547	Oris et al. 1991
Cladoceran, <i>Ceriodaphnia dubia</i>	LC,T	Copper sulfate	Survival and reproduction	57	-	34.60	-				Oris et al. 1991
Cladoceran, <i>Ceriodaphnia dubia</i>	LC,T,D	Copper chloride	Reproduction		12-32	19.59	9.17			2.069	Carlson et al. 1986
Cladoceran, <i>Daphnia magna</i>	LC,T	Copper chloride	Reproduction	85	10-30	17.32	-	14.1	8.96		Blaylock et al. 1985
Cladoceran, <i>Daphnia magna</i>	LC,T	Copper chloride	Carapace length	225	12.6-36.8	21.50	-				van Leeuwen et al. 1988
Cladoceran, <i>Daphnia magna</i>	LC,T	Copper chloride	Reproduction	51	11.4-16.3	13.63	12.58			2.067	Chapman et al. Manuscript
Cladoceran, <i>Daphnia magna</i>	LC,T	Copper chloride	Reproduction	104	20-43	29.33	19.89			1.697	Chapman et al. Manuscript
Cladoceran, <i>Daphnia magna</i>	LC,T	Copper chloride	Reproduction	211	7.2-12.6	9.53	6.06			11.39	Chapman et al. Manuscript
Cladoceran, <i>Daphnia pulex</i>	LC,T	Copper sulfate	Survival	57.5 (No HA)	4.0-6.0	4.90	2.83	5.68		9.104	Winner 1985
Cladoceran, <i>Daphnia pulex</i>	LC,T	Copper sulfate	Survival	115 (No HA)	5.0-10.0	7.07				3.904	Winner 1985
Cladoceran, <i>Daphnia pulex</i>	LC,T	Copper sulfate	Survival	230 (0.15 HA)	10-15	12.25	9.16			3.143	Winner 1985

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Caddisfly, <i>Clistoronia magnifica</i>	LC,T	Copper chloride	Emergence (adult 1st gen)	26	8.3-13	10.39	7.67	7.67	7.67		Nebeker et al. 1984b
Rainbow trout, <i>Oncorhynchus mykiss</i>	ELS,T continuous	Copper chloride	Biomass	120			27.77	23.8	11.9	2.881	Seim et al. 1984
Rainbow trout, <i>Oncorhynchus mykiss</i>	ELS,T	Copper sulfate	Biomass	160-180	12-22	16.25	20.32				Besser et al. 2001
Chinook salmon, <i>Oncorhynchus tshawytscha</i>	ELS,T	Copper chloride	Biomass	20-45	<7.4	<7.4	5.92	5.92		5.594	Chapman 1975, 1982
Brown trout, <i>Salmo trutta</i>	ELS,T	Copper sulfate	Biomass	45.4	20.8-43.8	29.91	-	29.9	29.9		McKim et al. 1978
Brook trout, <i>Salvelinus fontinalis</i>	PLC,T	Copper sulfate	Biomass	35.0	<5 -5	<5	-	12.5	19.7		Sauter et al. 1976
Brook trout, <i>Salvelinus fontinalis</i>	ELS,T	Copper sulfate	Biomass	45.4	22.3-43.5	31.15	-				McKim et al. 1978
Lake trout, <i>Salvelinus namaycush</i>	ELS, T	Copper sulfate	Biomass	45.4	22.0-43.5	30.94	-	30.9			McKim et al. 1978
Northern pike, <i>Esox lucius</i>	ELS, T	Copper sulfate	Biomass	45.4	34.9-104.4	60.36	-	60.4	60.4		McKim et al. 1978
Bluntnose minnow <i>Pimephales notatus</i>	LC,T	Copper sulfate	Egg production	172-230	<18-18	18.00	-	18.0	13.0	12.88	Horning and Neiheisel 1979
Fathead minnow, <i>Pimephales promelas</i>	ELS,T,D	-	Biomass	45			9.38	9.38		11.40	Lind et al. manuscript
White sucker, <i>Catostomus commersoni</i>	ELS, T	Copper sulfate	Biomass	45.4	12.9-33.8	20.88	-	20.9	20.9		McKim et al. 1978
Bluegill (larval), <i>Lepomis macrochirus</i>	ELS,T,D	Copper sulfate	Survival	44-50	21-40	28.98	27.15	27.2	27.2	40.52	Benoit 1975

^a LC = life-cycle; PLC = partial life-cycle; ELS = early life state; T = total copper; D = dissolved copper.

^b Results are based on copper, not the chemical.

^c Chronic values based on dissolved copper concentration.