

SEWRPC Technical Report No. 62

IMPACTS OF CHLORIDE ON THE NATURAL AND BUILT ENVIRONMENT

## **Appendix B**

# **ACUTE TOXICITY OF CHLORIDE COMPOUNDS TO FRESHWATER AQUATIC ORGANISMS**



**Table B.1**  
**Acute Toxicity of Chloride Compounds to Freshwater Aquatic Organisms**

<b>Species</b>	<b>Common Name</b>	<b>Cation<sup>a</sup></b>	<b>Cation Concentration (mg/l)</b>	<b>Chloride Concentration (mg/l)</b>	<b>Exposure Time (hours)</b>	<b>Response<sup>b</sup></b>	<b>Reference<sup>c</sup></b>
<i>Salvelinus fontinalis</i>	Brook trout	Na <sup>+</sup>	19,670	30,330	0.25	LC50	Phillips, 1944
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	721	654	2.00	LC50	Densmore et al., 2018
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	271	246	4.00	LC50	Densmore et al., 2018
<i>Lepomis macrochirus</i>	Bluegill	Na <sup>+</sup>	7,868	12,132	6.00	LC47	Waller, et al., 1996
<i>Oncorhynchus mykiss</i>	Rainbow trout	Na <sup>+</sup>	7,868	12,132	6.00	LC40	Waller, et al., 1996
<i>Labeo rohita</i>	Rohu carp (fingerlings)	Ca <sup>2+</sup>	4,425	7,830	6.00	LC50	Mallick, et al., 2014
<i>Chironomus attenuatus</i>	Midge	Na <sup>+</sup>	3,932	6,063	6.00	LC50	Thornton and Sauer, 1972
<i>Labeo rohita</i>	Rohu carp (spawn)	Ca <sup>2+</sup>	2,613	4,624	6.00	LC50	Mallick, et al., 2014
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	1,349	2,388	6.00	LC50	Mallick, et al., 2014
<i>Labeo rohita</i>	Rohu carp (fingerlings)	Ca <sup>2+</sup>	4,112	7,275	12.00	LC50	Mallick, et al., 2014
<i>Labeo rohita</i>	Rohu carp (fry)	Ca <sup>2+</sup>	3,559	6,296	12.00	LC50	Mallick, et al., 2014
<i>Labeo rohita</i>	Rohu carp (spawn)	Ca <sup>2+</sup>	1,985	3,513	12.00	LC50	Mallick, et al., 2014
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	838	1,484	12.00	LC50	Mallick, et al., 2014
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	387	686	18.00	LC50	Mallick, et al., 2014
<i>Caenorhabditis elegans</i>	Round worm	Ca <sup>2+</sup>	16,033	28,367	24.00	LC50	Tartara et al., 1997
<i>Gambusia affinis</i>	Mosquito fish	Mg <sup>2+</sup>	4,776	13,932	24.00	LC50	Wallen et al., 1957
<i>Gambusia affinis</i>	Mosquito fish	Na <sup>+</sup>	7,105	10,955	24.00	LC50	Wallen et al., 1957
<i>Lepomis macrochirus</i>	Bluegill	Na <sup>+</sup>	5,557	8,568	24.00	LC50	Dowden and Bennett, 1965
<i>Lepomis macrochirus</i>	Bluegill	Na <sup>+</sup>	5,547	8,553	24.00	LC50	Doudoroff and Katz, 1953
<i>Gambusia affinis</i>	Mosquito fish	Ca <sup>2+</sup>	4,828	8,542	24.00	LC50	Wallen et al., 1957
<i>Carassius auratus</i>	Goldfish	Na <sup>+</sup>	5,409	8,341	24.00	LC50	Dowden and Bennett, 1965
<i>Labeo rohita</i>	Rohu carp (fingerlings)	Ca <sup>2+</sup>	3,778	6,684	24.00	LC50	Mallick, et al., 2014
<i>Culex</i> sp.	Mosquito	Na <sup>+</sup>	4,131	6,369	24.00	LC50	Dowden and Bennett, 1965
<i>Labeo rohita</i>	Rohu carp (fry)	Ca <sup>2+</sup>	3,523	6,234	24.00	LC50	Mallick, et al., 2014
<i>Lithobates sylvatica<sup>d</sup></i>	Wood frog (tadpoles)	Mg <sup>2+</sup>	1,882	5,488	24.00	LC50	Harless et al., 2011
<i>Lepomis macrochirus</i>	Bluegill	Ca <sup>2+</sup>	3,015	5,335	24.00	LC50	Dowden and Bennett, 1965
<i>Lithobates sylvatica<sup>d</sup></i>	Wood frog	Ca <sup>2+</sup>	3,588	5,532	24.00	LC50	Harless et al., 2011
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	3,257	5,023	24.00	LC50	Mount et al., 1997
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	3,116	4,804	24.00	LC50	Adelman et al., 1976
<i>Gambusia affinis</i>	Mosquito fish	K <sup>+</sup>	5,233	4,745	24.00	LC50	Wallen et al., 1957

Table continued on next page.

**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	3,050	4,704	24.00	LC50	Cowgill and Milazzo, 1990
<i>Cirrhinius mirigato</i>	Mrigal carp (fry)	Na <sup>+</sup>	2,950	4,550	24.00	LC50	Ghosh and Pal, 1969
<i>Labeo rohito</i>	Rohu carp (fry)	Na <sup>+</sup>	2,950	4,550	24.00	LC50	Ghosh and Pal, 1969
<i>Catla catla</i>	Major (Indian) carp (fry)	Na <sup>+</sup>	2,950	4,550	24.00	LC50	Ghosh and Pal, 1969
<i>Streptocephalus probocideus</i>	Fairy shirmp	Na <sup>+</sup>	2,569	3,961	24.00	LC50	Calleja et al., 1994
<i>Microhylia ornata</i>	Ornate narrow-mouthed frog (hind-limb tadpoles)	Na <sup>+</sup>	2,550	3,932	24.00	LC50	Padhye and Ghate, 1992
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	2,510	3,870	24.00	LC50	Mount et al., 1997
<i>Ictalurus punctatus</i>	Channel catfish (5.0-6.0 cm)	K <sup>+</sup>	3,849	3,489	24.00	LC50	Durand-Hoffman, 1995
<i>Ptychobranchius fasilolaris</i>	Kidneyhell mussel (glochidia)	Na <sup>+</sup>	2,215	3,416	24.00	EC50	Gillis, 2011
<i>Physa heterostrophia</i>	European physa snail	Na <sup>+</sup>	2,176	3,354	24.00	LC50	Wurtz and Bridges, 1961
<i>Oncorhynchus mykiss</i>	Rainbow trout	Na <sup>+</sup>	2,162	3,334	24.00	LC50	Kostecki and Jones, 1983
<i>Bufo boreas</i>	Boreal toad	Mg <sup>2+</sup>	1,121	3,271	24.00	LC50	Lewis, 1999
<i>Lithobates sylvatica<sup>d</sup></i>	Wood frog (tadpoles)	Ca <sup>2+</sup>	1,751	3,099	24.00	LC50	Harless et al., 2011
<i>Lymnaea</i> sp.	Pond snail (eggs)	Ca <sup>2+</sup>	1,620	2,865	24.00	LC50	Dowden and Bennett, 1965
<i>Pimephales promelas</i>	Fathead minnow	Mg <sup>2+</sup>	899	2,621	24.00	LC50	Mount et al., 1997
<i>Lepomis macrochirus</i>	Bluegill	K <sup>+</sup>	2,885	2,615	24.00	LC50	Dowden and Bennett, 1965
<i>Anodonta anatina</i>	Duck mussel	Na <sup>+</sup>	1,624	2,505	24.00	LC50	Beggel and Geist, 2015
<i>Labeo rohita</i>	Rohu carp (spawn)	Ca <sup>2+</sup>	1,347	2,384	24.00	LC50	Mallick, et al., 2014
<i>Microhylia ornata</i>	Ornate narrow-mouthed frog (late gastrula stage)	K <sup>+</sup>	2,623	2,378	24.00	LC50	Padhye and Ghate, 1992
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 33 tadpoles)	Na <sup>+</sup>	1,479	2,281	24.00	LC50	Copan, 2016
<i>Brachionus calyciflorus</i>	Rotifer	Na <sup>+</sup>	1,440	2,220	24.00	LC50	Calleja et al., 1994
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,420	2,190	24.00	LC50	Calleja et al., 1994
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 29 tadpoles)	Na <sup>+</sup>	1,361	2,099	24.00	LC50	Copan, 2016
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	1,174	2,076	24.00	LC50	Mount et al., 1997
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,342	2,070	24.00	LC50	Dowden and Bennett, 1965
<i>Lymnaea</i> sp.	Pond snail (eggs)	Na <sup>+</sup>	1,342	2,070	24.00	LC50	Dowden and Bennett, 1965
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	1,330	2,050	24.00	LC50	Mount et al., 1997
<i>Villosa delumbis</i>	Eastern creekshell mussel (glochidia)	Na <sup>+</sup>	1,302	2,008	24.00	EC50	Bringolf et al., 2007
<i>Tubifex tubifex</i>	Sludge worm	Na <sup>+</sup>	1,250	1,928	24.00	EC50	Khangarot, 1991
<i>Tubifex tubifex</i>	Sludge worm	K <sup>+</sup>	2,000	1,813	24.00	EC50	Khangarot, 1991
<i>Villosa constricta</i>	Notched rainbow mussel (glochidia)	Na <sup>+</sup>	1,086	1,674	24.00	EC50	Bringolf et al., 2007
<i>Daphnia pulex</i>	Water flea	Na <sup>+</sup>	1,072	1,652	24.00	LC50	Cowgill and Milazzo, 1990
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	1,072	1,652	24.00	LC50	Cowgill and Milazzo, 1990
<i>Brachionus calyciflorus</i>	Rotifer	Na <sup>+</sup>	1,067	1,645	24.00	LC50	Elphick et al., 2011
<i>Ellipto complanata</i>	Easter elliptio mussel	Na <sup>+</sup>	1,050	1,620	24.00	EC50	Bringolf et al., 2007
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel (glochidia)	Na <sup>+</sup>	1,011	1,559	24.00	EC50	Bringolf et al., 2007

Table continued on next page.

**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Ceriodaphnia dubia</i>	Water flea	Ca <sup>2+</sup>	816	1,444	24.00	LC50	Mount et al., 1997
<i>Tubifex tubifex</i>	Sludge worm	Ca <sup>2+</sup>	814	1,441	24.00	EC50	Khangarot, 1991
<i>Lampsilis siliquoidea</i>	Fat mucket mussel (glochidia)	Na <sup>+</sup>	927	1,430	24.00	EC50	Gillis, 2011
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel (glochidia)	Na <sup>+</sup>	902	1,391	24.00	EC50	Gillis, 2011
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel (glochidia)	Na <sup>+</sup>	852	1,313	24.00	EC50	Gillis, 2011
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel (glochidia)	Na <sup>+</sup>	820	1,265	24.00	EC50	Gillis, 2011
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	664	1,174	24.00	LC50	Dowden and Bennett, 1965
<i>Pimephales promelas</i>	Fathead minnow	K <sup>+</sup>	1,293	1,172	24.00	LC50	Durand-Hoffman, 1995
<i>Daphnia magna</i>	Water flea	Mg <sup>2+</sup>	398	1,162	24.00	LC50	Mount et al., 1997
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel (glochidia)	Na <sup>+</sup>	724	1,116	24.00	EC50	Gillis, 2011
<i>Ceriodaphnia dubia</i>	Water flea	Mg <sup>2+</sup>	324	946	24.00	LC50	Mount et al., 1997
<i>Lymnaea</i> sp.	Pond snails (eggs)	K <sup>+</sup>	1,018	923	24.00	LC50	Dowden and Bennett, 1965
<i>Streptocephalus proboscideus</i>	Fairy shrimp	K <sup>+</sup>	981	889	24.00	LC50	Calleja et al., 1994
<i>Lampsilis siliquoidea</i>	Fat mucket mussel (glochidia)	Na <sup>+</sup>	535	825	24.00	LC50	Hazelton et al., 2013
<i>Lampsilis cardium</i>	Plain pocketbook mussel (glochidia)	Na <sup>+</sup>	530	817	24.00	EC50	Gillis, 2011
<i>Brachionus calyciflorus</i>	Rotifer	K <sup>+</sup>	886	804	24.00	LC50	Calleja et al., 1994
<i>Ligurnia recta</i>	Black sandshell mussel (glochidia)	Na <sup>+</sup>	496	764	24.00	LC50	Hazelton et al., 2013
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 26 tadpoles)	Na <sup>+</sup>	492	758	24.00	LC50	Copan, 2016
<i>Salmo gairdneri</i>	Rainbow trout (5.0-6.0 cm)	K <sup>+</sup>	625	566	24.00	LC50	Durand-Hoffman, 1995
<i>Pimephales promelas</i>	Fathead minnow	K <sup>+</sup>	498	452	24.00	LC50	Mount et al., 1997
<i>Notemigonus crysolucas</i>	Golden shiner	K <sup>+</sup>	428	388	24.00	LC50	Durand-Hoffman, 1995
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 19 tadpoles)	Na <sup>+</sup>	230	354	24.00	LC50	Copan, 2016
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	388	352	24.00	LC50	Mount et al., 1997
<i>Stizostedion vitreum</i>	Walleye (1.5-2.5 cm)	K <sup>+</sup>	380	344	24.00	LC50	Durand-Hoffman, 1995
<i>Lampsilis siliquoidea</i>	Fat mucket mussel (glochidia)	Na <sup>+</sup>	216	334	24.00	EC50	Bringolf et al., 2007
<i>Ceriodaphnia dubia</i>	Water flea	K <sup>+</sup>	330	300	24.00	LC50	Mount et al., 1997
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel (glochidia)	Na <sup>+</sup>	185	285	24.00	EC50	Gillis, 2011
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 22 tadpoles)	Na <sup>+</sup>	161	248	24.00	LC50	Copan, 2016
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	287	261	24.00	LC50	Calleja et al., 1994
<i>Epioblasma torulosa rangiana</i>	Northern riffle shell mussel (glochidia)	Na <sup>+</sup>	158	244	24.00	EC50	Gillis, 2011
<i>Stizostedion canadense</i>	Sanger	K <sup>+</sup>	262	238	24.00	LC50	Durand-Hoffman, 1995
<i>Lampsilis siliquoidea</i>	Fat mucket mussel (glochidia)	Na <sup>+</sup>	109	168	24.00	EC50	Gillis, 2011
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	180	163	24.00	LC50	Dowden and Bennett, 1965
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	92	163	24.00	LC50	Mallick et al., 2014
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	145	132	24.00	LC50	Densmore et al., 2018
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel (glochidia)	Na <sup>+</sup>	73	113	24.00	EC50	Gillis, 2011

Table continued on next page.

**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Dreissena polymorpha</i>	Zebra mussel	K <sup>+</sup>	72	66	24.00	LC50	Waller <i>et al.</i> , 1993
<i>Dreissena polymorpha</i>	Zebra mussel (0.5-1.5 cm)	K <sup>+</sup>	72	66	24.00	LC50	Durand-Hoffman, 1995
<i>Dreissena polymorpha</i>	Zebra mussel (2.0-2.5 cm)	K <sup>+</sup>	53	49	24.00	LC50	Durand-Hoffman, 1995
<i>Mollisia latipinna</i>	Sailfin mollie	Na <sup>+</sup>	2,536	3,911	25.00	LC50	Dowden and Bennett, 1965
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,517	2,340	25.00	LC50	Dowden and Bennett, 1965
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	1,273	2,253	25.00	LC50	Dowden and Bennett, 1965
<i>Daphnia magna</i>	Water flea	Mg <sup>2+</sup>	866	2,525	25.00	LC50	Dowden and Bennett, 1965
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	23	41	36.00	LC50	Mallick <i>et al.</i> , 2014
<i>Gambusia affinis</i>	Mosquito fish	Mg <sup>2+</sup>	4,521	13,189	48.00	LC50	Waller <i>et al.</i> , 1957
<i>Cyclops abyssorum</i>	Cyclopoid copepod	Ca <sup>2+</sup>	7,005	12,395	48.00	LC50	Baudouin and Scoppa, 1974
<i>Caridina denticulata denticulata</i>	Cherry shrimp	Ca <sup>2+</sup>	6,545	11,580	48.00	LC50	Baek <i>et al.</i> , 2014
<i>Gambusia affinis</i>	Mosquito fish	Na <sup>+</sup>	7,105	10,955	48.00	LC50	Waller <i>et al.</i> , 1957
<i>Mollisia latipinna</i>	Sailfin mollie	Na <sup>+</sup>	6,528	10,067	48.00	LC50	Dowden and Bennett, 1965
<i>Gambusia affinis</i>	Mosquito fish	Ca <sup>2+</sup>	4,828	8,542	48.00	LC50	Waller <i>et al.</i> , 1957
<i>Eudiaptomus padanus</i>	Calanoid copepod	Ca <sup>2+</sup>	4,008	7,092	48.00	LC50	Baudouin and Scoppa, 1974
<i>Labeo rohita</i>	Rohu carp (fingerling)	Ca <sup>2+</sup>	3,688	6,524	48.00	LC50	Mallick <i>et al.</i> , 2014
<i>Culex</i> sp.	Mosquito	Na <sup>+</sup>	4,034	6,222	48.00	LC50	Dowden and Bennett, 1965
<i>Labeo rohita</i>	Rohu carp (fry)	Ca <sup>2+</sup>	3,193	5,650	48.00	LC50	Mallick <i>et al.</i> , 2014
<i>Lithobates sylvatica<sup>d</sup></i>	Wood frog (tadpoles)	Mg <sup>2+</sup>	1,859	5,421	48.00	LC50	Harless <i>et al.</i> , 2011
<i>Daphnia hyalina</i>	Water flea	Ca <sup>2+</sup>	2,997	5,303	48.00	LC50	Baudouin and Scoppa, 1974
<i>Lithobates sylvatica<sup>d</sup></i>	Wood frog (tadpoles)	Na <sup>+</sup>	3,076	4,744	48.00	LC50	Harless <i>et al.</i> , 2011
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	3,025	4,655	48.00	LC50	Adelman <i>et al.</i> , 1976
<i>Ameletus</i> sp.	Brown dun mayfly	Na <sup>+</sup>	2,738	4,222	48.00	LC50	Echols <i>et al.</i> , 2009
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	2,596	4,004	48.00	LC50	Schuytema <i>et al.</i> , 1997
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	2,561	3,949	48.00	LC50	Mount <i>et al.</i> , 1997
<i>Lemna minor</i>	Small duckweed	Na <sup>+</sup>	2,529	3,900	48.00	EC50	Simmons, 2012
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	2,529	3,900	48.00	EC50	Goncalves <i>et al.</i> , 2007
<i>Ecdyonurus levis</i>	Little slate-winged dun mayfly	Ca <sup>2+</sup>	2,191	3,876	48.00	LC50	Baek <i>et al.</i> , 2014
<i>Cleon dipterum</i>	Common wetland mayfly	Ca <sup>2+</sup>	2,128	3,776	48.00	LC50	Baek <i>et al.</i> , 2014
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	2,156	3,324	48.00	LC50	Martinez-Jeronimo and Martinez-Jeronimo, 2007
<i>Baetis tricaudatus</i>	Blue-winged olive mayfly	Na <sup>+</sup>	2,140	3,300	48.00	LC50	Lowell <i>et al.</i> , 1995
<i>Bufo boreas</i>	Boreal toad	Mg <sup>2+</sup>	1,121	3,271	48.00	LC50	Lewis, 1999
<i>Baetis tricaudatus</i>	Blue-winged olive mayfly	Na <sup>+</sup>	2,097	3,233	48.00	LC50	Lowell <i>et al.</i> , 1995
<i>Physa heterostropha</i>	European physa snail	Na <sup>+</sup>	2,018	3,112	48.00	LC50	Wurtz and Bridges, 1961
<i>Lithobates sylvatica<sup>d</sup></i>	Wood frog (tadpoles)	Ca <sup>2+</sup>	1,704	3,016	48.00	LC50	Harless <i>et al.</i> , 2011

Table continued on next page.

**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,951	3,009	48.00	EC50	Abe <i>et al.</i> , 2014
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,915	2,954	48.00	LC50	Struwing <i>et al.</i> , 2015
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,877	2,893	48.00	LC50	Mount <i>et al.</i> , 1997
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,821	2,808	48.00	LC50	Biesinger and Christensen, 1972
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,641	2,530	48.00	LC50	Biesinger and Christensen, 1972
<i>Glyptotendipes tokunagai</i>	Midge	Ca <sup>2+</sup>	1,331	2,355	48.00	LC50	Baek <i>et al.</i> , 2014
<i>Ligurnia recta</i>	Black sandshell mussel (juveniles)	Na <sup>+</sup>	1,475	2,275	48.00	LC50	Hazelton <i>et al.</i> , 2013
<i>Villosa delumbis</i>	Eastern creekshell mussel (glochidia)	Na <sup>+</sup>	1,428	2,202	48.00	EC50	Bringolf <i>et al.</i> , 2007
<i>Gammarus sobaegenis</i>	Scud	Ca <sup>2+</sup>	1,227	2,171	48.00	LC50	Baek <i>et al.</i> , 2014
<i>Lampsis silivoides</i>	Fat mucket mussel (glochidia)	Na <sup>+</sup>	1,404	2,166	48.00	LC50	Hazelton <i>et al.</i> , 2013
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 33 tadpoles)	Na <sup>+</sup>	1,374	2,118	48.00	LC50	Copan, 2016
<i>Pimephales promelas</i>	Fathead minnow	Mg <sup>2+</sup>	725	2,115	48.00	LC50	Mount <i>et al.</i> , 1997
<i>Lymnaea</i> sp.	Pond snail (eggs)	Na <sup>+</sup>	1,333	2,055	48.00	LC50	Dowden and Bennett, 1965
<i>Laboe rohita</i>	Rohu carp (spawn)	Ca <sup>2+</sup>	1,151	2,036	48.00	LC50	Mallick <i>et al.</i> , 2014
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,302	2,008	48.00	LC50	Dowden and Bennett, 1965
<i>Lymnaea</i> sp.	Pond snail (eggs)	Ca <sup>2+</sup>	1,117	1,977	48.00	LC50	Dowden and Bennett, 1965
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	1,191	1,836	48.00	LC50	GLEC and INHS, 2008; Soucek <i>et al.</i> , 2011
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,174	1,809	48.00	LC50	Ghazy <i>et al.</i> , 2009
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	1,154	1,779	48.00	LC50	GLEC and INHS, 2008; Soucek <i>et al.</i> , 2011
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 29 tadpoles)	Na <sup>+</sup>	1,154	1,779	48.00	LC50	Copan, 2016
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	1,000	1,770	48.00	LC50	Mount <i>et al.</i> , 1997
<i>Daphnia longispina</i>	Water flea	Na <sup>+</sup>	1,141	1,759	48.00	EC50	Goncalves <i>et al.</i> , 2007
<i>Daphnia longispina</i>	Water flea	Na <sup>+</sup>	1,121	1,729	48.00	LC50	Leitao <i>et al.</i> , 2013
<i>Daphnia longispina</i>	Water flea	Na <sup>+</sup>	1,109	1,711	48.00	LC50	Leitao <i>et al.</i> , 2013
<i>Daphnia longispina</i>	Water flea	Na <sup>+</sup>	1,102	1,698	48.00	LC50	Leitao <i>et al.</i> , 2013
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	1,031	1,589	48.00	LC50	GLEC and INHS, 2008; Soucek <i>et al.</i> , 2011
<i>Villosa constricta</i>	Notched rainbow mussel (glochidia)	Na <sup>+</sup>	1,019	1,571	48.00	EC50	Bringolf <i>et al.</i> , 2007
<i>Tubifex tubifex</i>	Sludge worm	Na <sup>+</sup>	1,016	1,567	48.00	EC50	Khangatrot, 1991
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	867	1,533	48.00	EC50	DeGroot and Groeneveld, 1998
<i>Maccaffertium modestum</i> <sup>e</sup>	Cream cahill mayfly	Na <sup>+</sup>	984	1,517	48.00	LC50	Roback, 1965
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	985	1,519	48.00	LC50	Cowgill and Milazzo, 1990
<i>Daphnia longispina</i>	Water flea	Na <sup>+</sup>	984	1,517	48.00	LC50	Leitao <i>et al.</i> , 2013
<i>Daphnia longispina</i>	Water flea	Na <sup>+</sup>	976	1,504	48.00	LC50	Leitao <i>et al.</i> , 2013

**Table continued on next page.**

**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	966	1,489	48.00	LC50	GLEC and INHS, 2008;
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	909	1,402	48.00	LC50	Soucek <i>et al.</i> , 2011
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	880	1,357	48.00	LC50	GLEC and INHS, 2008;
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	879	1,356	48.00	LC50	Soucek <i>et al.</i> , 2011
<i>Elloptio complanata</i>	Eastern elliptio mussel	Na <sup>+</sup>	877	1,353	48.00	EC50	Bringolf <i>et al.</i> , 2007
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	854	1,317	48.00	LC50	GLEC and INHS, 2008;
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	811	1,250	48.00	LC50	Soucek <i>et al.</i> , 2011
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	810	1,249	48.00	LC50	Soucek <i>et al.</i> , 2011
<i>Daphnia pulex</i>	Water flea	Na <sup>+</sup>	803	1,239	48.00	LC50	Gardner and Royer, 2010
<i>Daphnia ambigua</i>	Water flea	Na <sup>+</sup>	787	1,213	48.00	LC50	Cowgill and Milazzo, 1991
<i>Tubifex tubifex</i>	Sludge worm	K <sup>+</sup>	1,320	1,197	48.00	EC50	Khangatrot, 1991
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	773	1,192	48.00	LC50	GLEC and INHS, 2008;
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	771	1,189	48.00	LC50	Soucek <i>et al.</i> , 2011
<i>Ceriodaphnia dubia</i>	Water flea	Ca <sup>2+</sup>	661	1,169	48.00	LC50	Mount <i>et al.</i> , 2016
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	748	1,154	48.00	LC50	Mount <i>et al.</i> , 2016
<i>Daphnia pulex</i>	Water flea	Na <sup>+</sup>	713	1,099	48.00	LC50	GLEC and INHS, 2008;
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	693	1,068	48.00	LC50	Soucek <i>et al.</i> , 2011
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel (glochidia)	Na <sup>+</sup>	685	1,055	48.00	EC50	Gardner and Royer, 2010
<i>Daphnia magna</i>	Water flea	Mg <sup>2+</sup>	340	990	48.00	LC50	Elphick <i>et al.</i> , 2011
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	634	977	48.00	LC50	Bringolf <i>et al.</i> , 2007
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	626	964	48.00	LC50	Mount <i>et al.</i> , 2016
<i>Daphnia magna</i>	Water flea	Mg <sup>2+</sup>	322	941	48.00	LC50	GLEC and INHS, 2008;
<i>Centroptilum triangulifer</i>	Triangle small minnow mayfly	K <sup>+</sup>	1,026	931	48.00	LC50	Soucek <i>et al.</i> , 2011
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	558	861	48.00	LC50	Cowgill and Milazzo, 1991
<i>Pseudosida ramosa</i>	Sida water flea	Na <sup>+</sup>	543	838	48.00	LC50	Biesinger and Christensen, 1972
<i>Daphnia pulex</i>	Water flea	Ca <sup>2+</sup>	460	815	48.00	LC50	Struwing <i>et al.</i> , 2015
<i>Oncorhynchus mykiss</i>	Rainbow trout	K <sup>+</sup>	844	766	48.00	LC50	GLEC and INHS, 2008;
							Soucek <i>et al.</i> , 2011
							Freitas and Rocha, 2011, 2011a
							Biesinger and Christensen, 1972
							Waller <i>et al.</i> , 1993

Table continued on next page.



**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Lymnaea</i> sp.	Pond snail (eggs)	K <sup>+</sup>	783	709	48.00	LC50	Dowden and Bennett, 1965
<i>Tubifex tubifex</i>	Sludge worm	Ca <sup>2+</sup>	389	688	48.00	LC50	Khangarot, 1991
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	383	679	48.00	LC50	Khangarot and Ray, 1989
<i>Ceriodaphnia dubia</i>	Water flea	Mg <sup>2+</sup>	225	655	48.00	LC50	Mount et al., 2016
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 26 tadpoles)	Na <sup>+</sup>	385	593	48.00	LC50	Copan, 2016
<i>Daphnia similis</i>	Water flea	K <sup>+</sup>	624	566	48.00	EC50	Utz and Bohrer, 2001
<i>Daphnia similis</i>	Water flea	K <sup>+</sup>	566	514	48.00	EC50	Utz and Bohrer, 2001
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	274	485	48.00	LC50	Dowden and Bennett, 1965
<i>Pimephales promelas</i>	Fathead minnow	K <sup>+</sup>	477	433	48.00	LC50	Mount et al., 1997
<i>Daphnia magna</i>	Water flea	Mg <sup>2+</sup>	140	409	48.00	LC50	Biesinger and Christensen, 1972
<i>Nitocra spinipes</i>	Harpacticoid copepod	K <sup>+</sup>	448	406	48.00	LC50	Bengtsson, 1978
<i>Centroptilum triangulifer</i>	Triangle small minnow mayfly	Na <sup>+</sup>	259	400	48.00	LC50	Struwing et al., 2015
<i>Ictalurus punctatus</i>	Channel catfish	K <sup>+</sup>	378	342	48.00	LC50	Waller et al., 1993
<i>Lampsilis siliquoidea</i>	Fat mucket mussel (glochidia)	Na <sup>+</sup>	220	340	48.00	EC50	Bringolf et al., 2007
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	367	333	48.00	LC50	Struwing et al., 2015
<i>Daphnia similis</i>	Water flea	K <sup>+</sup>	362	328	48.00	EC50	Utz and Bohrer, 2001
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	346	314	48.00	LC50	Mount et al., 1997
<i>Ceriodaphnia dubia</i>	Water flea	K <sup>+</sup>	330	300	48.00	LC50	Mount et al., 1997
<i>Ceriodaphnia dubia</i>	Water flea	K <sup>+</sup>	304	275	48.00	LC50	Struwing et al., 2015
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 22 tadpoles)	Na <sup>+</sup>	139	214	48.00	LC50	Copan, 2016
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	177	160	48.00	LC50	Dowden and Bennett, 1965
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	166	151	48.00	LC50	Biesinger and Christensen, 1972
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 19 tadpoles)	Na <sup>+</sup>	95	147	48.00	LC50	Copan, 2016
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	103	93	48.00	LC50	Densmore et al. 2018
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	52	91	48.00	LC50	Biesinger and Christensen, 1972
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	93	84	48.00	LC50	Biesinger and Christensen, 1972
<i>Dreissena polymorpha</i>	Zebra mussel	K <sup>+</sup>	79	71	48.00	LC50	Waller et al., 1993
<i>Dreissena polymorpha</i>	Zebra mussel	K <sup>+</sup>	77	70	48.00	LC50	Waller et al., 1993
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	21	38	48.00	LC50	Mallick et al., 2014
<i>Psuedosida ramosa</i>	Sida water flea	K <sup>+</sup>	18	16	48.00	LC50	Freitas and Rocha, 2011
<i>Psuedosida ramosa</i>	Sida water flea	K <sup>+</sup>	9	9	48.00	LC50	Freitas and Rocha, 2011a
<i>Daphnia magna</i>	Water flea	Mg <sup>2+</sup>	944	2,755	50.00	LC50	Dowden and Bennett, 1965
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	1,085	1,920	50.00	LC50	Dowden and Bennett, 1965
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	16	29	60.00	LC50	Mallick et al., 2014
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	3,644	6,448	72.00	LC50	Mallick et al., 2014
<i>Lithobates sylvatica</i> <sup>d</sup>	Wood frog (tadpoles)	Mg <sup>2+</sup>	1,848	5,392	72.00	LC50	Harless et al., 2011

Table continued on next page.

**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	3,010	4,640	72.00	LC50	Adelman, et al., 1976
<i>Lithobates sylvatica</i> <sup>d</sup>	Wood frog (tadpoles)	Na <sup>+</sup>	3,006	4,634	72.00	LC50	Harless et al., 2011
<i>Anabolia nervosa</i>	Brown sedge caddisfly	Na <sup>+</sup>	2,759	4,255	72.00	LC50	Sutcliffe, 1961
<i>Limnephilus stigma</i>	Summer flier sedge caddisfly	Na <sup>+</sup>	2,759	4,255	72.00	LC50	Sutcliffe, 1961
<i>Labeo rohita</i>	Rohu carp (fry)	Ca <sup>2+</sup>	2,127	3,763	72.00	LC50	Mallick et al., 2014
<i>Ameletus</i> sp.	Brown dun mayfly	Na <sup>+</sup>	2,022	3,118	72.00	LC50	Echols et al., 2009
<i>Physa heterostropha</i>	European physa snail	Na <sup>+</sup>	1,924	2,966	72.00	LC50	Wurtz and Bridges, 1961
<i>Lithobates sylvatica</i>	Wood frog (tadpoles)	Ca <sup>2+</sup>	1,509	2,671	72.00	LC50	Harless et al., 2011
<i>Lymnaea</i> sp.	Pond snail (eggs)	Ca <sup>2+</sup>	1,195	2,113	72.00	LC50	Dowden and Bennett, 1965
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 33 tadpoles)	Na <sup>+</sup>	1,175	1,812	72.00	LC50	Copan, 2016
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 29 tadpoles)	Na <sup>+</sup>	1,010	1,558	72.00	LC50	Copan, 2016
<i>Labeo rohita</i>	Rohu carp (spawn)	Ca <sup>2+</sup>	845	1,495	72.00	LC50	Mallick et al., 2014
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	274	485	72.00	LC50	Dowden and Bennett, 1965
<i>Lymnaea</i> sp.	Pond snail (eggs)	K <sup>+</sup>	534	484	72.00	LC50	Dowden and Bennett, 1965
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 26 tadpoles)	Na <sup>+</sup>	306	472	72.00	LC50	Copan, 2016
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 22 tadpoles)	Na <sup>+</sup>	108	116	72.00	LC50	Copan, 2016
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 19 tadpoles)	Na <sup>+</sup>	73	112	72.00	LC50	Copan, 2016
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	61	56	72.00	LC50	Dowden and Bennett, 1965
<i>Labeo rohita</i>	Rohu carp (spawn)	Ca <sup>2+</sup>	16	27	72.00	LC50	Mallick et al., 2014
<i>Anguilla rostrata</i>	American eel (black eel stage)	Na <sup>+</sup>	8,486	13,085	96.00	LC50	Hinton and Eversole, 1979
<i>Oncorhynchus mykiss</i>	Rainbow trout	Na <sup>+</sup>	8,017	12,371	96.00	LC50	Vosyliene et al., 2006
<i>Gambusia affinis</i>	Mosquito fish	Mg <sup>2+</sup>	4,203	12,260	96.00	LC50	Wallen, et al., 1957
<i>Anguilla rostrata</i>	American eel (black eel stage)	Na <sup>+</sup>	7,069	10,900	96.00	LC50	Hinton and Eversole, 1979
<i>Gambusia affinis</i>	Mosquito fish	Na <sup>+</sup>	6,889	10,622	96.00	LC50	Wallen, et al., 1957
<i>Gambusia affinis</i>	Mosquito fish	Ca <sup>2+</sup>	4,828	8,542	96.00	LC50	Wallen, et al., 1957
<i>Hydropsyche betteni</i>	Spotted sedge caddisfly	Na <sup>+</sup>	5,235	8,073	96.00	LC50	Kundman, 1998
<i>Lepomis macrochirus</i>	Bluegill	Na <sup>+</sup>	5,100	7,864	96.00	LC50	Trama, 1954
<i>Lepomis macrochirus</i>	Bluegill	Na <sup>+</sup>	5,093	7,853	96.00	LC50	Patrick et al., 1968
<i>Lepomis macrochirus</i>	Bluegill	Ca <sup>2+</sup>	4,080	7,220	96.00	LC50	Cairns and Scheier, 1959
<i>Lepomis macrochirus</i>	Bluegill	Ca <sup>2+</sup>	3,846	6,804	96.00	LC50	Trama, 1954; Patrick et al., 1968
<i>Oncorhynchus mykiss</i>	Rainbow trout	Na <sup>+</sup>	4,369	6,743	96.00	LC50	Spehar, 1987
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	4,261	6,570	96.00	LC50	Birge et al., 1985
<i>Labeo rohita</i>	Rohu carp (fingerlings)	Ca <sup>2+</sup>	3,600	6,300	96.00	LC50	Mallick et al., 2014
<i>Culex</i> sp.	Mosquito	Na <sup>+</sup>	4,032	6,222	96.00	LC50	Dowden and Bennett, 1965
<i>Lepomis macrochirus</i>	Bluegill	Ca <sup>2+</sup>	3,430	6,070	96.00	LC50	Cairns and Scheier, 1959

Table continued on next page.

**Table B.1 (Continued)**

<b>Species</b>	<b>Common Name</b>	<b>Cation<sup>a</sup></b>	<b>Cation Concentration (mg/l)</b>	<b>Chloride Concentration (mg/l)</b>	<b>Exposure Time (hours)</b>	<b>Response<sup>b</sup></b>	<b>Reference<sup>c</sup></b>
<i>Tubifex tubifex</i>	Sludge Worm	Na <sup>+</sup>	3,896	6,008	96.00	LC50	GLEC and INHS, 2008;
<i>Chironomus dilutus</i>	Midge	Na <sup>+</sup>	3,805	5,867	96.00	LC50	Soucek <i>et al.</i> , 2011
<i>Tubifex tubifex</i>	Sludge Worm	Na <sup>+</sup>	3,663	5,648	96.00	LC50	Elphick, <i>et al.</i> , 2011
<i>Lepomis macrochirus</i>	Bluegill	Na <sup>+</sup>	3,787	5,840	96.00	LC50	Elphick, <i>et al.</i> , 2011
<i>Eurycea bislineata</i>	Northern two-lined salamander (larvae)	Na <sup>+</sup>	3,570	5,505	96.00	LC50	Birge <i>et al.</i> , 1985
<i>Hydropsyche</i> sp.	Spotted sedge caddisfly	Na <sup>+</sup>	3,541	5,459	96.00	LC50	Jones, <i>et al.</i> , 2015
<i>Lithobates sylvatica<sup>d</sup></i>	Wood frog (tadpoles)	Mg <sup>2+</sup>	1,815	5,295	96.00	LC50	Roback, 1965
<i>Gammarus pseudolimnaeus</i>	Scud	Na <sup>+</sup>	3,030	4,670	96.00	LC50	Harless, <i>et al.</i> , 2011
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	3,022	4,659	96.00	LC50	Blasius and Merritt, 2002
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	3,010	4,640	96.00	LC50	Wisconsin State Laboratory of Health, 1998
<i>Lithobates sylvatica<sup>d</sup></i>	Wood frog (tadpoles)	Na <sup>+</sup>	2,974	4,659	96.00	LC50	Adelman <i>et al.</i> , 1976
<i>Carassius auratus</i>	Goldfish	Na <sup>+</sup>	2,888	4,453	96.00	LC50	Harless, <i>et al.</i> , 2011
<i>Tubifex tubifex</i>	Sludge worm	Na <sup>+</sup>	2,774	4,278	96.00	LC50	Adelman <i>et al.</i> , 1976
<i>Microhylla ornata</i>	Ornate narrow-mouthed frog (hind-limb tadpoles)	Na <sup>+</sup>	2,774	4,278	96.00	LC50	GLEC and INHS, 2008;
<i>Anabolia nevosa</i>	Brown sedge caddisfly	Na <sup>+</sup>	2,759	4,255	96.00	LC50	Soucek <i>et al.</i> , 2011
<i>Limnephilus stigma</i>	Summer flier sedge caddisfly	Na <sup>+</sup>	2,759	4,255	96.00	LC50	Padhye and Ghate, 1992
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	2,645	4,079	96.00	LC50	Sutcliffe, 1961
<i>Labeo rohita</i>	Rohu carp (fry)	Ca <sup>2+</sup>	2,301	4,072	96.00	LC50	Sutcliffe, 1961
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	2,638	4,071	96.00	LC50	Elphick, <i>et al.</i> , 2011
<i>Chironomus attenuatus</i>	Midge	Na <sup>+</sup>	2,611	4,026	96.00	LC50 at 18°C	Mallick <i>et al.</i> , 2014
<i>Hyalella azteca</i>	Amphipod	Na <sup>+</sup>	2,560	3,947	96.00	LC50	Wisconsin State Laboratory of Health, 1998
<i>Bufo americanus</i>	American toad (tadpoles)	Na <sup>+</sup>	2,547	3,928	96.00	LC50	Thomton and Sauer, 1972
<i>Pimephales promelas</i>	Fathead minnow	Na <sup>+</sup>	2,514	3,876	96.00	LC50	Lasier <i>et al.</i> , 1997
<i>Hexagenia limbata</i>	Giant burrowing mayfly	Na <sup>+</sup>	2,478	3,822	96.00	LC50	Collins and Russell, 2009
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	2,373	3,658	96.00	LC50	Mount <i>et al.</i> , 1997
<i>Lepidostoma</i> sp.	Little brown sedge caddisfly	Na <sup>+</sup>	2,360	3,640	96.00	LC50	Chadwick, 2001
<i>Corbicula fluminea</i>	Asian clam	Ca <sup>2+</sup>	2,009	3,554	96.00	LC50	Cowgill and Milazzo, 1990
<i>Hydroptila angusta</i>	Varicolored microcaddisfly	Na <sup>+</sup>	2,174	3,352	96.00	LC50	Williams <i>et al.</i> , 1999
<i>Villosa delumbis</i>	Easter creekshell mussel (juveniles)	Na <sup>+</sup>	2,057	3,173	96.00	EC50	Coldsnow and Relyea, 2018
<i>Cricotopus trifascia</i>	Midge	Na <sup>+</sup>	2,043	3,149	96.00	LC50	Hamilton <i>et al.</i> , 1975
<i>Rana clamitans</i>	Green frog (tadpoles)	Na <sup>+</sup>	2,016	3,109	96.00	LC50	Bringolf, <i>et al.</i> , 2007
<i>Lumbriculus variegatus</i>	California blackworm	Na <sup>+</sup>	2,010	3,100	96.00	LC50	Hamilton <i>et al.</i> , 1975
							Collins and Russell, 2009
							Elphick, <i>et al.</i> , 2011

Table continued on next page.

**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Lithobates sylvatica</i> <sup>d</sup>	Wood frog (tadpoles)	Na <sup>+</sup>	2,010	3,099	96.00	LC50	Sanzo and Hecnar, 2006
<i>Gyraulus parvus</i>	Planorbid snail	Na <sup>+</sup>	1,996	3,078	96.00	LC50	GLEC and INHS, 2008; Soucek et al., 2011
<i>Microhyla ornata</i>	Ornate narrow-mouthed frog (8-day embryos)	Na <sup>+</sup>	1,978	3,049	96.00	LC50	Padhye and Ghate, 1992
<i>Cirrhinus mrigala</i>	Mrigal carp (fry)	Na <sup>+</sup>	1,959	3,021	96.00	LC50	Ghosh and Pal, 1969
<i>Labeo rohito</i>	Rohu carp (fry)	Na <sup>+</sup>	1,959	3,021	96.00	LC50	Ghosh and Pal, 1969
<i>Catla catla</i>	Major (Indian) carp (fry)	Na <sup>+</sup>	1,959	3,021	96.00	LC50	Ghosh and Pal, 1969
<i>Gyraulus parvus</i>	Planorbid snail	Na <sup>+</sup>	1,951	3,009	96.00	LC50	GLEC and INHS, 2008; Soucek et al., 2011
<i>Lirceus fontinalis</i>	Isopod	Na <sup>+</sup>	1,926	2,970	96.00	LC50	Birge et al., 1985
<i>Pimephales promelas</i>	Fathead minnow	Ca <sup>2+</sup>	1,672	2,958	96.00	LC50	Mount et al., 1997
<i>Physa heterostrophia</i>	European physa snail	Na <sup>+</sup>	1,857	2,863	96.00	LC50	Wurtz and Bridges, 1961
<i>Pseudacris crucifer</i>	Spring peeper (tadpoles)	Na <sup>+</sup>	1,835	2,830	96.00	LC50	Collins and Russell, 2009
<i>Lampsilis siliquoides</i>	Fat mucket mussel (juveniles)	Na <sup>+</sup>	1,794	2,766	96.00	EC50	Bringolf, et al., 2007
<i>Lithobates sylvatica</i> <sup>d</sup>	Wood frog (tadpoles)	Ca <sup>2+</sup>	1,437	2,543	96.00	LC50	Harless et al., 2011
<i>Ameletus</i> sp.	Brown dun mayfly	Na <sup>+</sup>	1,625	2,505	96.00	LC50	Echols et al., 2009
<i>Physa gyrina</i>	Tadpole physa snail	Na <sup>+</sup>	1,608	2,480	96.00	LC50	Birge et al., 1985
<i>Lithobates clamitans</i>	Green frog (tadpoles)	Na <sup>+</sup>	1,570	2,421	96.00	LC50	Jones et al., 2015
<i>Lampsilis fasciola</i>	Wavy-rayed lampmussel	Na <sup>+</sup>	1,566	2,414	96.00	EC50	Bringolf, et al., 2007
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,549	2,390	96.00	LC50	Arambasic et al., 1995
<i>Corbicula fluminea</i>	Asian clam	Mg <sup>2+</sup>	712	2,162	96.00	LC50	Coldsnow and Relyea, 2018
<i>Pycnopsyche guttifer</i>	Great autumn brown sedge caddisfly	Na <sup>+</sup>	1,386	2,140	96.00	LC50	Blasius and Merritt, 2002
<i>Pycnopsyche lepida</i>	Northern caddisfly	Na <sup>+</sup>	1,386	2,140	96.00	LC50	Blasius and Merritt, 2002
<i>Musculium transversum</i>	Long fingernail clam	Na <sup>+</sup>	1,252	1,930	96.00	LC50	Soucek et al., 2011
<i>Isonychia bicolor</i>	Mahogany dun mayfly	Na <sup>+</sup>	1,220	1,880	96.00	LC50	Echols et al., 2009
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,201	1,853	96.00	LC50	Anderson, 1950
<i>Lithobates sylvatica</i> <sup>d</sup>	Wood frog (tadpoles)	Na <sup>+</sup>	1,116	1,721	96.00	LC50	Collins and Russell, 2009
<i>Microhyla ornata</i>	Ornate narrow-mouthed frog (late gastrula)	Na <sup>+</sup>	1,067	1,644	96.00	LC50	Padhye and Ghate, 1992
<i>Lymnaea</i> sp.	Pond snail (eggs)	Ca <sup>2+</sup>	929	1,644	96.00	LC50	Dowden and Bennett, 1965
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 33 tadpoles)	Na <sup>+</sup>	1,066	1,643	96.00	LC50	Copan, 2016
<i>Lithobates sylvatica</i> <sup>d</sup>	Wood frog (tadpoles)	Na <sup>+</sup>	1,037	1,599	96.00	LC50	Sanzo and Hecnar, 2006
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	1,035	1,596	96.00	LC50	Wisconsin State Laboratory of Health, 1998
<i>Lampsilis siliquoides</i>	Fat mucket mussel (juveniles)	Na <sup>+</sup>	1,035	1,595	96.00	LC50	Hazelton et al., 2013
<i>Pimephales promelas</i>	Fathead minnow	Mg <sup>2+</sup>	541	1,579	96.00	LC50	Mount et al., 1997
<i>Ligumia recta</i>	Black sandshell mussel (juveniles)	Na <sup>+</sup>	987	1,523	96.00	LC50	Hazelton et al., 2013

Table continued on next page.

**Table B.1 (Continued)**

<b>Species</b>	<b>Common Name</b>	<b>Cation<sup>a</sup></b>	<b>Cation Concentration (mg/l)</b>	<b>Chloride Concentration (mg/l)</b>	<b>Exposure Time (hours)</b>	<b>Response<sup>b</sup></b>	<b>Reference<sup>c</sup></b>
<i>Lithobates clamitans</i>	Wood frog (Gosner stage 29 tadpoles)	Na <sup>+</sup>	977	1,507	96.00	LC50	Copan, 2016
<i>Daphnia pulex</i>	Water flea	Na <sup>+</sup>	952	1,470	96.00	LC50	Birge <i>et al.</i> , 1985
<i>Hexagenia limbata</i>	Giant burrowing mayfly	Na <sup>+</sup>	944	1,456	96.00	LC50 at 28°C	Chadwick, 2001
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 33 tadpoles)	Na <sup>+</sup>	912	1,407	96.00	LC50	Copan, 2016
<i>Ceriodaphnia dubia</i>	Water flea	Na <sup>+</sup>	908	1,400	96.00	LC50	Cowgill and Milazzo, 1990
<i>Daphnia carinata</i>	Water flea	Na <sup>+</sup>	908	1,400	96.00	LC50	Hall and Burns, 2002
<i>Hyalella azteca</i>	Amphipod	Na <sup>+</sup>	896	1,382	96.00	LC50	Elphick, <i>et al.</i> , 2011
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 29 tadpoles)	Na <sup>+</sup>	871	1,343	96.00	LC50	Copan, 2016
<i>Microhylla ornata</i>	Ornate narrow-mouthed frog (hind-limb tadpoles)	K <sup>+</sup>	1,332	1,207	96.00	LC50	Padhye and Ghate, 1992
<i>Tubifex tubifex</i>	Sludge worm	Na <sup>+</sup>	781	1,204	96.00	EC50	Khangarot, 1991
<i>Ambystoma maculatum</i>	Spotted salamander (tadpoles)	Na <sup>+</sup>	764	1,178	96.00	LC50	Collins and Russell, 2009
<i>Sphaerium simile</i>	Fingernail clam (juveniles)	Na <sup>+</sup>	713	1,100	96.00	LC50	GLEC and INHS, 2008; Soucek <i>et al.</i> , 2011
<i>Daphnia carinata</i>	Water flea	Na <sup>+</sup>	689	1,062	96.00	LC50	Hall and Burns, 2002
<i>Neocleoneo triangulifer</i>	Triangle small minnow mayfly	Na <sup>+</sup>	689	1,062	96.00	LC50	Soucek and Dickenson, 2015
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 19 tadpoles)	Na <sup>+</sup>	630	972	96.00	LC50	Copan, 2016
<i>Lepomis macrochirus</i>	Bluegill	K <sup>+</sup>	1,054	956	96.00	LC50	Trama, 1954; Patrick <i>et al.</i> , 1968
<i>Tubifex tubifex</i>	Sludge worm	K <sup>+</sup>	912	827	96.00	EC50	Khangarot, 1991
<i>Labo rohita</i>	Rohu carp (spawn)	Ca <sup>2+</sup>	454	804	96.00	LC50	Mallick <i>et al.</i> , 2014
<i>Microhylla ornata</i>	Ornate narrow-mouthed frog (8-day tadpoles)	K <sup>+</sup>	836	757	96.00	LC50	Padhye and Ghate, 1992
<i>Sphaerium simile</i>	Fingernail clam (juveniles)	Na <sup>+</sup>	480	740	96.00	LC50	GLEC and INHS, 2008; Soucek <i>et al.</i> , 2011
<i>Microhylla ornata</i>	Ornate narrow-mouthed frog (late gastrula)	K <sup>+</sup>	742	672	96.00	LC50	Padhye and Ghate, 1992
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 26 tadpoles)	Na <sup>+</sup>	387	596	96.00	LC50	Copan, 2016
<i>Lymnaea</i> sp.	Pond snail (eggs)	K <sup>+</sup>	577	523	96.00	LC50	Dowden and Bennett, 1965
<i>Tubifex tubifex</i>	Sludge worm	Ca <sup>2+</sup>	281	497	96.00	EC50	Khangarot, 1991
<i>Bufo boreas</i>	Boreal toad	Mg <sup>2+</sup>	165	483	96.00	EC50	Lewis, 1999
<i>Physa heterosperma</i>	European physa snail	K <sup>+</sup>	447	447	96.00	LC50	Patrick <i>et al.</i> , 1968
<i>Gambusia affinis</i>	Mosquito fish	K <sup>+</sup>	481	437	96.00	LC50	Wallen <i>et al.</i> , 1957
<i>Pimephales promelas</i>	Fathead minnow	K <sup>+</sup>	462	418	96.00	LC50	Mount <i>et al.</i> , 1997
<i>Callibaetis coloradensis</i>	Gray quill mayfly	Na <sup>+</sup>	275	425	96.00	LC50	Wichard, 1975
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 26 tadpoles)	Na <sup>+</sup>	273	421	96.00	LC50	Copan, 2016
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 22 tadpoles)	Na <sup>+</sup>	141	217	96.00	LC50	Copan, 2016
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 22 tadpoles)	Na <sup>+</sup>	86	133	96.00	LC50	Copan, 2016
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 19 tadpoles)	Na <sup>+</sup>	79	122	96.00	LC50	Copan, 2016

**Table continued on next page.**

**Table B.1 (Continued)**

Species	Common Name	Cation <sup>a</sup>	Cation Concentration (mg/l)	Chloride Concentration (mg/l)	Exposure Time (hours)	Response <sup>b</sup>	Reference <sup>c</sup>
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 19 tadpoles)	Na <sup>+</sup>	63	97	96.00	LC50	Copan, 2016
<i>Lithobates sylvatica</i>	Wood frog (Gosner stage 19 tadpoles)	Na <sup>+</sup>	56	86	96.00	LC50	Copan, 2016
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	15	14	96.00	LC50	Dowden and Bennett, 1965
<i>Labeo rohita</i>	Rohu carp (eggs)	Ca <sup>2+</sup>	10	19	96.00	LC50	Mallick <i>et al.</i> , 2014
<i>Daphnia magna</i>	Water flea	Mg <sup>2+</sup>	889	2,595	100.00	LC50	Dowden and Bennett, 1965
<i>Daphnia magna</i>	Water flea	Na <sup>+</sup>	1,225	1,889	100.00	LC50	Dowden and Bennett, 1965
<i>Daphnia magna</i>	Water flea	Ca <sup>2+</sup>	649	415	100.00	LC50	Dowden and Bennett, 1965
<i>Daphnia magna</i>	Water flea	K <sup>+</sup>	356	323	100.00	LC50	Dowden and Bennett, 1965
<i>Nitzschia linearis</i>	Pennate diatom	Ca <sup>2+</sup>	1,130	2,000	120.00	LC50	Patrick, <i>et al.</i> , 1968
<i>Nitzschia linearis</i>	Pennate diatom	Na <sup>+</sup>	956	1,474	120.00	LC50	Patrick, <i>et al.</i> , 1968
<i>Nitzschia linearis</i>	Pennate diatom	K <sup>+</sup>	701	636	120.00	LC50	Patrick, <i>et al.</i> , 1968
<i>Isonychia bicolor</i>	Mahogany dun mayfly	Na <sup>+</sup>	681	1,049	168.00	LC50	Echols <i>et al.</i> , 2009
<i>Corbicula fluminea</i>	Asian Clam	Na <sup>+</sup>	6,530	10,069	192.00	LC50	Coldsnow and Relyea, 2018
<i>Corbicula fluminea</i>	Asian Clam	Ca <sup>2+</sup>	1,130	2,235	192.00	LC50	Coldsnow and Relyea, 2018
<i>Corbicula fluminea</i>	Asian Clam	Mg <sup>2+</sup>	583	1,769	192.00	LC50	Coldsnow and Relyea, 2018
<i>Aedes tritatus</i>	Floodwater mosquito (larvae)	Na <sup>+</sup>	1,784	2,752	194.00	LC50	Kardatzke, 1980
<i>Aedes cinereus</i>	Ashy mosquito (larvae)	Na <sup>+</sup>	1,346	2,076	230.00	LC50	Kardatzke, 1980
<i>Aedes communis</i>	Woodland snow pool mosquito (larvae)	Na <sup>+</sup>	574	884	278.00	LC50	Kardatzke, 1980
<i>Aedes provocans</i>	Provoking mosquito (larvae)	Na <sup>+</sup>	517	798	278.00	LC50	Kardatzke, 1980
<i>Aedes punctator</i>	Puncturing mosquito (larvae)	Na <sup>+</sup>	1,416	2,184	281.00	LC50	Kardatzke, 1980
<i>Aedes stimulans</i>	Woodland mosquito (larvae)	Na <sup>+</sup>	1,606	2,477	290.00	LC50	Kardatzke, 1980
<i>Aedes canadensis</i>	Woodland pool mosquito (larvae)	Na <sup>+</sup>	1,785	2,753	293.00	LC50	Kardatzke, 1980
<i>Aedes aberratus</i>	Serrated mosquito (larvae)	Na <sup>+</sup>	1,231	1,899	298.00	LC50	Kardatzke, 1980
<i>Aedes fitchii</i>	Fitch's ditch mosquito (larvae)	Na <sup>+</sup>	1,180	1,820	322.00	LC50	Kardatzke, 1980
<i>Aedes dianthaeus</i>	Long-antennaed mosquito (larvae)	Na <sup>+</sup>	1,231	1,899	456.00	LC50	Kardatzke, 1980

<sup>a</sup>Cations include calcium (Ca<sup>2+</sup>), magnesium (Mg<sup>2+</sup>), potassium (K<sup>+</sup>), and sodium (Na<sup>+</sup>).

<sup>b</sup>LC50 is the concentration that is lethal to 50 percent of the test organisms over the test period. EC50 is the concentration at which 50 percent of the test organisms showed a toxicity effect. Mortality was the effect for the EC50s reported in this table. Higher LC50 and EC50 values means lower toxicity of the chemical to the organism.

<sup>c</sup>References are listed in Appendix B.

<sup>d</sup>Reported as *Rana sylvatica*. This species has since been reclassified as *Lithobates sylvatica*.

<sup>e</sup>Reported as *Stenonema rubrum*. This species has since been reclassified as *Maccaffertium modestum*.

Source: SEWRPC

Abe, F.R., A.C. Coleone, A.A. Machado, and J.G. Machado-Neto, "Ecotoxicity and Environmental Risk Assessment of Larvicides Used in the Control of *Aedes aegypti* to *Daphnia magna* (Crustacea, Cladocera)," *Journal of Toxicology and Environmental Health Part A*, 77:37-45, 2014.

Adelman, I.R., and L.L. Smith, Jr., *Standard Test Fish Development. Part I. Fathead Minnows (Pimephales promelas) and Goldfish (Carassius auratus) as Standard Fish in Bioassays and Their Reaction to Potential Reference Toxicants*, U.S. Environmental Protection Agency EPA-600/3-76-061A, 1976.

Anderson, B. G., "The Apparent Thresholds of Toxicity to *Daphnia magna* for Chlorides of Various Metals When Added to Lake Erie Water," *Transactions of the American Fisheries Society*, 78:96-113, 1950.

Arambasic, M. B., S. Bjelic, and G. Subakov, "Acute Toxicity of Heavy Metals (Copper, Lead, Zinc), Phenol and Sodium on *Allium cepa* L., *Lepidum sativum* L. and *Daphnia magna* St.: Comparative Investigations and Practical Applications," *Water Research*, 29:497-503, 1995.

Baek, M.J.; T.J. Yoon, D.G. Kim, C.Y. Lee, K. Cho, and Y.J. Bae, "Effects of Road Deicer Runoff on Benthic Macroinvertebrate Communities in Korean Freshwaters with Toxicity Test of Calcium Chloride (CaCl<sub>2</sub>)," *Water, Air and Soil Pollution*, 225:1-14, 2014.

Baudouin, M.F., and P. Scoppa, "Acute Toxicity of Various Metals to Freshwater Zooplankton," *Bulletin of Environmental Contamination and Toxicology*, 12:745-751, 1974.

Beggel, S., and J. Geist, "Acute Effects of Salinity Exposure on Glochidia Viability and Host Infection of the Freshwater Mussel *Anodonta anatina* (Linnaeus, 1758)," *Science of the Total Environment*, 502:659-665, 2015.

Bengtsson, B.E., "Use of a Harpacticoid Copepod in Toxicity Tests," *Marine Pollution Bulletin*, 9:238-241, 1978.

Biesinger, K.E., and G.M. Christensen, "Effects of Various Metals on Survival, Growth, Reproduction, and Metabolism of *Daphnia magna*," *Journal of the Fisheries Research Board of Canada*, 29:1,691-1,700, 1972.

Birge, W. J., J. A. Black, A. G. Westerman, T. M. Short, S. B. Taylor, D. M. Bruser, and E. D. Wallingford, *Recommendations on Numerical Values for Regulating Iron and Chloride Concentrations for the Purpose of Protecting Warmwater Species of Aquatic Life in the Commonwealth of Kentucky*, Kentucky Natural Resources and Environmental Protection Cabinet, Lexington Kentucky (Memorandum of Agreement No. 5429), 1985.

Blasius, B. J., and R. W. Merritt, "Field and Laboratory Investigations on the Effects of Road Salt (NaCl) on Stream Macroinvertebrate Communities," *Environmental Pollution*, 120:219-231, 2002.

Bringolf, R.B., W.G. Cope, C.B. Eads, P.R. Lazaro, M.C. Barnhart, and D. Shea, "Acute and chronic toxicity of technical-grade pesticides to glochidia and juveniles of freshwater mussels (Unionidae)," *Environmental Toxicology and Chemistry*, 26:2,086-2,093, 2007.

Cairns, J. Jr., and A. Scheier, "The Relationship of Bluegill Sunfish Body Size to Tolerance for Some Common Chemicals," *Proceedings of the 13th Industrial Waste Conference, Purdue University Engineering Bulletin*, 96:243-252, 1959.

Calleja, M.C., G. Persoone, and P. Geladi, "Comparative Acute Toxicity of the First 50 Multicentre Evaluations of In Vitro Cytotoxicity Chemicals to Aquatic Non-vertebrates," *Archives of Environmental Contamination and Toxicology*, 26:69-78, 1994.

Chadwick, M. A.; and J. W. Feminella, "Influence of Salinity and Temperature on the Growth and Production of a Freshwater Mayfly in the Lower Mobile River, Alabama," *Limnology and Oceanography*, 46:532-542, 2001.

Coldsnow, K.D., and R. Relyea, "Toxicity of Various Road-Deicing Salts to Asian Clams (*Corbicula fluminea*)," *Environmental Toxicology*, <https://doi.org/10.1002/etc.4126>, 2018.

Collins, S.J. and R.W. Russell, "Toxicity of Road Salt to Nova Scotia Amphibians," *Environmental Pollution*, 157: 320-324, 2009.

Copan, A.L., *Acute Toxicity of Deicing Compounds and Personal Care Products to Early Amphibian Life Stages*, Master's Thesis, Saint Mary's University, Halifax, Nova Scotia, 2016.

Cowgill, U.M., and D.P. Milazzo, "The Sensitivity of Two Cladocerans to Water Quality Variables: Salinity and Hardness," *Archiv fur Hydrobiologie*. 120:185-196, 1990.

Cowgill, U.M., and D.P. Milazzo, "The Sensitivity of Two Cladocerans to Water Quality Variables: Salinity <467 mg NaCl/L and Hardness <200 mg CaCO<sub>3</sub>/L," *Archives of Environmental Contamination and Toxicology*, 21:218-223, 1991.

DeGroot, W.A. and A.H.C. Groeneveld, *The Acute Toxicity of Sodium Chloride and Calcium Chloride to Daphnia magna*, Solvay Pharmaceuticals Study No. C.SOL.51.112/Int.Doc. No. 56834/45/98, 1998.

Densmore, C.L., L.R. Iwanowicz, A.P. Henderson, V.S. Blazer, B.M. Reed-Grimmett, and L.R. Sanders. *An Evaluation of the Toxicity of Potassium Chloride, Active Compound in the Molluscicide Potash, on Salmonid Fish and their Forage Base*, U.S. Geological Survey Open-File Report No. 2018-1080, 2018.

Doudoroff, P., and M. Katz, "Critical Review of Literature on the Toxicity of Industrial Wastes and their Components to Fish. II. The Metals as Salts," *Sewage and Industrial Wastes*, 25:802-835, 1953.

Dowden, B.F., and H.J. Bennett, "Toxicity of Selected Chemicals to Certain Animals," *Journal of the Water Pollution Control Federation*, 37:1,308-1,316, 1965.

Durand-Hoffman, M.E., Durand-Hoffman, M.E., *Analysis of Physiological and Toxicological Effects of Potassium on Dreissena polymorpha and Toxicological Effects on Fish*, Master's Thesis, Ohio State University, Columbus, Ohio, 1995.

Echols, B.S., R.J. Currie, and D. S. Cherry, "Preliminary Results of Laboratory Toxicity Tests with the Mayfly, *Isonychia bicolor* (Ephemeroptera: Isonychiidae) for Development as a Standard Test Organisms for Evaluating Streams in the Appalachian Coalfields of Virginia and West Virginia," *Environmental Monitoring and Assessment*, DOI 10.1007/s10661-009-1191-3, 2009.

Elphick, J.R., K.D. Bergh, and H.C. Bailey, "Chronic Toxicity of Chloride to Freshwater Species: Effects of Hardness and Implications for Water Quality Guidelines," *Environmental Toxicology and Chemistry*, 30:239-246, 2011.



- Freitas, E.C., and O. Rocha, "Acute and Chronic Effects of Sodium and Potassium on the Tropical Freshwater Cladoceran *Pseudosida ramosa*," *Ecotoxicology*, 20: 88-96, 2011.
- Freitas, E.C., and O. Rocha, "Acute Toxicity Tests with the Tropical Cladoceran *Pseudosida ramosa*: The Importance of Using Native Species as Test Organisms," *Archives of Environmental Contamination and Toxicology*, 60: 241-249, 2011a.
- Gardner, K. M., and T. V. Royer, "Effects of Road Salt Application of Seasonal Chloride Concentrations and Toxicity in South-central Indiana Streams," *Journal of Environmental Quality*, 39:1,036-1,042, 2010.
- Ghazy, M.M.E.D., M.M. Habashy, F.I. Kossa, and E.Y. Mohammady, "Effects of Salinity on Survival, Growth and Reproduction of the Water Flea, *Daphnia magna*," *Natural Science*, 7:28-42, 2009.
- Ghosh, A.K., and R.N. Pal, "Toxicity of Four Therapeutic Compounds to Fry of Indian Major Carps," *Fishery Technology*, 6:120-123, 1969.
- Gillis, P.L., "Assessing the Toxicity of Sodium Chloride to Glochidia of Freshwater Mussels: Implications for Salinization of Surface Waters," *Environmental Pollution*, 159:1,702-1,708, 2011.
- Gonçalves, A.M.M., B.B. Castro, M.A. Pardal, and F. Gonçalves,; "Salinity Effects of Survival and Life History of Two Freshwater Cladocerans (*Daphnia magna* and *Daphnia longispina*)," ; *Annals of Limnology-International Journal of Limnology*, 43:13-20, 2007.
- Great Lakes Environmental Center and Illinois Natural History Survey, *Acute Toxicity of Chloride to Select Freshwater Invertebrates*. Final Draft Report Prepared for the U.S. Environmental Protection Agency. October 28, 2008.
- Hall, C.J., and C.W. Burns, " Mortality and Growth Responses of *Daphnia carinata* to Increases in Temperature and Salinity," *Freshwater Biology*, 47: 451-458, 2002.
- Hamilton, R. W., J. K. Buttner, and R. G. Brunetti, "Lethal Levels of Sodium Chloride and Potassium Chloride for an Oligochaete, a Chironomid Midge, and a Caddisfly of Lake Michigan," *Environmental Entomology*, 4:1,003-1,006, 1975.
- Harless, M.L., C.L. Huckins, J.B. Grant, and T.G. Pypker, "Effects of Six Chemical Deicers on Larval Wood Frogs (*Rana sylvatica*)," *Environmental Toxicology and Chemistry*, 30:1,637-1,641, 2011.
- Hazelton, P.D., W.G. Cope, S. Mosher, T.J. Pandolfo, J.B. Belden, M.C. Barnhart, and R.B. Bringolf, "Fluoxetine Alters Adult Freshwater Mussel Behavior and Larval Metamorphosis," *Science of the Total Environment*, 445/446:94-100, 2013.
- Hinton, M. J. and A. G. Eversole, "Toxicity of Ten Chemicals Commonly Used in Aquaculture to the Black Eel Stage of the American Eel," *Proceedings of the World Mariculture Society*, 10:554-569, 1979.
- Jones, B., J.W. Snodgrass, and D.R. Ownby, "Relative Toxicity of NaCl and Road Deicing Salt to Developing Amphibians," *Copeia*, 103:72-77, 2015.
- Kardatzke, J.T., "Effect of Sodium Chloride on Larval Snow-melt *Aedes* (Diptera:Culicidae)," *Mosquito News*, 40: 153-160, 1980.

Khargarot, B.S., and P.K. Ray, "Investigation of Correlation between Physicochemical Properties of Metals and their Toxicity to the Water Flea *Daphnia magna* Straus," *Ecotoxicology and Environmental Safety*, 18:109-120, 1989.

Khargarot, B.S., "Toxicity of metals to a freshwater tubificid worm, *Tubifex tubifex* (Muller)"; *Bulletin of Environmental Contamination and Toxicology*, 46: 906-912, 1991.

Kostecki, P.T., and J.J. Jones, "The Effect of Osmotic and Ion-osmotic Stresses on the Mortality of Rainbow Trout (*Salmo gairdneri*)," *Comparative Biochemistry and Physiology*, 74A:773-775, 1983.

Kundman, J. M., *The Effect of Road Salt Run-off (NaCl) on Caddisfly (Hydropsyche betteni) Drift in Mill Run Meadville, Pennsylvania*, Unpublished Senior Thesis, Department of Environmental Science Allegheny College, Meadville Pennsylvania, 1998.

Lasier, P.J., P.V. Winger, and R.E. Reinert, "Toxicity of Alkalinity to *Hyaella azteca*," *Bulletin of Environmental Contamination and Toxicology*, 59:807-814, 1997.

Leitao, J.; R. Ribeiro, A.M.V.M. Soares, and I. Lopes, "Tolerance to Copper and Salinity in *Daphnia longispina*: Implications within a Climate Change Scenario," *PLoS One*, 8:e68702, 2013.

Lewis, W.M., *Studies of Environmental Effects of Magnesium Chloride Deicer in Colorado*, Report to Colorado Department of Transportation, November 1999.

Lowell, R.B., J.M. Culp, and F.J. Wrona, "Toxicity Testing with Artificial Streams: Effects of Differences in Current Velocity," *Environmental Toxicology and Chemistry*, 14:1,209-1,217, 1995.

Mallick, A., B.C. Mohapatra, and N. Sarangi, "Acute Toxicity of Calcium Chloride on Different Stages (Egg, Spawn, Fry, and Fingerling) of Rohu (*Labeo rohita*, Hamilton)," *Research Journal of Animal, Veterinary, and Fishery Science*, 2:11-16, 2014.

Martínez-Jerónimo, F., and L. Martínez-Jerónimo, "Chronic Effect of NaCl Salinity on a Freshwater Strain of *Daphnia magna* Straus (Crustacea: Cladocera): A Demographic Study," *Ecotoxicology and Environmental Safety*, 67:411-416, 2007.

Mount, D.R., D.D. Gulley, J.R. Hockett, T.D. Garrison, and J.M. Evand, "Statistical Models to Predict the Toxicity of Major Ions to *Ceriodaphnia dubia*, *Daphnia magna*, and *Pimephales promelas* (Fathead Minnows)," *Environmental Toxicology and Chemistry*, 16:2,009-2,019, 1997.

Mount, D.R., R.J. Erickson, T.L. Highland, J.R. Hockett, D.J. Hoff, C.T. Jenson, T.J. Norberg-King, K.N. Peterson, Z.M. Polaske, and S. Wisniewski, "The Acute Toxicity of Major Ion Salts to *Ceriodaphnia dubia*. I. The Influence of Background Water Chemistry," *Environmental Toxicology and Chemistry*, 35:3,039-3,057, 2016.

Padhye, A.D., and H.V. Ghate, "Sodium Chloride and Potassium Chloride Tolerance of Different Stages of the Frog, *Microhyla ornata*," *Herpetological Journal*, 2:18-23, 1992.

Patrick, R., J.J. Cairns, and A. Scheier, "The Relative Sensitivity of Diatoms, Snails, and Fish to Twenty Common Constituents of Industrial Wastes," *The Progressive Fish-Culturist*, 30:137-140, 1968.

Phillips, A.M.J., "The Physiological Effect of Sodium Chloride upon Brook Trout," *Transactions of the American Fisheries Society*, 75:297-309, 1944.

Roback, S.S., "Environmental Requirements of Trichoptera," In C.M. Tarzwell (Editor), *Biological Problems in Water Pollution*. Technical Report 999-WP25, U.S. Public Health Service, 1965.

Sanzo, D., and S. J. Hecnar, "Effects of Road De-icing Salt (NaCl) on Larval Wood Frogs (*Rana sylvatica*)," *Environmental Pollution*, 140:247-256, 2006.

Schuytema, G.S., A.V. Nebeker, and T.W. Stutzman, "Salinity Tolerance of *Daphnia magna* and Potential Use for Estuarine Sediment Toxicity Tests," *Archives for Environmental Contamination and Toxicology*, 33: 194-198, 1997.

Simmons, J.A., "Toxicity of Major Cations and Anions ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Cl}^-$ , and  $\text{SO}_4^{2-}$ ) to a Macrophyte and an Alga," *Environmental Toxicology and Chemistry*, 31(6):1,370-1,374, 2012.

Soucek, D.J., T.K. Linton, C.D. Tarr, A. Dickinson, A. Wickramanayake, C.G. Delos, and L. Cruz, "Influence of Water Hardness and Sulfate on the Acute Toxicity of Chloride to Sensitive Freshwater Invertebrates," *Environmental Toxicology and Chemistry*, 30(4):930-938, 2011.

Soucek, D.J., and A. Dickinson, "Full-life Chronic Toxicity of Sodium Salts to the Mayfly *Neocloeon triangulifer* in Tests with Laboratory Cultured Food," *Environmental Toxicology and Chemistry*, 34: 2,126-2,137, 2015.

Spehar, R. L., Memorandum to C. Stephan, U.S. Environmental Protection Agency, June 1987 [cited in U.S. Environmental Protection Agency, *Ambient Water Quality Criteria for Chloride*, 1988.]

Struewing, K.A., J.M. Lazorchak, P.C. Weaver, B.R. Johnson, D.H. Funk, and D.B. Buchwalter, "Part 2: Sensitivity Comparisons of the Mayfly *Centroptilum triangulifer* to *Ceriodaphnia dubia* and *Daphnia magna* using standard reference toxicants; NaCl, KCl, and  $\text{CuSO}_4$ ," *Chemosphere*, 139:597-603, 2015.

Sutcliffe, D. W., "Studies on Salt and Water Balance in Caddis Larvae (Trichoptera): I. Osmotic and Ionic Regulation of Body Fluids in *Limnephilus affinis* Curtis," *Journal of Experimental Biology*, 38:501-519, 1961.

Sutcliffe, D. W., "Studies on Salt and Water Balance in Caddis Larvae (Trichoptera): II. Osmotic and Ionic Regulation of Body Fluids in *Limnephilus stigma* Curtis and *Anabolia nervosa* Leach," *Journal of Experimental Biology*, 38:521-530, 1961.

Tatara, C.P., M.C. Newman, J.T. McCloskey, and P.L. Williams, "Predicting Relative Metal Toxicity with Ion Characteristics: *Caenorhabditis elegans*  $\text{LC}_{50}$ ," *Aquatic Toxicology*, 39:279-290, 1997.

Thornton, K.W., and J.R. Sauer, "Physiological Effects of NaCl on *Chironomus attenuatus* (Diptera: Chironomidae)," *Annals of the Entomological Society of America*, 65:872-875, 1972.

Trama, F. B., "The Acute Toxicity of Some Common Salts of Sodium, Potassium, and Calcium to the Common Bluegill (*Lepomis macrochirus* Rafinesque), *Proceedings of the Academy of Natural Sciences Philadelphia*, 196:185-205, 1954.

Utz, L.R.P., and M.B.C. Bohrer, "Acute and Chronic Toxicity of Potassium Chloride (KCl) and Potassium Acetate ( $\text{KC}_2\text{H}_3\text{O}_2$ ) to *Daphnia similis* and *Ceriodaphnia dubia* (Crustacea; Cladocera)," *Bulletin of Environmental Contamination and Toxicology*, 66:379-385, 2001.

Vosyliene, M.Z., P. Baltrenas, and A. Kalauskiene, "Toxicity of Road Maintenance Salts to Rainbow Trout *Oncorhynchus mykiss*," *Ekologija*, 2:15-20, 2006.

Wallen, I.E., W.C. Greer, and R. Lasater, "Toxicity to *Gambusia affinis* of Certain Pure Chemicals in Turbid Waters," *Sewage and Industrial Wastes*, 29:695-711, 1957.

Waller, D.L., J.J. Rasch, W.G. Cope, and L.L. Marking, "Toxicity of Candidate Molluscicides to Zebra Mussels (*Dreissena polymorpha*) and Selected Nontarget Organisms," *Journal of Great Lakes Research*, 19:695-702, 1993.

Waller, D.L., S.W. Fisher, and H. Dabrowska, "Prevention of Zebra Mussel Infestation and Dispersal during Aquaculture Activities," *The Progressive Fish-Culturist*, 58:77-84, 1996.

Wichard, W., "Osmoregulatory Adaptations of Aquatic Insects in the Lake District 'Neursiedlersee,'" *Nachrichtenblatt der Bayerischen Entomologen*, 24:81-87, 1975.

Williams, D.D., N.E. Williams, and Y. Cao, "Road Salt Contamination of Groundwater in a Major Metropolitan Area and Development of a Biological Index to Monitor Its Impact," *Water Research*, 34:127-138, 1999.

Wisconsin State Laboratory of Hygiene, Unpublished Data on Chloride Toxicity of Aquatic Species. From A. Letts (Technical Manager, Morton International, Inc., Chicago, Illinois) to M. S. Evans (National Research Institute, Environment Canada), August 11, 1998 [cited in Environment Canada, *Priority Substances List Assessment Report: Road Salts*, 2001].

Wurtz, C.B., and C.H. Bridges, "Preliminary Results from Macro-invertebrate Bioassays," *Proceedings of the Pennsylvania Academy of Sciences*, 35:51-56, 1961.