Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Insect (8th-10th instar), *Erythromma najas*	Ammonium chloride	4 d	R,U	7.5	25	589	**1618**			Beketov 2002
Insect (8th-10th instar), *Erythromma najas*	Ammonium chloride	4 d	R,U	8.7	25	168	**4163**			Beketov 2002
Insect (8th-10th instar), *Erythromma najas*	Ammonium chloride	4 d	R,U	9.1	25	49.2	**2361**	2515	2515	Beketov 2002
Caddisfly, *Philarctus quaeris*	Ammonium chloride	4 d	F,M	7.8	21.9	296.5	**1032**			Arthur et al. 1987
Caddisfly, *Philarctus quaeris*	Ammonium chloride	4 d	F,M	7.8	13.3	561.7	**958.4**	994.5	994.5	West 1985; Arthur et al. 1987
Beetle, *Stenelmis sexlineata*	Ammonium chloride	4 d	F,M	8.7	25	29.7	**735.9**	735.9	735.9	Hazel et al. 1979
Crayfish, *Orconectes immunis*	Ammonium chloride	4 d	F,M	7.9	17.1	488.1	**1367**			Arthur et al. 1987
Crayfish (adult), *Orconectes immunis*	Ammonium chloride	4 d	F,M	8.2	4.6	999.4	**1757**	1550		West 1985; Arthur et al. 1987
Crayfish (2.78 cm), *Orconectes nais*	Ammonium chloride	4 d	F,M	8.3	26.5	23.15	**303.8**	303.8	686.2	Evans 1979
Midge (10 d old, 2-3 instar), *Chironomus riparius*	Ammonium chloride	4 d	R,M	7.7	21.7	357.7	**1029**	1029		Monda et al. 1995
Midge, *Chironomus tentans*	Ammonium chloride	4 d	S,M	6.69	23	430	443.0			Besser et al. 1998
Midge, *Chironomus tentans*	Ammonium chloride	4 d	S,M	7.56	23	564	1439			Besser et al. 1998
Midge (2nd instar), *Chironomus tentans*	Ammonium chloride	4 d	F,M	6.5	25	371	**415.1**			Schubauer-Berigan et al. 1995

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Midge (2nd instar), *Chironomus tentans*	Ammonium chloride	4 d	F,M	8.1	25	78.1	**614.0**			Schubauer-Berigan et al. 1995
Midge (2nd instar), *Chironomus tentans*	Ammonium chloride	4 d	F,M	6.5	25	368	**411.7**			Schubauer-Berigan et al. 1995
Midge (2nd instar), *Chironomus tentans*	Ammonium chloride	4 d	F,M	8.1	25	50.5	**397.0**	451.8	681.8	Schubauer-Berigan et al. 1995
Mayfly (middle to late instar), *Drunella grandis*	Ammonium chloride	4 d	F,M	7.84	12.8	259.1	**455.5**			Thurston et al. 1984b
Mayfly (middle to late instar), *Drunella grandis*	Ammonium chloride	4 d	F,M	7.84	13.2	195.6	**355.6**			Thurston et al. 1984b
Mayfly (middle to late instar), *Drunella grandis*	Ammonium chloride	4 d	F,M	7.85	12	319	**534.5**	442.4	442.4	Thurston et al. 1984b
Aquatic sowbug, *Caecidotea racovitzai* (previously *Asellus racovitzai*)	Ammonium chloride	4 d	F,M	7.8	22	148.8	**522.3**			Arthur et al. 1987
Aquatic sowbug (adult), *Caecidotea racovitzai*	Ammonium chloride	4 d	F,M	8	4	357.8	**407.7**			West 1985; Arthur et al. 1987
Aquatic sowbug, *Caecidotea racovitzai*	Ammonium chloride	4 d	F,M	7.81	11.9	176	**272.2**	387.0	387.0	Thurston et al. 1983
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	12	2.60	**575.2**			Dehedin et al. 2012
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	12	1.25	**276.6**			Dehedin et al. 2012
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	12	1.70	**376.1**			Dehedin et al. 2012
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	18	2.61	**603.8**			Dehedin et al. 2012
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	18	1.40	**323.9**			Dehedin et al. 2012
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	18	1.95	**451.1**			Dehedin et al. 2012
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	24	1.00	**246.6**			Dehedin et al. 2012

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Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	24	1.00	**246.6**			Dehedin et al. 2012
Isopod (adult), *Asellus aquaticus*	Ammonium chloride	4 d	F,M	7.05	24	2.00	**493.1**	378.2	378.2	Dehedin et al. 2012
Threespine stickleback (juvenile-adult, 32-60 mm), *Gasterosteus aculeatus*	Ammonium chloride	4 d	S,M	7.1	23.3	198.1	**216.5**			Hazel et al. 1971
Threespine stickleback (juvenile-adult, 32-60 mm), *Gasterosteus aculeatus*	Ammonium chloride	4 d	S,M	7.15	15	577	**667.4**			Hazel et al. 1971
Threespine stickleback (juvenile-adult, 32-60 mm), *Gasterosteus aculeatus*	Ammonium chloride	4 d	S,M	7.25	23.3	203.8	**264.0**			Hazel et al. 1971
Threespine stickleback (juvenile-adult, 32-60 mm), *Gasterosteus aculeatus*	Ammonium chloride	4 d	S,M	7.5	15	143.9	**261.1**			Hazel et al. 1971
Threespine stickleback (juvenile-adult, 32-60 mm), *Gasterosteus aculeatus*	Ammonium chloride	4 d	S,M	7.5	23.3	78.7	**142.8**			Hazel et al. 1971
Threespine stickleback (juvenile-adult, 32-60 mm), *Gasterosteus aculeatus*	Ammonium chloride	4 d	S,M	7.5	23.3	115.4	**209.5**			Hazel et al. 1971
Threespine stickleback (juvenile-adult, 32-60 mm), *Gasterosteus aculeatus*	Ammonium chloride	4 d	S,M	7.5	15	259	**470.0**	281.5	281.5	Hazel et al. 1971
Mayfly, *Callibaetis skokianus*	Ammonium chloride	4 d	F,M	7.7	10.8	263.5	**307.2**			Arthur et al. 1987
Mayfly, *Callibaetis skokianus*	Ammonium chloride	4 d	F,M	7.9	13.3	211.7	**432.7**	364.6		West 1985; Arthur et al. 1987
Mayfly (middle to late instar), *Callibaetis* sp.	Ammonium chloride	4 d	F,M	7.81	11.9	107.8	**166.7**	166.7	246.5	Thurston et al. 1984b

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Dragonfly (<233 d old), *Pachydiplax longipennis*	Ammonium chloride	4 d	F,M	8	12	76.92	**170.1**			Diamond et al. 1993
Dragonfly (<140 d old), *Pachydiplax longipennis*	Ammonium chloride	4 d	F,M	8	20	74.37	**319.2**	233.0	233.0	Diamond et al. 1993
Mottled sculpin (1.8 g, 5.4 cm), *Cottus bairdii*	Ammonium chloride	4 d	F,M	8.02	12.4	49.83	**222.2**	222.2	222.2	Thurston and Russo 1981
Western mosquitofish, *Gambusia affinis*	-	4 d	S,U	7.75	19	129.6	**352.9**			Wallen et al. 1957
Western mosquitofish, *Gambusia affinis*	-	4 d	S,U	8.2	19.5	34.54	**217.7**			Wallen et al. 1957
Western mosquitofish, *Gambusia affinis*	-	4 d	S,U	8.5	23	14.64	**165.0**			Wallen et al. 1957
Western mosquitofish, *Gambusia affinis*	-	4 d	S,U	8	24	42.53	**182.6**	219.3	219.3	Wallen et al. 1957
Oligochaete worm, *Lumbriculus variegatus*	Ammonium chloride	4 d	S,M	7.56	23	286	729.5			Besser et al. 1998
Oligochaete worm, *Lumbriculus variegatus*	Ammonium chloride	4 d	S,M	6.69	23	302	311.1			Besser et al. 1998
Oligochaete worm (10-25 mm), *Lumbriculus variegatus*	Ammonium chloride	4 d	R,M	8.2	15	13.66	56.88			Hickey and Vickers 1994
Oligochaete worm (adult), *Lumbriculus variegatus*	-	4 d	F,M	6.5	25	100	**111.9**			Schubauer-Berigan et al. 1995
Oligochaete worm (adult), *Lumbriculus variegatus*	-	4 d	F,M	6.5	25	200	**223.8**			Schubauer-Berigan et al. 1995
Oligochaete worm (adult), *Lumbriculus variegatus*	-	4 d	F,M	8.1	25	34	**267.3**			Schubauer-Berigan et al. 1995
Oligochaete worm (adult), *Lumbriculus variegatus*	-	4 d	F,M	8.1	25	43.5	**342.0**	218.7	218.7	Schubauer-Berigan et al. 1995
Tubificid worm, *Tubifex tubifex*	Ammonium chloride	4 d	S,U	8.2	12	66.67	**216.5**	216.5	216.5	Stammer 1953

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Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Marsh ramshorn snail, *Planorbella trivolvis* (previously *Helisoma trivolvis*)	Ammonium chloride	4 d	F,M	7.9	22	47.73	**200.7**			Arthur et al. 1987
Marsh ramshorn snail, *Planorbella trivolvis*	Ammonium chloride	4 d	F,M	8.2	12.9	63.73	**223.0**	211.6	211.6	Arthur et al. 1987
Scud (7-14 d old), *Hyalella azteca*	Ammonium chloride	4 d	R,M	8.3	25	39.8	**461.2**			Ankley et al. 1995
Scud (7-14 d old), *Hyalella azteca*	Ammonium chloride	4 d	R,M	7.31	25	64	**135.1**			Ankley et al. 1995
Scud (7-14 d old), *Hyalella azteca*	Ammonium chloride	4 d	R,M	6.43	25	105	**114.6**	192.6	192.6	Ankley et al. 1995
Stonefly, Little golden stonefly (middle to late instar), *Skwala americana*	Ammonium chloride	4 d	F,M	7.81	13.1	109.3	**186.7**			Thurston et al. 1984b
Stonefly, Little golden stonefly (middle to late instar), *Skwala americana*	Ammonium chloride	4 d	F,M	7.76	13.8	119.6	**198.3**	192.4	192.4	Thurston et al. 1984b
Mozambique tilapia (juvenile), *Oreochromis mossambicus*	Ammonium chloride	4 d	R,U	7.2	28	151.5	**185.2**	185.2	185.2	Rani et al. 1998
Amphipod (4-6 mm), *Crangonyx pseudogracilis*	Ammonium chloride	4 d	S,U	7.5	12	43.36	40.54			Prenter et al. 2004
Amphipod, *Crangonyx pseudogracilis*	Ammonium chloride	4 d	F,M	8	4	199.5	**227.3**			West 1985; Arthur et al. 1987
Amphipod, *Crangonyx pseudogracilis*	Ammonium chloride	4 d	F,M	8	12.1	216	**481.7**			West 1985; Arthur et al. 1987
Amphipod, *Crangonyx pseudogracilis*	Ammonium chloride	4 d	F,M	8	13.3	115.3	**284.1**			West 1985; Arthur et al. 1987
Amphipod, *Crangonyx pseudogracilis*	Ammonium chloride	4 d	F,M	8	24.9	25.1	**161.7**			West 1985; Arthur et al. 1987
Amphipod, *Crangonyx pseudogracilis*	Ammonium chloride	4 d	F,M	8.2	13	81.6	**287.9**	270.5		West 1985; Arthur et al. 1987

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Amphipod (13 d), *Crangonyx* sp.	Ammonium chloride	4 d	F,M	8	12	79.23	**175.3**			Diamond et al. 1993
Amphipod (8-42 d), *Crangonyx* sp.	Ammonium chloride	4 d	F,M	8	20	19.83	**85.13**	122.2	181.8	Diamond et al. 1993
Tubificid worm (30-40 mm), *Limnodrilus hoffmeisteri*	-	4 d	F,M	7.9	11.5	96.62	**170.2**	170.2	170.2	Williams et al. 1986
Pouch snail, *Physa gyrina*	Ammonium chloride	4 d	F,M	8	4	114.9	**131.0**			West 1985; Arthur et al. 1987
Pouch snail, *Physa gyrina*	Ammonium chloride	4 d	F,M	8.2	5.5	85.13	**161.3**			West 1985; Arthur et al. 1987
Pouch snail, *Physa gyrina*	Ammonium chloride	4 d	F,M	8.1	12.1	76.29	**205.9**			West 1985; Arthur et al. 1987
Pouch snail, *Physa gyrina*	Ammonium chloride	4 d	F,M	8.2	12.8	50.25	**174.4**			West 1985; Arthur et al. 1987
Pouch snail, *Physa gyrina*	Ammonium chloride	4 d	F,M	8	13.3	62.39	**153.7**			West 1985; Arthur et al. 1987
Pouch snail, *Physa gyrina*	Ammonium chloride	4 d	F,M	8	24.9	26.33	**169.7**	164.5	164.5	West 1985; Arthur et al. 1987
Damselfly (8-10 mm), *Enallagma* sp.	-	4 d	F,M	7.9	11.5	93.1	**164.0**	164.0	164.0	Williams et al. 1986
Water flea (<24 hr), *Chydorus sphaericus*	Ammonium chloride	4 d	S,M	8	20	37.88	**162.6**	162.6	162.6	Dekker et al. 2006
Fathead minnow (larva, 14 d), *Pimephales promelas*	-	4 d	S,U	7.6	20	37.56	79.59			Markle et al. 2000
Fathead minnow, *Pimephales promelas*	Ammonium chloride	4 d	S,M	7.52	20.25	36.73	68.17			EA Engineering 1985
Fathead minnow, *Pimephales promelas*	Ammonium chloride	4 d	S,M	7.48	19.85	40.93	72.10			EA Engineering 1985

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Fathead minnow, *Pimephales promelas*	Ammonium chloride	4 d	S,M	7.52	20.25	37.49	69.59			EA Engineering 1985
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Fathead minnow, *Pimephales promelas*	Ammonium chloride	4 d	S,M	7.48	19.85	41.79	73.61			EA Engineering 1985
Fathead minnow, *Pimephales promelas*	Ammonium chloride	4 d	S,M	7.48	19.85	43.49	76.61			EA Engineering 1985
Fathead minnow (4-6 d old), *Pimephales promelas*	Ammonium chloride	4 d	R,M	8.01	25	14.4	63.00			Buhl 2002
Fathead minnow, *Pimephales promelas*	Ammonium chloride	4 d	R,M	8	20	5.389	23.13			Diamond et al. 1993
Fathead minnow, *Pimephales promelas*	Ammonium chloride	4 d	R,M	8	20	6.1	26.19			Diamond et al. 1993
Fathead minnow (1.9 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.9	3.4	229.7	**818.4**			West 1985; Arthur et al. 1987
Fathead minnow (1.8 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.1	12.1	56.07	**291.3**			West 1985; Arthur et al. 1987
Fathead minnow (1.6 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8	17.1	52.22	**224.2**			West 1985; Arthur et al. 1987
Fathead minnow (1.7 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.1	26.1	29.23	**151.8**			West 1985; Arthur et al. 1987
Fathead minnow, *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.05	14	47.29	**223.2**			DeGraeve et al. 1980
Fathead minnow (4-5 mo), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.46	6	97.27	**166.4**			DeGraeve et al. 1987
Fathead minnow (4-5 mo), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.46	10	101.7	**174.0**			DeGraeve et al. 1987
Fathead minnow (4-5 mo), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.41	15	76.58	**122.0**			DeGraeve et al. 1987
Fathead minnow (4-5 mo), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.41	20	78.22	**124.6**			DeGraeve et al. 1987
Fathead minnow (4-5 mo), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.45	20	66.94	**112.9**			DeGraeve et al. 1987
Fathead minnow (4-5 mo), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.4	25	81.81	**128.5**			DeGraeve et al. 1987
Fathead minnow (4-5 mo), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.41	25	91.4	**145.6**			DeGraeve et al. 1987

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Fathead minnow (4-5 mo), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.44	30	64.12	**106.6**			DeGraeve et al. 1987
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Fathead minnow (0.28 g, 26.6 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.14	22	25.16	**141.2**			Mayes et al. 1986
Fathead minnow (10 mm length), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.9	20.6	28.9	**103.0**			Nimmo et al. 1989
Fathead minnow (10 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.2	6.2	7.322	**46.15**			Nimmo et al. 1989
Fathead minnow (10 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.8	20.1	18.73	**55.68**			Nimmo et al. 1989
Fathead minnow (10 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.8	19.8	32.12	**95.49**			Nimmo et al. 1989
Fathead minnow (25 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.1	19.6	24.89	**129.3**			Nimmo et al. 1989
Fathead minnow (25 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.2	6.2	11.56	**72.86**			Nimmo et al. 1989
Fathead minnow (25 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.1	5.8	19.94	**103.6**			Nimmo et al. 1989
Fathead minnow (25 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.1	5.8	21.44	**111.4**			Nimmo et al. 1989
Fathead minnow (25 mm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.7	20.1	32.25	**80.61**			Nimmo et al. 1989
Fathead minnow (15 mm, 0.0301 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.46	4.1	18.54	**193.5**			Reinbold and Pescitelli 1982b
Fathead minnow (16 mm, 0.0315 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.02	23.9	19.55	**87.16**			Reinbold and Pescitelli 1982b
Fathead minnow (19 mm, 0.0629 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.26	4.6	30.57	**216.5**			Reinbold and Pescitelli 1982b
Fathead minnow (21 mm, 0.0662 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.16	25.2	17.65	**102.9**			Reinbold and Pescitelli 1982b

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Fathead minnow (5.2 cm, 1.1 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.7	21.65	63.02	**157.5**			Sparks 1975
Fathead minnow (0.2 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.78	25.9	40.85	**117.3**			Swigert and Spacie 1983
Fathead minnow (0.5 g), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.8	25.6	42.65	**126.8**			Swigert and Spacie 1983
Fathead minnow (1.9 g, 5.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.83	11.8	45.71	**143.4**			Thurston et al. 1981c
Fathead minnow (1.9 g, 5.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.82	12	62.72	**193.3**			Thurston et al. 1981c
Fathead minnow (1.9 g, 5.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	6.51	13	260	**192.9**			Thurston et al. 1981c
Fathead minnow (1.9 g, 5.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	9.03	13.2	5.94	**169.6**			Thurston et al. 1981c
Fathead minnow (1.9 g, 5.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.51	13.5	18.88	**216.9**			Thurston et al. 1981c
Fathead minnow (1.9 g, 5.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.01	13.8	145.9	**147.2**			Thurston et al. 1981c
Fathead minnow (0.09 g, 2.0 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.91	16.3	51.55	**187.1**			Thurston et al. 1983
Fathead minnow (0.09 g, 2.1 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.89	13.1	50.2	**175.6**			Thurston et al. 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Fathead minnow (0.13 g, 2.3 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.64	13.6	58.4	**132.1**			Thurston et al. 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Fathead minnow (0.19 g, 2.6 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.68	13.5	64.7	**156.3**			Thurston et al. 1983
Fathead minnow (0.22 g, 2.7 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.03	22.1	47.6	**216.3**			Thurston et al. 1983
Fathead minnow (0.22 g, 2.9 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.06	22	42.6	**205.0**			Thurston et al. 1983
Fathead minnow (0.26 g, 3.0 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.67	13.9	58.8	**139.7**			Thurston et al. 1983
Fathead minnow (0.31 g, 3.0 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.05	13	74.65	**352.4**			Thurston et al. 1983
Fathead minnow (0.31 g, 3.1 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.05	13.6	66.48	**313.8**			Thurston et al. 1983
Fathead minnow (0.35 g, 3.1 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.94	19.1	42.3	**162.3**			Thurston et al. 1983
Fathead minnow (0.42 g, 3.0 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.76	19	50.28	**139.3**			Thurston et al. 1983
Fathead minnow (0.42 g, 3.6 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.66	13.4	58.2	**136.0**			Thurston et al. 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Fathead minnow (0.47 g, 3.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.87	15.8	58.91	**198.7**			Thurston et al. 1983
Fathead minnow (0.47 g, 3.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.83	22	50.6	**158.7**			Thurston et al. 1983
Fathead minnow (0.5 g, 3.8 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.91	18.9	49.3	**178.9**			Thurston et al. 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Fathead minnow (0.8 g, 4.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.77	14.3	66.7	**188.1**			Thurston et al. 1983
Fathead minnow (1.0 g, 4.6 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.77	14.1	72.71	**205.1**			Thurston et al. 1983
Fathead minnow (1.4 g, 4.9 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.04	22.4	36.59	**169.5**			Thurston et al. 1983
Fathead minnow (1.4 g, 5.0 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.08	21.4	44.8	**224.0**			Thurston et al. 1983
Fathead minnow (1.4 g, 5.0 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	8.16	21.4	47.39	**276.4**			Thurston et al. 1983
Fathead minnow (1.4 g, 5.1 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.88	21.7	50.9	**174.8**			Thurston et al. 1983
Fathead minnow (1.4 g, 5.4 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.68	12.9	91.8	**221.8**			Thurston et al. 1983
Fathead minnow (1.4 g, 5.5 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.63	13.2	89.85	**199.9**			Thurston et al. 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Fathead minnow (1.5 g, 5.6 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.76	12.9	107.5	**298.0**			Thurston et al. 1983
Fathead minnow (1.7 g, 5.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.84	21.7	55.43	**177.0**			Thurston et al. 1983
Fathead minnow (2.1 g, 6.1 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.76	13.1	66.73	**184.9**			Thurston et al. 1983
Fathead minnow (2.2 g, 6.2 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.74	12.8	52.2	**139.7**			Thurston et al. 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Fathead minnow (2.3 g, 6.3 cm), *Pimephales promelas*	Ammonium chloride	4 d	F,M	7.91	15.9	47.43	**172.1**	159.2	159.2	Thurston et al. 1983
Brook trout (3.12 g, 7.2 cm), *Salvelinus fontinalis*	Ammonium chloride	4 d	F,U	7.86	13.6	45.21	**149.7**			Thurston and Meyn 1984
Brook trout (3.40 g, 7.4 cm), *Salvelinus fontinalis*	Ammonium chloride	4 d	F,U	7.83	13.8	52.03	**163.2**	156.3		Thurston and Meyn 1984
Lake trout, siscowet (0.9 g), *Salvelinus namaycush*	Ammonium chloride	4 d	S,M	7.45	8.5	90.43	**152.5**			Soderberg and Meade 1992
Lake trout, siscowet (0.9 g), *Salvelinus namaycush*	Ammonium chloride	4 d	S,M	7.45	8.5	110.2	**185.9**			Soderberg and Meade 1992
Lake trout, siscowet (8 g), *Salvelinus namaycush*	Ammonium chloride	4 d	S,M	7.45	8.5	96.25	**162.3**			Soderberg and Meade 1992
Lake trout, siscowet (8 g), *Salvelinus namaycush*	Ammonium chloride	4 d	S,M	7.45	8.5	83.11	**140.1**	159.3	157.8	Soderberg and Meade 1992
Shortnose sturgeon (fingerling), *Acipenser brevirostrum*	Ammonium chloride	4 d	S,M	7.05	18	149.8	**156.7**	156.7	156.7	Fontenot et al. 1998

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

White sucker (5.6 g), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	7.8	3.6	89.57	**266.3**			West 1985; Arthur et al. 1987
White sucker (5.2 g), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	8.1	11.3	60.86	**316.1**			West 1985; Arthur et al. 1987
White sucker (12.6 g), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	8.2	12.6	40.85	**257.4**			West 1985; Arthur et al. 1987
White sucker (9.6 g), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	8.2	15.3	43.01	**271.0**			West 1985; Arthur et al. 1987
White sucker (110 mm), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	7.8	20.2	31.21	**92.80**			Nimmo et al. 1989
White sucker (110 mm), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	7.8	20.2	18.93	**56.28**			Nimmo et al. 1989
White sucker (92 mm, 6.3 g), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	8.16	15	30.28	**176.6**			Reinbold and Pescitelli 1982c

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
White sucker (92 mm, 6.3 g), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	8.14	15.4	29.65	**166.3**			Reinbold and Pescitelli 1982c
White sucker (11.4 g), *Catostomus commersonii*	Ammonium chloride	4 d	F,M	7.8	22.5	22.3	**66.32**	157.5		Swigert and Spacie 1983
Mountain sucker (63.3 g, 18.2 cm), *Catostomus platyrhynchus*	Ammonium chloride	4 d	F,U	7.67	12	66.91	**159.0**			Thurston and Meyn 1984
Mountain sucker (45.3 g, 16.2 cm), *Catostomus platyrhynchus*	Ammonium chloride	4 d	F,U	7.69	13.2	47.59	**117.0**			Thurston and Meyn 1984
Mountain sucker (47.8 g, 15.9 cm), *Catostomus platyrhynchus*	Ammonium chloride	4 d	F,U	7.73	11.7	51.62	**135.8**	136.2	146.5	Thurston and Meyn 1984
Water flea, *Ceriodaphnia acanthina*	Ammonium chloride	2 d	F,M	7.06	24	104.8	**154.3**	154.3		Mount 1982
Water flea (<24 hr), *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	8.02	24.8	21.26	**141.1**			Andersen and Buckley 1998

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Water flea (<24 hr), *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	7.5	25	47.05	**129.2**			Bailey et al. 2001
Water flea (<24 hr), *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	7.5	25	56.84	**156.1**			Bailey et al. 2001
Water flea (<24 hr), *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	8.16	22	24.77	**170.5**			Black 2001
Water flea (<24 hr), *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	8.4	23	28.06	**334.5**			Black 2001
Water flea (<24 hr), *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	8.4	23	32.63	**389.0**			Black 2001
Water flea (<24 hr), *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	8	25	14.52	**94.35**			Scheller 1997
Water flea, *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	8.08	24.75	15.6	**114.5**			Andersen and Buckley 1998
Water flea, *Ceriodaphnia dubia*	Ammonium hydroxide	2 d	R,M	8.4	26.4	7.412	**117.1**			Cowgill and Milazzo 1991
Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Water flea, *Ceriodaphnia dubia*	Ammonium sulfate	2 d	R,NR	7.4	23	48.59	**97.89**			Manning et al. 1996
Water flea, *Ceriodaphnia dubia*	Ammonium chloride	2 d	R,M	7.8	25	33.98	**152.9**			Nimmo et al. 1989
Water flea, *Ceriodaphnia dubia*	Ammonium chloride	2 d	R,M	8.2	7	16.65	**35.72**			Nimmo et al. 1989
Water flea, *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	7.85	23	28.65	**119.5**			Sarda 1994
Water flea, *Ceriodaphnia dubia*	Ammonium chloride	2 d	S,M	7.85	23	28.77	**120.0**	134.2	143.9	Sarda 1994
Water flea (adult), *Simocephalus vetulus*	Ammonium chloride	2 d	F,M	8.3	17	31.58	**188.5**			West 1985; Arthur et al. 1987
Water flea (adult), *Simocephalus vetulus*	Ammonium chloride	2 d	F,M	8.1	20.4	21.36	**114.7**			Arthur et al. 1987
Water flea, *Simocephalus vetulus*	Ammonium chloride	2 d	F,M	7.25	24.5	83.51	**157.0**			Mount 1982
Water flea, *Simocephalus vetulus*	Ammonium chloride	2 d	F,M	7.06	24	83.51	**122.9**	142.9	142.9	Mount 1982

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	S,U	8.7	22	10.56	172.9			Colt and Tchobanoglous 1976
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	S,U	8.7	26	10.19	166.9			Colt and Tchobanoglous 1976
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	S,U	8.7	30	10.88	178.1			Colt and Tchobanoglous 1976
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	S,M	7.49	19.7	131.5	235.0			EA Engineering 1985
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	S,M	7.53	19.75	99.67	189.3			EA Engineering 1985
Channel catfish (larvae, 1 d), *Ictalurus punctatus*	Ammonium chloride	4 d	R,M	8.2	23.8	13.03	82.10			Bader and Grizzle 1992
Channel catfish (juvenile, 7 d), *Ictalurus punctatus*	Ammonium chloride	4 d	R,M	8.2	23.9	17.22	108.5			Bader and Grizzle 1992
Channel catfish (3.5 g), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.8	19.6	44.71	**132.9**			West 1985; Arthur et al. 1987

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Channel catfish (5.8 g), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	8	3.5	37.64	**161.6**			West 1985; Arthur et al. 1987
Channel catfish (6.4 g), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	8.1	14.6	24.94	**129.5**			West 1985; Arthur et al. 1987
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	8.4	28	10.71	**99.59**			Colt and Tchobanoglous 1978
Channel catfish (3-11 mo), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.46	10	124.8	**213.5**			DeGraeve et al. 1987
Channel catfish (3-11 mo), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.41	15	113.1	**180.2**			DeGraeve et al. 1987
Channel catfish (3-11 mo), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.41	20	89.63	**142.8**			DeGraeve et al. 1987
Channel catfish (3-11 mo), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.45	20	72.15	**121.7**			DeGraeve et al. 1987
Channel catfish (3-11 mo), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.4	25	89.41	**140.5**			DeGraeve et al. 1987
Channel catfish (3-11 mo), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.41	25	85.69	**136.5**			DeGraeve et al. 1987

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Channel catfish (3-11 mo), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.44	30	65.25	**108.5**			DeGraeve et al. 1987
Channel catfish (<110 d), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	8	20	15.09	**64.77**			Diamond et al. 1993
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.94	23.8	33.1	**127.0**			Reinbold and Pescitelli 1982d
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.98	23.8	30.49	**126.1**			Reinbold and Pescitelli 1982d
Channel catfish (4.5-10.8 g), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	8.08	28	44.44	**222.2**			Roseboom and Richey 1977
Channel catfish (7.1-12.7 g), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	8.09	22	32.33	**164.8**			Roseboom and Richey 1977
Channel catfish (14.3 mm, 19.0 g), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.93	20	74.35	**277.4**			Sparks 1975
Channel catfish (0.5 g), *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	7.8	25.7	32.85	**97.67**			Swigert and Spacie 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals

Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	8	26	32.34	**138.8**			West 1985
Channel catfish, *Ictalurus punctatus*	Ammonium chloride	4 d	F,M	8.1	17	40.83	**212.1**	142.4	142.4	West 1985
Red swamp crayfish (2.1 cm), *Procambarus clarkii*	Ammonium chloride	4 d	F,M	8	20	26.08	**112.0**			Diamond et al. 1993
Red swamp crayfish (<2.5 cm), *Procambarus clarkii*	Ammonium chloride	4 d	F,M	8	12	76.92	**170.1**	138.0	138.0	Diamond et al. 1993
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.4	1.8	123	**87.86**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.4	1.8	133.9	**95.64**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6	2.1	297.2	**195.1**			Knoph 1992

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Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6	2.1	341.1	**223.9**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.05	2.5	400	**264.4**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.05	2.5	491.7	**325.0**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6	7.3	581.5	**381.7**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6	7.3	587.6	**385.7**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.45	7.4	171.3	**124.4**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.45	7.4	214.4	**155.7**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.45	12.5	230.6	**167.4**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.45	12.5	248.3	**180.3**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.05	12.5	403.5	**266.7**			Knoph 1992

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals

Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.05	12.5	451.5	**298.5**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.05	17.1	356.1	**235.4**			Knoph 1992
Atlantic salmon (4.8-9.2 cm), *Salmo salar*	Ammonium sulfate	4 d	S,M	6.05	17.1	373	**246.6**			Knoph 1992
Atlantic salmon (1.5 g), *Salmo salar*	Ammonium chloride	4 d	S,M	7.45	8.5	60.29	**101.7**			Soderberg and Meade 1992
Atlantic salmon (1.5 g), *Salmo salar*	Ammonium chloride	4 d	S,M	7.45	8.5	35.74	**60.26**			Soderberg and Meade 1992
Atlantic salmon (36 g), *Salmo salar*	Ammonium chloride	4 d	S,M	7.45	8.5	118.2	**199.3**			Soderberg and Meade 1992
Atlantic salmon (36 g), *Salmo salar*	Ammonium chloride	4 d	S,M	7.45	8.5	70.62	**119.1**	183.3		Soderberg and Meade 1992

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Brown trout (1.20 g, 5.4 cm), *Salmo trutta*	Ammonium chloride	4 d	F,U	7.85	13.2	29.58	**96.20**			Thurston and Meyn 1984
Brown trout (1.17 g, 5.3 cm), *Salmo trutta*	Ammonium chloride	4 d.	F,U	7.86	13.8	32.46	**107.5**			Thurston and Meyn 1984
Brown trout (0.91 g, 4.9 cm), *Salmo trutta*	Ammonium chloride	4 d	F,U	7.82	14.2	33.3	**102.6**	102.0	136.7	Thurston and Meyn 1984
White perch (76 mm), *Morone americana*	Ammonium chloride	4 d	S,M	8	16	14.93	**64.09**			Stevenson 1977
White perch (76 mm), *Morone americana*	Ammonium chloride	4 d	S,M	6	16	418.4	**274.7**	132.7		Stevenson 1977
White bass (4.4 g), *Morone chrysops*	Ammonium chloride	4 d	S,M	7.09	19.7	132.4	**144.0**	144.0		Ashe et al. 1996
Striped bass (20-93 mm), *Morone saxatilis*	Ammonium chloride	4 d	S,M	7.4	23.3	92.17	**144.8**			Hazel et al. 1971
Striped bass (20-93 mm), *Morone saxatilis*	Ammonium chloride	4 d	S,M	7.5	23.3	73.45	**133.3**			Hazel et al. 1971
Striped bass (20-93 mm), *Morone saxatilis*	Ammonium chloride	4 d	S,M	7.35	15	259.7	**378.9**			Hazel et al. 1971

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Striped bass (20-93 mm), *Morone saxatilis*	Ammonium chloride	4 d	S,M	7.5	15	182.3	**330.7**			Hazel et al. 1971
Striped bass (20-93 mm), *Morone saxatilis*	Ammonium chloride	4 d	S,M	7.93	23.3	48.03	**180.8**			Hazel et al. 1971
Striped bass (20-93 mm), *Morone saxatilis*	Ammonium chloride	4 d	S,M	7.5	23.3	125.9	**228.5**			Hazel et al. 1971
Striped bass (20-93 mm), *Morone saxatilis*	Ammonium chloride	4 d	S,M	7.84	15	165.7	**524.6**			Hazel et al. 1971
Striped bass (20-93 mm), *Morone saxatilis*	Ammonium chloride	4 d	S,M	7.5	15	354.9	**644.0**			Hazel et al. 1971
Striped bass (126.6 g), *Morone saxatilis*	Ammonium chloride	4 d	S,M	8.3	21	12.86	**98.43**	246.2		Oppenborn and Goudie 1993

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Sunshine bass (larvae, 12 h), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	8.5	18.7	3.903	**43.99**			Harcke and Daniels 1999
Sunshine bass (367.2 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	8.3	21	8.147	**62.37**			Oppenborn and Goudie 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	63.62	**63.62**			Weirich et al. 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	83.06	**83.06**			Weirich et al. 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	56.55	**56.55**			Weirich et al. 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	65.39	**65.39**			Weirich et al. 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	60.09	**60.09**			Weirich et al. 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	64.51	**64.51**			Weirich et al. 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	79.53	**79.53**			Weirich et al. 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	86.6	**86.60**			Weirich et al. 1993
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	95.43	**95.43**			Weirich et al. 1993

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Sunshine bass (42.7 g), *Morone saxatilis x chrysops*	Ammonium chloride	4 d	S,M	7	25	105.2	**105.2**	70.22	134.8	Weirich et al. 1993
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	8.5	20	26.34	**296.9**			Gersich and Hopkins 1986
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	7.92	21	9.463	**37.66**			Gulyas and Fleit 1990
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	8.2	25	20.71	**197.5**			Parkhurst et al. 1979, 1981
Water flea, *Daphnia magna*	Ammonium chloride	2 d	R,U	8.34	19.7	51.92	**419.1**			Reinbold and Pescitelli 1982a

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	8.07	19.6	51.09	**242.4**			Russo et al. 1985
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	7.51	20.1	48.32	**89.74**			Russo et al. 1985
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	7.53	20.1	55.41	**106.1**			Russo et al. 1985
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	7.5	20.3	43.52	**80.98**			Russo et al. 1985
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	7.4	20.6	42.31	**69.88**			Russo et al. 1985
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	8.09	20.9	41.51	**227.9**			Russo et al. 1985
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	7.95	22	51.3	**236.7**			Russo et al. 1985
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	8.15	22	37.44	**252.8**			Russo et al. 1985
Water flea, *Daphnia magna*	Ammonium chloride	2 d	S,M	8.04	22.8	38.7	**226.1**	157.7		Russo et al. 1985
Water flea, *Daphnia pulicaria*	Ammonium chloride	2 d	F,M	8.05	14	34.5	**99.03**	99.03	125.0	DeGraeve et al. 1980
Clawed toad (embryo), *Xenopus laevis*	Ammonium sulfate	4 d	R,M	7.2	22	38.59	**40.91**			Schuytema and Nebeker 1999a

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Clawed toad (embryo), *Xenopus laevis*	Ammonium sulfate	4 d	R,M	7.2	22	119.6	**126.8**			Schuytema and Nebeker 1999a
Clawed toad (embryo), *Xenopus laevis*	Ammonium nitrate	4 d	R,M	7.2	24	32.37	**39.55**			Schuytema and Nebeker 1999a
Clawed toad (embryo), *Xenopus laevis*	Ammonium sulfate	4 d	R,M	7.2	24	60.71	**74.17**			Schuytema and Nebeker 1999a
Clawed toad (17 mg, Gosner Stage 26-27), *Xenopus laevis*	Nitric acid ammonium salt	4 d	R,M	7.15	22	101.4	**117.2**			Schuytema and Nebeker 1999b

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Clawed toad (17 mg, Gosner Stage 26-27), *Xenopus laevis*	Ammonium sulfate	4 d	R,M	7.15	22	135.9	**157.2**			Schuytema and Nebeker 1999b
Clawed toad (21 mg, Gosner Stage 26-27), *Xenopus laevis*	Ammonium chloride	4 d	R,M	7.15	22	128.3	**148.4**			Schuytema and Nebeker 1999b
Clawed toad (embryo), *Xenopus laevis*	Ammonium phosphate	4 d	R,M	8.43	25	37.3	**367.4**			Tietge et al. 2000
Clawed toad (embryo), *Xenopus laevis*	Ammonium phosphate	4 d	R,M	8.62	25	28.7	**405.6**	122.5	122.5	Tietge et al. 2000
Flatworm, *Dendrocoelum lacteum*	Ammonium chloride	4 d	S,U	8.2	18	22.37	**119.5**	119.5	119.5	Stammer 1953
Walleye, *Sander vitreus*	Ammonium chloride	4 d	F,U	8.08	18.2	17.43	87.13			Reinbold and Pescitelli 1982a
Walleye (22.6 g), *Sander vitreus*	Ammonium chloride	4 d	F,M	7.9	3.7	48.37	**172.3**			West 1985; Arthur et al. 1987
Walleye (19.4 g), *Sander vitreus*	Ammonium chloride	4 d	F,M	7.7	11.1	89.93	**224.8**			West 1985; Arthur et al. 1987
Walleye (13.4 g), *Sander vitreus*	Ammonium chloride	4 d	F,M	8.3	19	6.123	**46.87**			West 1985; Arthur et al. 1987
Walleye (3.0 g, 65.6 mm), *Sander vitreus*	Ammonium chloride	4 d	F,M	8.06	21.5	21.49	**103.4**	117.1	117.1	Mayes et al. 1986
Central stoneroller (2.1 g), *Campostoma anomalum*	Ammonium chloride	4 d	F,M	7.8	25.7	38.97	**115.9**	115.9	115.9	Swigert and Spacie 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals

Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow dace, *Cyprinella lutrensis*	Ammonium chloride	4 d	F,M	8.3	24	24.37	**186.5**			Hazel et al. 1979
Rainbow dace, *Cyprinella lutrensis*	Ammonium chloride	4 d	F,M	9.1	24	6.502	**206.1**	196.1		Hazel et al. 1979
Spotfin shiner (31-85 mm), *Cyprinella spiloptera*	Ammonium chloride	4 d	F,M	7.95	26.5	18.52	**72.39**			Rosage et al. 1979

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Spotfin shiner (41-78 mm), *Cyprinella spiloptera*	Ammonium chloride	4 d	F,M	8.15	26.5	16.27	**93.07**			Rosage et al. 1979
Spotfin shiner (0.5 g), *Cyprinella spiloptera*	Ammonium chloride	4 d	F,M	7.9	25.7	24.52	**87.36**	83.80		Swigert and Spacie 1983
Steelcolor shiner (0.5 g), *Cyprinella whipplei*	Ammonium chloride	4 d	F,M	7.9	25.7	22.72	**80.94**	80.94	110.0	Swigert and Spacie 1983
Dwarf wedgemussel (glochidia), *Alasmidonta heterodon*	Ammonium chloride	1 d	S,M	8.3	20	>14.24 [c]	**>109.0**	>109.0	>109.0	Wang et al. 2007b
Pink papershell (glochidia), *Potamilus ohiensis*	Ammonium chloride	1 d	S,M	8.3	20	>14.24 [c]	**>109.0**	>109.0	>109.0	Wang et al. 2007b
Green sunfish (larvae, 9 d swim up fry), *Lepomis cyanellus*	Ammonium chloride	4 d	F,U	8.28	26.2	8.43	62.07			Reinbold and Pescitelli 1982a
Green sunfish, *Lepomis cyanellus*	Ammonium chloride	4 d	F,M	7.84	12.3	33.09	**105.7**			Jude 1973
Green sunfish (62.5 mg), *Lepomis cyanellus*	Ammonium chloride	4 d	F,M	7.2	22.4	142.9	**174.5**			McCormick et al. 1984
Green sunfish (62.5 mg), *Lepomis cyanellus*	Ammonium chloride	4 d	F,M	6.61	22.4	254.5	**197.0**			McCormick et al. 1984
Green sunfish (62.5 mg), *Lepomis cyanellus*	Ammonium chloride	4 d	F,M	7.72	22.4	55.79	**144.3**			McCormick et al. 1984
Green sunfish (62.5 mg), *Lepomis cyanellus*	Ammonium chloride	4 d	F,M	8.69	22.4	9.24	**148.6**	150.8		McCormick et al. 1984

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Pumpkinseed (4.13-9.22 g), *Lepomis gibbosus*	Ammonium chloride	4 d	F,M	7.77	12	9.11	**25.69**			Jude 1973
Pumpkinseed, *Lepomis gibbosus*	Ammonium chloride	4 d	F,M	7.77	14	48.09	**135.6**			Thurston 1981

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Pumpkinseed, *Lepomis gibbosus*	Ammonium chloride	4 d	F,M	7.77	14.5	42.02	**118.5**			Thurston 1981
Pumpkinseed, *Lepomis gibbosus*	Ammonium chloride	4 d	F,M	7.71	15.7	48.54	**87.54**	77.53		Thurston 1981
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	S,M	7.51	20.35	40.41	73.88			EA Engineering 1985
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	S,M	7.51	20.35	41.96	76.72			EA Engineering 1985
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	S,M	7.52	20.65	41.9	78.36			EA Engineering 1985
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	S,M	7.51	20.35	44.3	80.98			EA Engineering 1985
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	S,M	7.52	20.65	42.63	79.73			EA Engineering 1985
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	S,M	7.52	20.65	44.1	82.48			EA Engineering 1985
Bluegill (1.7 cm), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8	20	21.56	**92.54**			Diamond et al. 1993
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8	12	25.12	**107.9**			Diamond et al. 1993
Bluegill (20.0-70.0 mm, young of year), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.11	18.5	16.73	**88.57**			Emery and Welch 1969
Bluegill (20.0-70.0 mm, young of year), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.24	18.5	42.01	**286.1**			Emery and Welch 1969
Bluegill (20.0-70.0 mm, young of year), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.75	18.5	12.7	**227.4**			Emery and Welch 1969

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Bluegill (20.0-70.0 mm, young of year), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	9.05	18.5	6.581	**193.8**			Emery and Welch 1969

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Bluegill (20.0-70.0 mm, young of year), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	9.19	18.5	3.755	**135.0**			Emery and Welch 1969
Bluegill (20.0-70.0 mm, young of year), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	9.62	18.5	0.7859	**44.84**			Emery and Welch 1969
Bluegill (20.0-70.0 mm, young of year), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	9.85	18.5	1.346	**89.70**			Emery and Welch 1969
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.6	24	5.509	**75.01**			Hazel et al. 1979
Bluegill (5.2 cm), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	7.9	24.25	33.06	**117.8**			Lubinski et al. 1974
Bluegill (0.38 g, 26.3 mm), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.1	22	19.39	**100.7**			Mayes et al. 1986
Bluegill (19 mm, 0.0781 g), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.4	4	14.64	**136.1**			Reinbold and Pescitelli 1982b
Bluegill (22 mm, 0.1106 g), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.12	25	23.37	**126.2**			Reinbold and Pescitelli 1982b
Bluegill (28 mm, 0.250 g), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.16	4.5	12.55	**73.19**			Reinbold and Pescitelli 1982b
Bluegill (30 mm, 0.267 g), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.09	24.8	17.22	**87.75**			Reinbold and Pescitelli 1982b
Bluegill (217 mg), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8	22	12.75	**54.74**			Roseboom and Richey 1977
Bluegill (342 mg), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.2	28	14.81	**93.31**			Roseboom and Richey 1977
Bluegill (646 mg), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	7.93	22	24.08	**90.66**			Roseboom and Richey 1977
Bluegill (72 mg), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	8.07	22	8.846	**43.38**			Roseboom and Richey 1977
Bluegill, *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	7.6	21.7	44.03	**93.31**			Smith et al. 1984

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Bluegill (4.8 cm, 1.1 g), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	7.85	22.05	59.93	**194.9**			Sparks 1975
Bluegill (0.9 g), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	7.8	24.2	33.88	**100.7**			Swigert and Spacie 1983
Bluegill (0.9 g), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	7.6	26.5	58.69	**124.4**			Swigert and Spacie 1983
Bluegill (1.2 g), *Lepomis macrochirus*	Ammonium chloride	4 d	F,M	7.8	26.6	37.52	**111.6**	104.5	106.9	Swigert and Spacie 1983
Common carp (206 mg), *Cyprinus carpio*	Ammonium chloride	4 d	R,M	7.72	28	51.78	**133.9**			Hasan and MacIntosh 1986
Common carp (299 mg), *Cyprinus carpio*	Ammonium chloride	4 d	R,M	7.72	28	48.97	**126.6**			Hasan and MacIntosh 1986
Common carp (4-5 cm), *Cyprinus carpio*	Ammonium chloride	4 d	R,M	7.4	28	45.05	**70.78**	106.3	106.3	Rao et al. 1975
Golden trout (0.09 g, 24 cm), *Oncorhynchus aguabonita*	Ammonium chloride	4 d	F,M	8.06	13.2	23.3	**112.1**	112.1		Thurston and Russo 1981
Cutthroat trout (3.6 g), *Oncorhynchus clarkii*	Ammonium chloride	4 d	F,M	7.7	10	17.3	**43.24**			Thurston et al. 1981a
Cutthroat trout (3.6 g), *Oncorhynchus clarkii*	Ammonium chloride	4 d	F,M	7.7	10	29.1	**72.73**			Thurston et al. 1981a
Cutthroat trout (4.1 g), *Oncorhynchus clarkii*	Ammonium chloride	4 d	F,M	7.7	10	19.3	**48.24**			Thurston et al. 1981a
Cutthroat trout (4.1 g), *Oncorhynchus clarkii*	Ammonium chloride	4 d	F,M	7.7	10	26.3	**65.73**			Thurston et al. 1981a
Cutthroat trout (3.4 g), *Oncorhynchus clarkii*	Ammonium chloride	4 d	F,M	7.78	12.2	32.57	**93.49**			Thurston et al. 1978
Cutthroat trout (3.3 g), *Oncorhynchus clarkii*	Ammonium chloride	4 d	F,M	7.8	12.4	36.55	**108.7**			Thurston et al. 1978
Cutthroat trout (1.0 g), *Oncorhynchus clarkii*	Ammonium chloride	4 d	F,M	7.8	12.8	37.75	**112.2**			Thurston et al. 1978
Cutthroat trout (1.0 g), *Oncorhynchus clarkii*	Ammonium chloride	4 d	F,M	7.81	13.1	43.72	**132.3**	78.92		Thurston et al. 1978

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Species	Chemical Name	Duration	Methods[a]	pH	Temp. (˚C)	Total Ammonia (mg TAN/L)	Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)	SMAV (mg TAN/L)	GMAV (mg TAN/L)	Reference
Pink salmon (late alevins), *Oncorhynchus gorbuscha*	Ammonium sulfate	4 d	S,M	6.4	4.3	230.5	**164.6**			Rice and Bailey 1980
Pink salmon (fry), *Oncorhynchus gorbuscha*	Ammonium sulfate	4 d	S,M	6.4	4.3	277.7	**198.3**	180.7		Rice and Bailey 1980
Coho salmon (6 g), *Oncorhynchus kisutch*	Ammonium chloride	4 d	F,M	8.1	17.2	11.59	**60.20**			Buckley 1978
Coho salmon, *Oncorhynchus kisutch*	Ammonium chloride	4 d	F,M	7	15	82.02	**82.02**			Wilson 1974; Robinson-Wilson and Seim 1975
Coho salmon, *Oncorhynchus kisutch*	Ammonium chloride	4 d	F,M	7	15	84.43	**84.43**			Wilson 1974; Robinson-Wilson and Seim 1975
Coho salmon, *Oncorhynchus kisutch*	Ammonium chloride	4 d	F,M	7.5	15	50.65	**91.90**			Wilson 1974; Robinson-Wilson and Seim 1975
Coho salmon, *Oncorhynchus kisutch*	Ammonium chloride	4 d	F,M	7.5	15	52.76	**95.73**			Wilson 1974; Robinson-Wilson and Seim 1975
Coho salmon, *Oncorhynchus kisutch*	Ammonium chloride	4 d	F,M	8	15	21.63	**92.84**			Wilson 1974; Robinson-Wilson and Seim 1975
Coho salmon, *Oncorhynchus kisutch*	Ammonium chloride	4 d	F,M	8	15	22	**94.44**			Wilson 1974; Robinson-Wilson and Seim 1975
Coho salmon, *Oncorhynchus kisutch*	Ammonium chloride	4 d	F,M	8.5	15	9.093	**102.5**	87.05		Wilson 1974; Robinson-Wilson and Seim 1975
Rainbow trout (0.5-3.0 g), *Oncorhynchus mykiss*	Ammonium sulfate	4 d	S,U	7.95	15	51.06	199.6			Qureshi et al. 1982
Rainbow trout (McConaughy strain, 251 mg), *Oncorhynchus mykiss*	Ammonium chloride	4 d	S,M	6.84	12	112	98.86			Buhl and Hamilton 2000
Rainbow trout, *Oncorhynchus mykiss*	Ammonium chloride	4 d	S,M	7.55	15	34.23	67.04			Craig and Beggs 1979
Rainbow trout (0.80 g), *Oncorhynchus mykiss*	-	4 d	S,M	6.95	14.7	163.6	156.9			Environment Canada 2004
Rainbow trout (0.60 g), *Oncorhynchus mykiss*	-	4 d	S,M	6.97	14.5	144	140.3			Environment Canada 2004
Rainbow trout (0.63 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.02	15.4	146.7	149.4			Environment Canada 2004

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Species	Chemical Name	Duration	Methods[a]	pH	Temp. (˚C)	Total Ammonia (mg TAN/L)	Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)	SMAV (mg TAN/L)	GMAV (mg TAN/L)	Reference
Rainbow trout (0.80 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.02	14.6	159	161.8			Environment Canada 2004
Rainbow trout (0.80 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.03	15.1	156.6	160.9			Environment Canada 2004
Rainbow trout (0.90 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.18	15.1	141.6	169.2			Environment Canada 2004
Rainbow trout (2.01 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.45	15.1	104.4	176.0			Environment Canada 2004
Rainbow trout (1.30 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.47	14.7	72.65	126.1			Environment Canada 2004
Rainbow trout (0.78 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.47	14.5	79.67	138.3			Environment Canada 2004
Rainbow trout (0.40 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.51	14.2	73.71	135.8			Environment Canada 2004
Rainbow trout (1.64 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.54	14.6	75.3	145.2			Environment Canada 2004
Rainbow trout (1.13 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.59	13.9	59.4	123.9			Environment Canada 2004
Rainbow trout (1.50 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.87	15.1	42.9	144.7			Environment Canada 2004
Rainbow trout (1.38 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.93	15.2	41.15	155.0			Environment Canada 2004
Rainbow trout (0.90 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.97	15.2	36.17	145.4			Environment Canada 2004
Rainbow trout (1.00 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.98	15.1	35.29	145.9			Environment Canada 2004
Rainbow trout (1.30 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.03	14.9	23.03	104.6			Environment Canada 2004
Rainbow trout (1.26 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.04	14.3	25.84	119.7			Environment Canada 2004
Rainbow trout (1.60 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.34	15.3	19.15	158.5			Environment Canada 2004
Rainbow trout (1.30 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.39	15.3	12.05	109.9			Environment Canada 2004
Rainbow trout (1.11 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.4	14.9	12.84	119.4			Environment Canada 2004
Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Species	Chemical Name	Duration	Methods[a]	pH	Temp. (˚C)	Total Ammonia (mg TAN/L)	Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)	SMAV (mg TAN/L)	GMAV (mg TAN/L)	Reference
Rainbow trout (0.80 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.02	14.6	159	161.8			Environment Canada 2004
Rainbow trout (0.80 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.03	15.1	156.6	160.9			Environment Canada 2004
Rainbow trout (0.90 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.18	15.1	141.6	169.2			Environment Canada 2004
Rainbow trout (2.01 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.45	15.1	104.4	176.0			Environment Canada 2004
Rainbow trout (1.30 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.47	14.7	72.65	126.1			Environment Canada 2004
Rainbow trout (0.78 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.47	14.5	79.67	138.3			Environment Canada 2004
Rainbow trout (0.40 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.51	14.2	73.71	135.8			Environment Canada 2004
Rainbow trout (1.64 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.54	14.6	75.3	145.2			Environment Canada 2004
Rainbow trout (1.13 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.59	13.9	59.4	123.9			Environment Canada 2004
Rainbow trout (1.50 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.87	15.1	42.9	144.7			Environment Canada 2004
Rainbow trout (1.38 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.93	15.2	41.15	155.0			Environment Canada 2004
Rainbow trout (0.90 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.97	15.2	36.17	145.4			Environment Canada 2004
Rainbow trout (1.00 g), *Oncorhynchus mykiss*	-	4 d	S,M	7.98	15.1	35.29	145.9			Environment Canada 2004
Rainbow trout (1.30 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.03	14.9	23.03	104.6			Environment Canada 2004
Rainbow trout (1.26 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.04	14.3	25.84	119.7			Environment Canada 2004
Rainbow trout (1.60 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.34	15.3	19.15	158.5			Environment Canada 2004
Rainbow trout (1.30 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.39	15.3	12.05	109.9			Environment Canada 2004
Rainbow trout (1.11 g), *Oncorhynchus mykiss*	-	4 d	S,M	8.4	14.9	12.84	119.4			Environment Canada 2004

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow trout (53 mm, 1.48 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.95	10	35.14	**137.3**			Broderius and Smith Jr. 1979
Rainbow trout (stage 8), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.4	14.4	40.99	**64.40**			Calamari et al. 1977
Rainbow trout, *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.05	14	22.9	**108.1**			DeGraeve et al. 1980
Rainbow trout (45 mm, 0.86 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.16	14.2	23.39	**136.4**			Reinbold and Pescitelli 1982b
Rainbow trout (119 mm, 20.6 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.28	12.8	15.4	**113.4**			Reinbold and Pescitelli 1982b
Rainbow trout (115 mm, 18.1 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.34	5	17.32	**143.3**			Reinbold and Pescitelli 1982b
Rainbow trout (42 mm, 0.61 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.43	3	11.86	**116.8**			Reinbold and Pescitelli 1982b
Rainbow trout (52 mm, 1.47 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.5	14.9	10.09	**113.7**			Reinbold and Pescitelli 1982b
Rainbow trout (44 mm, 0.76 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.6	3.3	15.27	**207.9**			Reinbold and Pescitelli 1982b
Rainbow trout (6.3 g, 8.1 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.44	12.8	32.49	**54.00**			Thurston and Russo 1983
Rainbow trout (8.0 g, 8.9 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.5	14.5	24.2	**43.91**			Thurston and Russo 1983
Rainbow trout (29.8 g, 13.1 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.59	12.7	32.62	**68.03**			Thurston and Russo 1983
Rainbow trout (28.0 g, 13.1 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.6	13	23.8	**50.43**			Thurston and Russo 1983
Rainbow trout (24.5 g, 12.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.6	12.9	25.14	**53.27**			Thurston and Russo 1983
Rainbow trout (2596 g, 57.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.62	7.9	20.53	**44.93[f]**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow trout (15.1 g, 10.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.62	14.4	28.62	**62.64**			Thurston and Russo 1983
Rainbow trout (29.6 g, 13.3 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.63	12.9	25.65	**57.06**			Thurston and Russo 1983
Rainbow trout (1496 g, 48.5 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.64	9.8	25.82	**58.38[f]**			Thurston and Russo 1983
Rainbow trout (18.9 g, 11.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.64	13.1	29.28	**66.21**			Thurston and Russo 1983
Rainbow trout (558 g, 37.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.64	10	31.85	**72.02**			Thurston and Russo 1983
Rainbow trout (1698 g, 50.9 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.65	9.8	19.46	**44.73[f]**			Thurston and Russo 1983
Rainbow trout (22.8 g, 12.3 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.65	13.2	28.64	**65.84**			Thurston and Russo 1983
Rainbow trout (12.3 g, 10.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.65	14.3	29.02	**66.71**			Thurston and Russo 1983
Rainbow trout (513 g, 35.9 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.66	9.8	25.95	**60.65**			Thurston and Russo 1983
Rainbow trout (22.6 g, 12.3 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.66	13.6	28.27	**66.07**			Thurston and Russo 1983
Rainbow trout (26.0 g, 13.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.66	12.8	33.97	**79.39**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Rainbow trout (14.8 g, 10.5 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.67	14	27.3	**64.87**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow trout (38.0 g, 14.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.68	13	33.15	**80.11**			Thurston and Russo 1983
Rainbow trout (1122 g, 45.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.69	10.4	17.75	**43.62[f]**			Thurston and Russo 1983
Rainbow trout (1140 g, 46.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.69	10.7	20.18	**49.59[f]**			Thurston and Russo 1983
Rainbow trout (152 g, 23.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.69	10.7	25.62	**62.96**			Thurston and Russo 1983
Rainbow trout (23.6 g, 13.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.69	13.4	27.51	**67.60**			Thurston and Russo 1983
Rainbow trout (9.5 g, 9.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.9	12.7	20.03	**71.36**			Thurston and Russo 1983
Rainbow trout (4.3 g, 7.1 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.71	11.5	30.22	**76.83**			Thurston and Russo 1983
Rainbow trout (4.0 g, 7.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.71	11.4	32.02	**81.40**			Thurston and Russo 1983
Rainbow trout (248 g, 25.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.74	10.4	25.76	**68.95**			Thurston and Russo 1983
Rainbow trout (25.8 g, 13.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.75	11.8	31.53	**85.87**			Thurston and Russo 1983
Rainbow trout (8.1 g, 9.3 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.75	12.3	33.94	**92.43**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Rainbow trout (380 g, 32.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.76	10	22.44	**62.19**			Thurston and Russo 1983
Rainbow trout (42.0 g, 16.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.77	13.6	31.81	**89.71**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow trout (1.7 g, 5.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.79	12.4	41.97	**122.6**			Thurston and Russo 1983
Rainbow trout (11.2 g, 10.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.8	9.7	23.65	**70.32**			Thurston and Russo 1983
Rainbow trout (5.7 g, 8.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.8	13.3	42.02	**124.9**			Thurston and Russo 1983
Rainbow trout (2.3 g, 6.1 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.8	12.4	47.87	**142.3**			Thurston and Russo 1983
Rainbow trout (8.0 g, 9.5 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.82	13.2	33.67	**103.7**			Thurston and Russo 1983
Rainbow trout (4.6 g, 7.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.83	13.5	33.55	**105.2**			Thurston and Russo 1983
Rainbow trout (6.7 g, 8.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.84	12.2	24.54	**78.38**			Thurston and Russo 1983
Rainbow trout (9.0 g, 9.3 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.84	12.9	32.3	**103.2**			Thurston and Russo 1983
Rainbow trout (1.8 g, 5.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.84	13.8	33.09	**105.7**			Thurston and Russo 1983
Rainbow trout (4.3 g, 7.1 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.84	13	38.69	**123.6**			Thurston and Russo 1983
Rainbow trout (0.47 g, 4.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.85	12.5	29.77	**96.81**			Thurston and Russo 1983
Rainbow trout (2.5 g, 6.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.85	13.1	31.55	**102.6**			Thurston and Russo 1983
Rainbow trout (0.61 g, 4.3 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.85	13.1	33.59	**109.2**			Thurston and Russo 1983

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Rainbow trout (1.02 g, 4.9 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.85	12.3	33.99	**110.5**			Thurston and Russo 1983
Rainbow trout (9.4 g, 9.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.85	16.1	34.17	**111.1**			Thurston and Russo 1983
Rainbow trout (0.33 g, 3.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.86	13	20.7	**68.55**			Thurston and Russo 1983
Rainbow trout (0.33 g, 3.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.86	13.4	23.71	**78.52**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow trout (0.47 g, 4.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.86	12.7	28.77	**95.27**			Thurston and Russo 1983
Rainbow trout (1.7 g, 5.8 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.86	14.1	34.95	**115.7**			Thurston and Russo 1983
Rainbow trout (48.6 g, 15.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.86	10.2	35.31	**116.9**			Thurston and Russo 1983
Rainbow trout (0.15 g, 2.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.87	12.9	16.81	**56.69**			Thurston and Russo 1983
Rainbow trout (0.18 g, 2.9 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.87	12.9	18.99	**64.04**			Thurston and Russo 1983
Rainbow trout (0.23 g, 3.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.87	13.1	19.08	**64.34**			Thurston and Russo 1983
Rainbow trout (7.0 g, 8.8 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.87	12.2	20.02	**67.51**			Thurston and Russo 1983
Rainbow trout (0.18 g, 2.9 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.87	13	21.15	**71.32**			Thurston and Russo 1983
Rainbow trout (2.6 g, 6.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.87	12.1	31.8	**107.2**			Thurston and Russo 1983
Rainbow trout (11.1 g, 9.9 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.87	13	34.32	**115.7**			Thurston and Russo 1983
Rainbow trout (0.12 g, 2.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.88	12.8	11.07	**38.02**			Thurston and Russo 1983
Rainbow trout (0.14 g, 2.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.88	12.9	15.91	**54.64**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Rainbow trout (0.23 g, 3.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.88	13.4	19.43	**66.73**			Thurston and Russo 1983
Rainbow trout (52.1 g, 15.5 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.88	10	28.6	**98.22**			Thurston and Russo 1983
Rainbow trout (1.8 g, 5.9 cm), *Oncorhynchus mykiss*	Ammonium sulfate	4 d	F,M	7.89	12.4	36.73	**128.5**			Thurston and Russo 1983
Rainbow trout (0.06 g, 1.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.9	13.4	19.44	**69.26**			Thurston and Russo 1983
Rainbow trout (0.06 g, 1.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.7	13.9	28.54	**71.33**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals

Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (°C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow trout (7.9 g, 9.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.9	11.9	22.65	**80.69**			Thurston and Russo 1983
Rainbow trout (9.7 g, 9.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.9	13	35.75	**127.4**			Thurston and Russo 1983
Rainbow trout (9.3 g, 9.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.9	13	37.41	**133.3**			Thurston and Russo 1983
Rainbow trout (0.08 g, 2.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.91	13.1	12.68	**46.01**			Thurston and Russo 1983
Rainbow trout (0.06 g, 1.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.91	13	20.99	**76.17**			Thurston and Russo 1983
Rainbow trout (7.1 g, 8.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.91	19	25.36	**92.03**			Thurston and Russo 1983
Rainbow trout (10.1 g, 9.8 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.91	19.1	26.44	**95.95**			Thurston and Russo 1983
Rainbow trout (1.7 g, 5.8 cm), *Oncorhynchus mykiss*	Phosphoric acid, Diammonium salt	4 d	F,M	7.94	12.8	26.49	**101.6**			Thurston and Russo 1983
Rainbow trout (2.1 g, 6.2 cm), *Oncorhynchus mykiss*	Ammonium sulfate	4 d	F,M	7.94	12.5	39.25	**150.6**			Thurston and Russo 1983
Rainbow trout (0.15 g, 2.7 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.95	12.5	19.75	**77.19**			Thurston and Russo 1983
Rainbow trout (8.6 g, 8.9 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.96	19.2	23.21	**92.42**			Thurston and Russo 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Rainbow trout (2.1 g, 6.2 cm), *Oncorhynchus mykiss*	Phosphoric acid, Diammonium salt	4 d	F,M	7.98	12.5	27.02	**111.7**			Thurston and Russo 1983
Rainbow trout (1.01 g, 4.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.06	13.2	33.64	**161.8**			Thurston and Russo 1983
Rainbow trout (0.36 g, 3.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.08	12.8	23.05	**115.2**			Thurston and Russo 1983
Rainbow trout (1.7 g, 5.9 cm), *Oncorhynchus mykiss*	Ammonium bicarbonate	4 d	F,M	8.1	13.9	18.14	**94.23**			Thurston and Russo 1983
Rainbow trout (1.8 g, 5.8 cm), *Oncorhynchus mykiss*	Ammonium bicarbonate	4 d	F,M	8.12	13.6	17.34	**93.61**			Thurston and Russo 1983
Rainbow trout (2596 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.62	7.9	21.6	**47.27**			Thurston et al. 1981a

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow trout (2080 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.67	7.7	17	**40.40**			Thurston et al. 1981a
Rainbow trout (293 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.71	8.5	20.7	**52.62**			Thurston et al. 1981a
Rainbow trout (230 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.72	8.2	10.5	**27.15**			Thurston et al. 1981a
Rainbow trout (244 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.72	8.1	19.8	**51.20**			Thurston et al. 1981a
Rainbow trout (230 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.74	8.3	22.3	**59.69**			Thurston et al. 1981a
Rainbow trout (247 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.74	8.1	28	**74.94**			Thurston et al. 1981a
Rainbow trout (18 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.86	9.6	19.3	**63.91**			Thurston et al. 1981a
Rainbow trout (21 g), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.86	9.7	31.6	**104.6**			Thurston et al. 1981a
Rainbow trout (4.6 g, 7.3 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.75	12.7	32.09	**87.39**			Thurston et al. 1981b
Rainbow trout (5.7 g, 8.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.75	12.5	36.97	**100.7**			Thurston et al. 1981b

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Rainbow trout (5.0 g, 7.6 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.76	12.5	39.08	**108.3**			Thurston et al. 1981b
Rainbow trout (5.7 g, 8.0 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.79	12.9	40.88	**119.4**			Thurston et al. 1981b
Rainbow trout (4.0 g, 7.2 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.83	12.8	36.49	**114.5**			Thurston et al. 1981b
Rainbow trout (9.5 g, 9.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	6.51	14.1	157.4	**116.8**			Thurston et al. 1981c
Rainbow trout (9.5 g, 9.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	6.8	14.1	94.05	**80.83**			Thurston et al. 1981c
Rainbow trout (9.5 g, 9.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.3	14	74.2	**102.2**			Thurston et al. 1981c
Rainbow trout (9.5 g, 9.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.29	14.1	13.85	**104.0**			Thurston et al. 1981c
Rainbow trout (9.5 g, 9.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	8.82	13.9	3.95	**80.02**			Thurston et al. 1981c

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals

Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow trout (9.5 g, 9.4 cm), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	9.01	14.5	2.51	**69.50**			Thurston et al. 1981c
Rainbow trout (juvenile), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	7.2	10	174	**212.6**			Wicks and Randall 2002
Rainbow trout (40.0 g; swimming fish), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	6.97	16.6	32.38	**31.56**			Wicks et al. 2002
Rainbow trout (40.0 g; resting fish), *Oncorhynchus mykiss*	Ammonium chloride	4 d	F,M	6.97	16.6	207	**201.7**	82.88		Wicks et al. 2002
Chinook salmon (1.0-7 g), *Oncorhynchus tshawytscha*	Ammonia	4 d	S,M	7.96	7	28.03	**111.6**			Servizi and Gordon 1990
Chinook salmon (14.4 g, 11.9 cm), *Oncorhynchus tshawytscha*	Ammonium chloride	4 d	F,U	7.87	13.5	18.47	**62.29**			Thurston and Meyn 1984
Chinook salmon (15.3 g, 12.1 cm), *Oncorhynchus tshawytscha*	Ammonium chloride	4 d	F,U	7.82	12.2	27.23	**83.90**			Thurston and Meyn 1984

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Chinook salmon (18.1 g, 12.7 cm), *Oncorhynchus tshawytscha*	Ammonium chloride	4 d	F,U	7.84	12.3	24.74	**79.02**	82.39	99.15	Thurston and Meyn 1984
Topeka shiner (adult, 29 mo), *Notropis topeka*	Ammonium chloride	4 d	F,M	7.85	24.6	21.40	**69.59**			Adelman et al. 2009
Topeka shiner (juvenile, 16 mo), *Notropis topeka*	Ammonium chloride	4 d	F,M	8.05	25.0	18.70	**88.27**			Adelman et al. 2009
Topeka shiner (juvenile, 15 mo), *Notropis topeka*	Ammonium chloride	4 d	F,M	8.09	13.2	28.90	**147.3**	96.72	96.72	Adelman et al. 2009
Leopard frog (embryo), *Rana pipiens*	Ammonium chloride	4 d	F,M	8	20	31.04	**133.3**			Diamond et al. 1993
Leopard frog (8 d), *Rana pipiens*	Ammonium chloride	4 d	F,M	8	12	16.23	**69.69**	96.38	96.38	Diamond et al. 1993

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Long fingernailclam, *Musculium transversum*	Ammonium chloride	4 d	F,M	8.1	14.6	32.83	**109.0**			West 1985; Arthur et al. 1987
Long fingernailclam, *Musculium transversum*	Ammonium chloride	4 d	F,M	8.2	5.4	38.18	**71.74**			West 1985; Arthur et al. 1987
Long fingernailclam, *Musculium transversum*	Ammonium chloride	4 d	F,M	8.6	20.5	6.429	**91.24**	89.36	89.36	West 1985; Arthur et al. 1987
Smallmouth bass (26-29 mm, 264-267 mg), *Micropterus dolomieu*	Ammonium chloride	4 d	F,M	7.16	22.3	123.4	**144.3**			Broderius et al. 1985
Smallmouth bass (26-29 mm, 264-267 mg), *Micropterus dolomieu*	Ammonium chloride	4 d	F,M	6.53	22.3	359.9	**269.2**			Broderius et al. 1985
Smallmouth bass (26-29 mm, 264-267 mg), *Micropterus dolomieu*	Ammonium chloride	4 d	F,M	7.74	22.3	39.3	**105.2**			Broderius et al. 1985

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Smallmouth bass (26-29 mm, 264-267 mg), *Micropterus dolomieu*	Ammonium chloride	4 d	F,M	8.71	22.3	7.56	**126.0**	150.6		Broderius et al. 1985
Largemouth bass (0.086-0.322 g), *Micropterus salmoides*	Ammonium chloride	4 d	F,M	8.04	28	19.59	**90.72**			Roseboom and Richey 1977
Largemouth bass (2.018-6.286 g), *Micropterus salmoides*	Ammonium chloride	4 d	F,M	7.96	22	20.48	**81.56**	86.02		Roseboom and Richey 1977
Guadalupe bass (6.5 g), *Micropterus treculii*	Ammonium chloride	4 d	S,M/	8	22	12.7	**54.52**	54.52	89.06	Tomasso and Carmichael 1986
Great pond snail (25-30 mm), *Lymnaea stagnalis*	-	4 d	F,M	7.9	11.5	50.33	**88.62**	88.62	88.62	Williams et al. 1986
Guppy (0.13 g, 2.03 cm), *Poecilia reticulata*	Ammonium chloride	4 d	S,U	7.5	27.55	5.929	**10.76**			Kumar and Krishnamoorthi 1983

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals

Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Guppy (8.0 mm), *Poecilia reticulata*	-	4 d	S,U	7.22	25	129.4	**161.8**			Rubin and Elmaraghy 1976
Guppy (8.25(6.3-11.0) mm), *Poecilia reticulata*	-	4 d	S,U	7.45	25	75.65	**127.6**			Rubin and Elmaraghy 1976
Guppy (8.70(6.8-10.6) mm), *Poecilia reticulata*	-	4 d	S,U	7.45	25	82.95	**139.9**	74.66	74.66	Rubin and Elmaraghy 1976
Johnny darter (38 mm), *Etheostoma nigrum*	Ammonium chloride	4 d	F,M	7.9	20.6	28.9	**103.0**			Nimmo et al. 1989
Johnny darter (38 mm), *Etheostoma nigrum*	Ammonium chloride	4 d	F,M	8	20.1	24.61	**105.7**			Nimmo et al. 1989
Johnny darter (38 mm), *Etheostoma nigrum*	Ammonium chloride	4 d	F,M	8.2	6.2	6.937	**43.72**			Nimmo et al. 1989
Johnny darter (38 mm), *Etheostoma nigrum*	Ammonium chloride	4 d	F,M	8.1	5.8	11.47	**59.57**			Nimmo et al. 1989
Johnny darter (38 mm), *Etheostoma nigrum*	Ammonium chloride	4 d	F,M	8.1	5.8	13.46	**69.93**			Nimmo et al. 1989

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Johnny darter (38 mm), *Etheostoma nigrum*	Ammonium chloride	4 d	F,M	8	20.1	15.63	**67.08**	71.45		Nimmo et al. 1989
Orangethroat darter, *Etheostoma spectabile*	Ammonium chloride	4 d	F,M	8.1	22	16.12	**83.74**			Hazel et al. 1979
Orangethroat darter, *Etheostoma spectabile*	Ammonium chloride	4 d	F,M	8.4	21	7.65	**71.12**	77.17	74.25	Hazel et al. 1979
Rio Grande silvery minnow (3-5 d old), *Hybognathus amarus*	Ammonium chloride	4 d	R,M	8	25	16.9	**72.55**	72.55	72.55	Buhl 2002
Spring peeper (embryo), *Pseudacris crucifer*	Ammonium chloride	4 d	F,U	8	12	17.78	**76.33**			Diamond et al. 1993
Spring peeper, *Pseudacris crucifer*	Ammonium chloride	4 d	F,U	8	20	11.42	**49.04**	61.18		Diamond et al. 1993
Pacific tree frog (embryo), *Pseudacris regilla*	Ammonium nitrate	4 d	R,M	6.7	22	41.19	**33.36**			Schuytema and Nebeker 1999a

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Pacific tree frog (embryo), *Pseudacris regilla*	Ammonium chloride	4 d	R,M	6.7	22	60.44	**48.95**			Schuytema and Nebeker 1999a
Pacific tree frog (embryo), *Pseudacris regilla*	Ammonium sulfate	4 d	R,M	6.7	22	103.1	**83.53**			Schuytema and Nebeker 1999a
Pacific tree frog (90 mg, Gosner Stage 26-27), *Pseudacris regilla*	Nitric acid ammonium salt	4 d	R,M	7.3	22	136.6	**188.1**			Schuytema and Nebeker 1999b
Pacific tree frog (60 mg, Gosner Stage 26-27), *Pseudacris regilla*	Ammonium sulfate	4 d	R,M	7.3	22	116.4	**160.2**	83.71	71.56	Schuytema and Nebeker 1999b
Mucket (glochidia), *Actinonaias ligamentina*	Ammonium chloride	1 d	S,M	8.6	20	6.141[c]	**83.61**			Wang et al. 2007b
Mucket (glochidia), *Actinonaias ligamentina*	Ammonium chloride	1 d	S,M	8.4	20	8.099 [c]	**75.29**			Wang et al. 2007b

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Mucket (glochidia), *Actinonaias ligamentina*	Ammonium chloride	1 d	S,M	8.3	20	5.073 [c]	**38.84**			Wang et al. 2007b
Mucket (glochidia), *Actinonaias ligamentina*	Ammonium chloride	1 d	S,M	8.3	20	8.900 [c]	**68.13**	63.89		Wang et al. 2007b
Pheasantshell (juvenile), *Actinonaias pectorosa*	Ammonium chloride	4 d	S,M	7.9	25	14.06	**75.80**			Keller 2000
Pheasantshell (juvenile), *Actinonaias pectorosa*	Ammonium chloride	4 d	S,M	7.95	25	14.08	**83.30**	79.46	71.25	Keller 2000
Giant floater mussel (adult), *Pyganodon grandis*	Ammonium chloride	4 d	S,M	7.71	25	18.84	**72.49**			Scheller 1997
Giant floater mussel (adult), *Pyganodon grandis*	Ammonium chloride	4 d	S,M	7.5	25	25.13	**69.02**	70.73	70.73	Scheller 1997
Shortnose sucker (0.53-2.00 g), *Chasmistes brevirostris*	Ammonium chloride	4 d	F,M	8	20	11.42	**49.04**			Saiki et al. 1999
Shortnose sucker, *Chasmistes brevirostris*	Ammonium chloride	4 d	F,M	8	20	22.85	**98.09**	69.36	69.36	Saiki et al. 1999

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Pagoda hornsnail (adult), *Pleurocera uncialis*	Ammonium chloride	4 d	R,M	8.1	22	11.18	**68.54**	68.54	68.54	Goudreau et al. 1993
Golden shiner, *Notemigonus crysoleucas*	Ammonium chloride	4 d	S,M	7.5	19.6	89.61	162.6			EA Engineering 1985
Golden shiner, *Notemigonus crysoleucas*	Ammonium chloride	4 d	S,M	7.55	19.5	73.85	144.6			EA Engineering 1985
Golden shiner (8.7 g), *Notemigonus crysoleucas*	Ammonium chloride	4 d	F,M	7.5	24.5	34.73	**63.02**	63.02	63.02	Swigert and Spacie 1983
Pebblesnail (1.8 mm), *Fluminicola* sp.	Ammonium chloride	4 d	F,M	8.25	20.2	>8.801	**>62.15**	>62.15	>62.15	Besser 2011

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Lost River sucker (0.49-0.80 g), *Deltistes luxatus*	Ammonium chloride	4 d	F,M	8	20	16.81	**72.18**			Saiki et al. 1999
Lost River sucker (larvae), *Deltistes luxatus*	Ammonium chloride	4 d	F,M	8	20	10.35	**44.42**	56.62	56.62	Saiki et al. 1999
Mountain whitefish (177 g, 27.0 cm), *Prosopium williamsoni*	Ammonium chloride	4 d	F,U	7.68	12.1	11.3	**27.31**			Thurston and Meyn 1984
Mountain whitefish (56.9 g, 19.1 cm), *Prosopium williamsoni*	Ammonium chloride	4 d	F,U	7.84	12.4	25.47	**81.35**			Thurston and Meyn 1984
Mountain whitefish (63.0 g, 20.4 cm), *Prosopium williamsoni*	Ammonium chloride	4 d	F,U	7.8	12.3	21.2	**63.04**	51.93	51.93	Thurston and Meyn 1984
Atlantic pigtoe (glochidia), *Fusconaia masoni*	Ammonium chloride	6 h	S,M	7.6	24.9	15.9	**47.40**	47.40	47.40	Black 2001
Pondshell mussel (juvenile), *Utterbackia imbecillis*	Ammonium chloride	4 d	S,M	7.9	24	8.235	**40.87**			Keller 2000
Pondshell mussel (juvenile), *Utterbackia imbecillis*	Ammonium chloride	4 d	S,M	8.35	25	3.269	**41.75**			Keller 2000

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Pondshell mussel (juvenile), *Utterbackia imbecillis*	Ammonium chloride	4 d	S,M	7.9	25	9.355	**50.45**			Keller 2000
Pondshell mussel (8 d old juvenile), *Utterbackia imbecillis*	Ammonium chloride	4 d	R,M	7.8	24	14.29	**59.19**			Wade et al. 1992
Pondshell mussel (<2 d old juvenile), *Utterbackia imbecillis*	Ammonium chloride	4 d	R,M	8.16	25	5.254	**46.38**			Black 2001
Pondshell mussel (<2 d old juvenile), *Utterbackia imbecillis*	Ammonium chloride	4 d	R,M	8.17	25	5.781	**52.03**			Black 2001

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Pondshell mussel (<2 d old juvenile), *Utterbackia imbecillis*	Ammonium chloride	4 d	R,M	8.29	25	8.845	**100.5**			Black 2001
Pondshell mussel (<2 d old juvenile), *Utterbackia imbecillis*	Ammonium chloride	4 d	R,M	8	25.1	2.734	**17.91**			Black 2001
Pondshell mussel (glochidia), *Utterbackia imbecillis*	Ammonium chloride	1 d	S,M	8.02	25	7.395	**49.90**	46.93	46.93	Black 2001
Pink mucket (2 mo old juvenile), *Lampsilis abrupta*	Ammonium chloride	4 d	R,M	8.3	20	1.921[d]	14.71			Wang et al. 2007b
Pink mucket (2 mo old juvenile), *Lampsilis abrupta*	Ammonium chloride	4 d	F,M	8.4	20	2.8	**26.03**	26.03		Wang et al. 2007a
Plain pocketbook (3-5 d old juvenile), *Lampsilis cardium*	Ammonium chloride	4 d	S,M	8.2	20.5	23.50[e]	154.4			Newton et al. 2003
Plain pocketbook (3-5 d old juvenile), *Lampsilis cardium*	Ammonium chloride	4 d	S,M	8.2	21.2	23.70[e]	165.0			Newton et al. 2003
Plain pocketbook (1-2 d old juvenile), *Lampsilis cardium*	Ammonium chloride	4 d	F,M	7.6	21.2	23.1	**54.07**			Newton and Bartsch 2007

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Plain pocketbook (1-2 d old juvenile), *Lampsilis cardium*	Ammonium chloride	4 d	F,M	7.1	21.2	38.9	**47.19**	50.51		Newton and Bartsch 2007
Wavy-rayed lampmussel (2-5 d old juvenile), *Lampsilis fasciola*	Ammonium chloride	4 d	R,M	7.83	12.6	14.9	**25.31**			Mummert et al. 2003

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Wavy-rayed lampmussel (<5 d old juvenile), *Lampsilis fasciola*	Ammonium chloride	4 d	R,M	8.5	20	6.179[d]	**69.63**			Wang et al. 2007b
Wavy-rayed lampmussel (glochidia), *Lampsilis fasciola*	Ammonium chloride	1 d	S,M	8.3	20	7.743 [c]	**59.28**			Wang et al. 2007b
Wavy-rayed lampmussel (glochidia), *Lampsilis fasciola*	Ammonium chloride	1 d	S,M	8.4	20	5.518 [c]	**51.30**	48.11		Wang et al. 2007b
Higgin's eye (1-2 d old juvenile), *Lampsilis higginsii*	Ammonium chloride	4 d	F,M	7.6	21.2	19.5	**45.64**			Newton and Bartsch 2007
Higgin's eye (1-2 d old juvenile), *Lampsilis higginsii*	Ammonium chloride	4 d	F,M	7.1	21.2	31.7	**38.46**	41.90		Newton and Bartsch 2007
Neosho mucket (<5 d old juvenile), *Lampsilis rafinesqueana*	Ammonium chloride	4 d	R,M	8.3	20	9.185[d]	**70.31**			Wang et al. 2007b
Neosho mucket (<5 d old juvenile), *Lampsilis rafinesqueana*	Ammonium chloride	4 d	R,M	8.4	20	9.269[d]	**86.17**			Wang et al. 2007b
Neosho mucket (glochidia), *Lampsilis rafinesqueana*	Ammonium chloride	1 d	S,M	8.3	20	7.387 [c]	**56.55**	69.97		Wang et al. 2007b
Fatmucket (juvenile), *Lampsilis siliquoidea*	Ammonium chloride	4 d	S,M	8.3	24	1.275	13.60			Myers-Kinzie 1998

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Fatmucket (3 mo old juvenile), *Lampsilis siliquoidea*	Ammonium chloride, ammonium hydroxide	4 d	F,M	8.35	20	8.80	**74.25**			Miao et al. 2010
Fatmucket (2 mo old juvenile), *Lampsilis siliquoidea*	Ammonium chloride	4 d	R,M	8.1	20	4.092[d]	21.26			Wang et al. 2007b

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Fatmucket (2 mo old juvenile), *Lampsilis siliquoidea*	Ammonium chloride	4 d	F,M	8.2	20	4.6	**28.99**			Wang et al. 2007a
Fatmucket (7 d old juvenile), *Lampsilis siliquoidea*	Ammonium chloride, ammonium hydroxide	4 d	F,M	7.6	20.5	11	**24.30**			Wang et al. 2008
Fatmucket (7 d old juvenile), *Lampsilis siliquoidea*	Ammonium chloride, ammonium hydroxide	4 d	F,M	8.1	20.6	5.2	**28.39**			Wang et al. 2008
Fatmucket (7 d old juvenile), *Lampsilis siliquoidea*	Ammonium chloride, ammonium hydroxide	4 d	F,M	8.5	20.6	3.4	**40.27**			Wang et al. 2008
Fatmucket (7 d old juvenile), *Lampsilis siliquoidea*	Ammonium chloride, ammonium hydroxide	4 d	F,M	9	20.6	0.96	**27.51**			Wang et al. 2008
Fatmucket (7 d old juvenile), *Lampsilis siliquoidea*	Ammonium chloride, ammonium hydroxide	4 d	F,M	6.6	19.6	88	**65.59**			Wang et al. 2008
Fatmucket (7 d old juvenile), *Lampsilis siliquoidea*	Ammonium chloride, ammonium hydroxide	4 d	F,M	8.1	19.4	11	**54.37**			Wang et al. 2008
Fatmucket (<5 d old juvenile), *Lampsilis siliquoidea*	Ammonium chloride	4 d	R,M	8.5	20	8.350[d]	94.09			Wang et al. 2007b
Fatmucket (glochidia), *Lampsilis siliquoidea*	Ammonium chloride	1 d	S,M	8.4	20	9.790 [c]	**91.01**			Wang et al. 2007b

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Fatmucket (glochidia), *Lampsilis siliquoidea*	Ammonium chloride	1 d	S,M	8.2	20	13.35 [c]	**84.14**			Wang et al. 2007b
Fatmucket (glochidia), *Lampsilis siliquoidea*	Ammonium chloride	1 d	S,M	8.4	20	11.57 [c]	**107.6**			Wang et al. 2007b

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Fatmucket (glochidia), *Lampsilis siliquoidea*	Ammonium chloride	1 d	S,M	8.5	20	>14.24 [c]	**160.5**			Wang et al. 2007b
Fatmucket (glochidia), *Lampsilis siliquoidea*	Ammonium chloride	1 d	S,M	8.3	20	6.497 [c]	**49.74**			Wang et al. 2007b
Fatmucket (glochidia), *Lampsilis siliquoidea*	Ammonium chloride	1 d	S,M	8.3	20	8.772 [c]	**66.77**	55.42	46.63	Wang et al. 2007b
Rainbow mussel (2 mo old juvenile), *Villosa iris*	Ammonium chloride	4 d	R,M	8.4	20	2.505[d]	**23.29**			Wang et al. 2007b
Rainbow mussel (2 mo old juvenile), *Villosa iris*	Ammonium chloride	4 d	R,M	8.3	20	8.935[d]	**68.40**			Wang et al. 2007b
Rainbow mussel (5 d old juvenile), *Villosa iris*	Ammonium chloride	4 d	S,M	8.18	25	7.81	**71.66**			Scheller 1997
Rainbow mussel (<5 d old juvenile), *Villosa iris*	Ammonium chloride	4 d	R,M	8.1	20	5.261[d]	**27.33**			Wang et al. 2007b
Rainbow mussel (2-5 d old juvenile), *Villosa iris*	Ammonium chloride	4 d	R,M	7.29	12.6	20.6	**15.17**			Mummert et al. 2003
Rainbow mussel (<3 d old juvenile), *Villosa iris*	Ammonium chloride	4 d	S,M	8.18	25	7.07	**64.87**			Scheller 1997
Rainbow mussel (< 24 h old glochidia), *Villosa iris*	Ammonium chloride	1 d	S,M	7.94	20.0	3.290	**12.62**			Scheller 1997
Rainbow mussel (glochidia), *Villosa iris*	Ammonium chloride	1 d	S,M	8.4	20	10.68 [c]	**99.28**			Wang et al. 2007b

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals										
Species	**Chemical Name**	**Duration**	**Methods[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Total Ammonia[b] (mg TAN/L) adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*)**	**SMAV (mg TAN/L)**	**GMAV (mg TAN/L)**	**Reference**
Rainbow mussel (<1 h old glochidia), *Villosa iris*	Ammonium chloride	1 d	R,M	8.1	22	3.570	**21.89**			Goudreau et al. 1993

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Rainbow mussel (<1 h old glochidia), *Villosa iris*	Ammonium chloride	1 d	R,M	8.1	22	4.278	**26.23**	34.23	34.23	Goudreau et al. 1993
Oyster mussel (<5 d old juvenile), *Epioblasma capsaeformis*	Ammonium chloride	4 d	R,M	8.5	20	4.760[d]	**53.63**			Wang et al. 2007b
Oyster mussel (glochidia), *Epioblasma capsaeformis*	Ammonium chloride	6 h	R,M	8.5	20	5.0 [c]	**17.81**			Wang et al. 2007b
Oyster mussel (glochidia), *Epioblasma capsaeformis*	Ammonium chloride	6 h	R,M	8.5	20	3.4 [c]	**31.61**	31.14	31.14	Wang et al. 2007b
Green floater (<2 d old juvenile), *Lasmigona subviridis*	Ammonium chloride	4 d	R,M	7.73	24	6.613	**24.24**			Black 2001
Green floater (<2 d old juvenile), *Lasmigona subviridis*	Ammonium chloride	4 d	R,M	7.73	24	6.613	**24.24**			Black 2001
Green floater (<2 d old juvenile), *Lasmigona subviridis*	Ammonium chloride	4 d	R,M	7.92	24.8	3.969	**21.84**	23.41	23.41	Black 2001
Ellipse (glochidia), *Venustaconcha ellipsiformis*	Ammonium chloride	1 d	S,M	8.1	20	4.550 [c]	**23.12**	23.12	23.12	Wang et al. 2007b

[a] S = static, R = renewal, F = flow-through, and NR= not reported (uncertain) exposure types; M = measured and U = unmeasured tests.

[b] Acute values are normalized to pH 7 (all organisms) and temperature 20°C (invertebrates) as per the equations provided in this document (see also 1999 AWQC document for the basis of the pH- and temperature-dependence of ammonia toxicity and Appendix D for an example calculation).

[c] The EC_{50}s reported in this study were based on nominal concentrations. Percent nominal concentrations of measured ammonia concentrations on exposure days 0 and 2 declined from 104 to 44. EC_{50}s based on measured concentrations were estimated from the reported EC_{50}s based on nominal concentrations by multiplying by 0.890 for the 24 hr test; this factor is the average of the percent nominal concentrations of measured concentrations from ammonia measurements made on exposure day 0 (i.e., 104) and estimated for day 1 (i.e, 74) of the study.

[d] The EC_{50}s reported in this study were based on nominal concentrations. Percent nominal concentrations of measured ammonia concentrations on exposure days 0 and 4 declined from 104 to 63. EC_{50}s based on measured concentrations were estimated from the reported EC_{50}s based on nominal concentrations by multiplying by 0.835 or the average of the percent nominal concentrations of measured concentrations from ammonia measurements made on exposure days 0 and 4 in the study.

[e] EC_{50} values based on sediment porewater concentrations. **Note**: these EC_{50}s were not used to calculate the SMAV for the species.

[f] This small subset of LC_{50}s for adult rainbow trout from Thurston and Russo (1983) was used as the basis for the FAV calculated in the 1999 AWQC document. The FAV in the 1999 AWQC document of 11.23 mg TAN/L at pH 8 was lowered to the geometric mean of these five LC_{50} values at the time in order to protect large rainbow trout, which were shown to be measurably more sensitive than other life stages. The FAV prior to adjusting it to protect the commercially and recreationally important adult rainbow trout was calculated to be 14.32 mg

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

TAN/L (CMC = 7.2 mg TAN/L) at pH 8. This FAV based on protection of adult rainbow trout at pH 7 is 48.21 mg TAN/L (see Table 7 in this document). Because several equivalent LC_{50}s representing different ages and life-stages have been added to the current (updated) acute criteria dataset, it no longer seems appropriate to lower the SMAV for rainbow trout based on only these five LC_{50}s considering the several other additional acute values which now exist.

Note: Each SMAV was calculated from the associated bold-face number(s) in the preceding column.

Appendix B. Chronic Toxicity of Ammonia to Aquatic Animals.

Appendix B. Chronic Toxicity of Ammonia to Aquatic Animals

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Species	Test and Effect	pH	Temp. (˚C)	Total Ammonia (mg TAN/L)	Chronic value[a] Adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*) (mg TAN/L)	SMCV (mg TAN/L)	GMCV (mg TAN/L)	Reference
Stonefly, *Pteronarcella badia*	30-d Juv Survival	8.04	12.1	133.8	**207.0**			Thurston et al. 1984b
Stonefly, *Pteronarcella badia*	24-d Juv Survival	7.81	13.2	21.66	**26.27**	73.74	73.74	Thurston et al. 1984b
Water flea, *Ceriodaphnia acanthina*	7-d LC Reproduction	7.15	24.5	44.90	**64.10**	64.10		Mount 1982
Water flea, *Ceriodaphnia dubia*	7-d LC Reproduction	7.80	25.0	15.20	**38.96**			Nimmo et al. 1989
Water flea, *Ceriodaphnia dubia*	7-d LC Reproduction	8.57	26.0	5.800	**52.15**	45.08	53.75	Willingham 1987
Water flea, *Daphnia magna*	21-d LC Reproduction	8.45	19.8	7.370	**36.27**			Gersich et al. 1985
Water flea, *Daphnia magna*	21-d LC Reproduction	7.92	20.1	21.70	**47.40**	41.46	41.46	Reinbold and Pescitelli 1982a
Amphipod, *Hyalella azteca*	28-d PLC Biomass	8.04	25.0	8.207	**29.17**	29.17	29.17	Borgmann 1994
Channel catfish, *Ictalurus punctatus*	30-d ELS Weight	7.80	25.8	12.20	**22.66**			Reinbold and Pescitelli 1982a
Channel catfish, *Ictalurus punctatus*	30-d Juv Survival	8.35	27.9	5.020	**21.15**			Colt and Tchobanoglous 1978
Channel catfish, *Ictalurus punctatus*	30-d ELS Biomass	7.76	26.9	11.50	**20.35**	21.36	21.36	Swigert and Spacie 1983
Northern pike (fertilized), *Esox lucius*	52-d ELS Biomass	7.62	8.70	13.44	**20.38**	20.38	20.38	Harrahy et al. 2004
Common carp (fertilized), *Cyprinus carpio*	28-d ELS Weight	7.85	23.0	8.360	**16.53**	16.53	16.53	Mallet and Sims 1994

Appendix B. Chronic Toxicity of Ammonia to Aquatic Animals

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Species	Test and Effect	pH	Temp. (˚C)	Total Ammonia (mg TAN/L)	Chronic value[a] Adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*) (mg TAN/L)	SMCV (mg TAN/L)	GMCV (mg TAN/L)	Reference
Lahontan cutthroat trout (fertilized), *Oncorhynchus clarkii henshawi*	103-d ELS Survival	7.57	13.7	17.89	**25.83**	25.83		Koch et al. 1980
Rainbow trout (fertilized), *Oncorhynchus mykiss*	42-d ELS Survival	7.50	10.0	<33.6	**<45.5**			Burkhalter and Kaya 1977
Rainbow trout, *Oncorhynchus mykiss*	72-d ELS Survival	7.40	14.5	2.600	**3.246**			Calamari et al. 1977, 1981
Rainbow trout (fertilized), *Oncorhynchus mykiss*	73-d ELS Survival	7.52	14.9	<2.55	**<3.515**			Solbe and Shurben 1989
Rainbow trout, *Oncorhynchus mykiss*	5-year LC	7.70	7.5-10.5	>6.71	**>11.08**			Thurston et al. 1984a
Rainbow trout, *Oncorhynchus mykiss*	90-d ELS Survival	7.75	11.4	8.919	**15.60**	6.663		Brinkman et al. 2009
Sockeye salmon, *Oncorhynchus nerka*	62-d Embryos Hatchability	8.42	10.0	<2.13	**<10.09**	10.09	12.02	Rankin 1979
White sucker (3 d old embryo), *Catostomus commersonii*	30-d ELS Biomass	8.32	18.6	2.900	**>11.62**	11.62	11.62	Reinbold and Pescitelli 1982a
Smallmouth bass, *Micropterus dolomieu*	32-d ELS Biomass	6.60	22.3	9.610	**8.650**			Broderius et al. 1985
Smallmouth bass, *Micropterus dolomieu*	32-d ELS Biomass	7.25	22.3	8.620	**9.726**			Broderius et al. 1985
Smallmouth bass, *Micropterus dolomieu*	32-d ELS Biomass	7.83	22.3	8.180	**15.77**			Broderius et al. 1985
Smallmouth bass, *Micropterus dolomieu*	32-d ELS Biomass	8.68	22.3	1.540	**11.31**	11.07	11.07	Broderius et al. 1985
Fathead minnow (embryo-larvae), *Pimephales promelas*	28-d ELS Survival	8.00	24.8	5.120	**12.43**			Mayes et al. 1986
Fathead minnow (embryo-larvae), *Pimephales promelas*	32-d ELS Biomass	7.95	25.5	7.457	**16.87**			Adelman et al. 2009
Fathead minnow, *Pimephales promelas*	30-d ELS Biomass	7.82	25.1	3.730	**7.101**			Swigert and Spacie 1983

Appendix B. Chronic Toxicity of Ammonia to Aquatic Animals

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Species	Test and Effect	pH	Temp. (˚C)	Total Ammonia (mg TAN/L)	Chronic value[a] Adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*) (mg TAN/L)	SMCV (mg TAN/L)	GMCV (mg TAN/L)	Reference
Fathead minnow, *Pimephales promelas*	LC Hatchability	8.00	24.2	1.970	**4.784**	9.187	9.187	Thurston et al. 1986
Pebblesnail (1.81 mm, juvenile), *Fluminicola* sp.	28-d Juv Change in Length	8.22	20.1	2.281	**7.828**	7.828	7.828	Besser 2011
Long fingernailclam, *Musculium transversum*	42-d Juv Survival	8.15	23.5	5.820	**22.21**			Anderson et al. 1978
Long fingernailclam, *Musculium transversum*	42-d Juv Survival	7.80	21.8	1.230	**2.565**	7.547	7.547	Sparks and Sandusky 1981
Green sunfish, *Lepomis cyanellus*	30-d ELS Biomass	7.90	22.0	5.610	**11.85**			McCormick et al. 1984
Green sunfish, *Lepomis cyanellus*	30-d ELS Survival	8.16	25.4	5.840	**18.06**	14.63		Reinbold and Pescitelli 1982a
Bluegill, *Lepomis macrochirus*	30-d ELS Biomass	7.76	22.5	1.850	**3.273**	3.273	6.920	Smith et al. 1984
Rainbow mussel (2 mo old juvenile), *Villosa iris*	28-d Juv Survival	8.20	20.0	1.063	**3.501**	3.501	3.501	Wang et al. 2007a
Fatmucket (2 mo old juvenile), *Lampsilis siliquoidea*	28-d Juv Survival	8.25	20.0	0.8988	**3.211**	3.211		Wang et al. 20011
Wavy-rayed lamp mussel (2 mo old juvenile), *Lampsilis fasciola*	28-d Juv Survival	8.20	20.0	0.4272	**1.408**	1.408	2.126	Wang et al. 2007a

[a] The chronic value is an EC_{20} value calculated using EPA's TRAP (Versions 1.0 or 1.21a). Note: all chronic values were normalized to pH 7 (all organisms) and 20°C (invertebrates) as per the equations provided in this document (see also 1999 AWQC document for the basis of the pH- and temperature-dependence of ammonia toxicity and Appendix E for an example calculation).

Note: Each SMCV was calculated from the associated bold-face number(s) in the preceding column.

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Appendix C. Other Chronic Ammonia Toxicity Data.

Appendix C. Other Chronic Ammonia Toxicity Data							
Species	**Test and Effect**	**Method[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Chronic value Adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*) (mg TAN/L)**	**Reference**
FRESHWATER INVERTEBRATES							
Pulmonate pondsnail (<1 wk post hatch), *Lymnaea stagnalis*	28-d NOEC - Growth	F,M	8.25	20.1	>8.00	>28.76	Besser et al. 2009
Pulmonate pondsnail (<1 wk post-hatch), *Lymnaea stagnalis*	28-d NOEC - Survival	F,M	8.25	20.1	>8.00	>28.76	Besser et al. 2009
Idaho springsnail (7-9 and 11-13 wk post hatch juvenile), *Pyrgulopsis idahoensis*	28-d NOEC - Growth	F,M	8.25	20.1	>8.00	>28.76	Besser et al. 2009
Idaho springsnail (7-9 and 11-13 wk post hatch juvenile), *Pyrgulopsis idahoensis*	28-d EC_{20} - Survival	F,M	8.25	20.1	0.480	1.726	Besser et al. 2009
Idaho springsnail (mixed-aged, adults), *Pyrgulopsis idahoensis*	28-d EC_{20} - Survival	F,M	8.26	20.8	3.24	12.39[b]	Besser et al. 2009
Pebblesnail (mixed-aged, field collected), *Fluminicola* sp.	28-d EC_{20} - Survival	F,M	8.26	20.8	1.02	3.900[c]	Besser et al. 2009
Pebblesnail (small, field collected), *Fluminicola* sp.	28-d MATC - Survival	F,M	8.19	20.1	2.75	8.977[d]	Besser 2011
Ozark springsnail (mixed age, field collected), *Fontigens aldrichi*	28-d EC_{20} - Survival	F,M	8.26	20.8	0.61	2.332[b]	Besser et al. 2009
Bliss Rapids snail (mixed age, field collected), *Taylorconcha serpenticola*	28-d EC_{20} - Survival	F,M	8.26	20.8	3.42	13.08[b]	Besser et al. 2009

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Appendix C. Other Chronic Ammonia Toxicity Data							
Species	**Test and Effect**	**Method[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Chronic value Adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*) (mg TAN/L)**	**Reference**
Silty hornsnail (mixed age, mature and field collected), *Pleurocera canaliculata*	28-d EC_{20} - Survival; (Alt Effect Conc.)	F,M	8.15	24.7	0.45 (≤1.86)	1.845 (≤7.667)[b, e]	GLEC 2011
Wavy-rayed lamp mussel (2 mo old juvenile), *Lampsilis fasciola*	28-d IC_{25} - Growth	F,M	8.20	20.0	0.5700	1.878	Wang et al. 2007a
Fatmucket (2 mo old juvenile), *Lampsilis siliquoidea*	28-d IC_{25} - Growth	F,M	8.20	20.0	0.4400	1.450	Wang et al. 2007a
Rainbow mussel (2 mo old juvenile), *Villosa iris*	28-d IC_{25} - Growth	F,M	8.20	20.0	0.7300	2.406	Wang et al. 2007a
Water flea, (<24 hr), *Ceriodaphnia dubia*	7-d; 3 broods in control IC_{25} Reproduction	R,U	7.90	25.0	1.300	3.790	Dwyer et al. 2005
FRESHWATER VERTEBRATES							
Cutthroat trout (3.3 g), *Oncorhynchus clarkii*	29-d LC_{50}	F,M	7.80	12.4	21.60	40.11	Thurston et al. 1978
Cutthroat trout (3.4 g), *Oncorhynchus clarkii*	29-d LC_{50}	F,M	7.78	12.2	21.40	38.78	Thurston et al. 1978
Cutthroat trout (1.0 g), *Oncorhynchus clarkii*	36-d LC_{50}	F,M	7.81	13.1	30.80	57.91	Thurston et al. 1978
Cutthroat trout (1.0 g), *Oncorhynchus clarkii*	36-d LC_{50}	F,M	7.80	12.8	32.20	59.79	Thurston et al. 1978
Atlantic salmon, *Salmo salar*	105-d Juv NOEC - Survival	F,M	6.84	12.1	>32.29	>30.64	Kolarevic et al. 2012
Lake trout, siscowet, *Salvelinus namaycush*	60-d LOEC- Weight gain	F,M	8.02	11.6	6.440	16.10	Beamish and Tandler 1990
Brook trout (juvenile), *Salvelinus fontinalis*	4-d Juv LOEC - Swimming Perf	F,M	9.10	15.0	0.7765	10.86	Tudorache et al. 2010
Bonytail chub (2 and 7 d post hatch), *Gila elegans*	7-d IC_{25} - Growth	R,U	7.90	25.0	11.00	23.24	Dwyer et al. 2005

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

Appendix C. Other Chronic Ammonia Toxicity Data							
Species	**Test and Effect**	**Method[a]**	**pH**	**Temp. (˚C)**	**Total Ammonia (mg TAN/L)**	**Chronic value Adjusted to pH 7 (all *organisms*) and 20°C (*invertebrates*) (mg TAN/L)**	**Reference**
Spotfin chub (<24 hr), *Erimonax monachus*	7-d IC_{25} - Growth	R,U	7.90	25.0	15.80	33.37	Dwyer et al. 2005
Cape Fear shiner (<24 hr), *Notropis mekistocholas*	7-d IC_{25} - Growth	R,U	7.90	25.0	8.800	18.59	Dwyer et al. 2005
Topeka shiner (adult), *Notropis topeka*	30-d EC_{20} - Survival	F,M	7.94	23.9	10.85	24.21	Adelman et al. 2009
Topeka shiner (juvenile, 11 mo), *Notropis topeka*	30-d EC_{20} - SGR	F,M	8.07	12.4	6.483	17.45	Adelman et al. 2009
Gila topminnow (<24, 48 and 72 hr), *Poeciliopsis occidentalis*	7-d IC_{25} - Growth	R,U	7.90	25.0	24.10	50.91	Dwyer et al. 2005
Fathead minnow (<24 hr), *Pimephales promelas*	7-d IC_{25} - Growth	R,U	7.90	25.0	7.200	15.21	Dwyer et al. 2005
Fathead minnow (4 d post hatch), *Pimephales promelas*	28-d LOEC-Survival	R,M	8.25	19.9	9.160	32.71	Fairchild et al. 2005
Colorado pikeminnow (5 and 6-d post hatch), *Ptychocheilus lucius*	7-d IC_{25} - Growth	R,U	7.90	25.0	8.900	18.80	Dwyer et al. 2005
Colorado pikeminnow (juvenile, 8 d), *Ptychocheilus lucius*	28-d LOEC- Growth	R,M	8.23	19.9	8.600	29.75	Fairchild et al. 2005
Razorback sucker (7 d post hatch), *Xyrauchen texanus*	7-d IC_{25} - Growth	R,U	7.90	25.0	13.40	28.30	Dwyer et al. 2005
Razorback sucker (9 d), *Xyrauchen texanus*	28-d LOEC-Survival	R,M	8.24	19.9	13.25	46.58	Fairchild et al. 2005
Lost River sucker (late-stage larva), *Deltistes luxatus*	30-d LOEC-Survival	F,M	9.43	22.3	1.230	25.31	Meyer and Hansen 2002
Green frog (Stage 24-26), *Rana clamitans*	103-d NOEC-Growth	R,M	8.70	24.0	>2.20	>16.74	Jofre and Karasov 1999

[a] R = renewal and F = flow-through exposure types; M = measured and U = unmeasured tests.

[b] Not used in the calculation of the SMCV because of the uncertainty of the chronic value, but included here as weight of evidence supporting the sensitivity of non-pulmonate snail species in general as determined by 28-day toxicity tests (see Additional 28-day Toxicity test Data for Freshwater Snails in Appendix I for more

Appendix A. Acute Toxicity of Ammonia to Aquatic Animals.

detail).

[c] Not used in the calculation of the SMCV because of the uncertainty of the chronic value, but included here as weight of evidence supporting the sensitivity of non-pulmonate snail species in general as determined by 28-day toxicity tests (see Chronic Toxicity Test Data: 28-day Tests with Juvenile and Adult Pebblesnails in Appendix H for more detail).