

Aquatic Life Ambient Water Quality Criteria for Ammonia –Freshwater Final 2013

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Webinar

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Overview

- EPA published final revised national recommended Clean Water Act 304(a) aquatic life water quality criteria for ammonia in fresh water in the Federal Register on August 22, 2013
 - The revised criteria include new toxicity data reflecting freshwater unionid mussel and non-pulmonate (gill-bearing) snail sensitivity
- Provide overview of the final revised criteria and how they differ from the 1999 final recommended criteria and the 2009 draft criteria
- Brief summary of supporting documents available for assisting States, Tribes, Territories considering adoption of the revised ammonia criteria



Ambient Water Quality Criteria & Water Quality Standards

- EPA publishes national recommended Ambient Water Quality Criteria (AWQC) for protection of human health and aquatic life
- States, Tribes, and Territories can set their water quality standards (WQS) based on the national AWQC or they can instead adopt other scientifically defensible WQS that differ from these recommendations
- EPA reviews changes or additions to state-adopted WQS
- Discharge permit limits are derived from the WQS for the state, not directly from the AWQC



History of Ammonia Criteria

- Criteria for ammonia in fresh water originally published in 1976; updated in 1985
- 1999 Update of the freshwater criteria included:
 - Consideration of pH and temperature effects and fish life stage on the criteria
 - Changed to a 30-day averaging period for the chronic criterion
 - 4-day averaging period was used in 1985 and is typical for most aquatic life criteria
 - Expressed criteria as total ammonia nitrogen (mg TAN/L)
 - 1985 criteria were expressed as unionized ammonia
- Draft updated criteria proposed in 2009
 - Reflected freshwater mussel sensitivity to ammonia
 - Bifurcated criteria for waters with mussels present or absent
 - New toxicity data (USGS 2009) for freshwater snails indicated that gill-bearing snails are sensitive to ammonia was discussed



2013 Final Ammonia Aquatic Life Criteria

- Reflect the latest scientific information on freshwater mussel and snail sensitivity to ammonia
 - Updated literature review through October 2012
- One set of criteria applicable to all fresh water to protect the aquatic community as a whole, including sensitive mollusks which are present in nearly all fresh waters of the contiguous U.S.
 - Site-specific criteria recalculations are permitted for sites where mussels are absent, as appropriate
 - Recalculated site-specific values (e.g., for sites with mussels absent) are provided in Appendix N of the 2013 ammonia criteria document
- Several supporting documents developed to aid states considering adoption of the updated criteria



Sources of Ammonia in Fresh Water

- In agriculture, ammonia is used both directly and as a precursor for other nitrogen-based fertilizers
- Numerous industrial applications including metal finishing, pharmaceuticals, processing of crude oil, corrosion protection
- Ammonia can enter the aquatic environment via anthropogenic sources or discharges (e.g., municipal effluent, agricultural runoff), and via natural sources such as decomposition of organic waste matter, the discharge of ammonia by biota, and nitrogen fixation processes
- Ammonia is converted relatively quickly to other forms of nitrogen in oxygenated waters

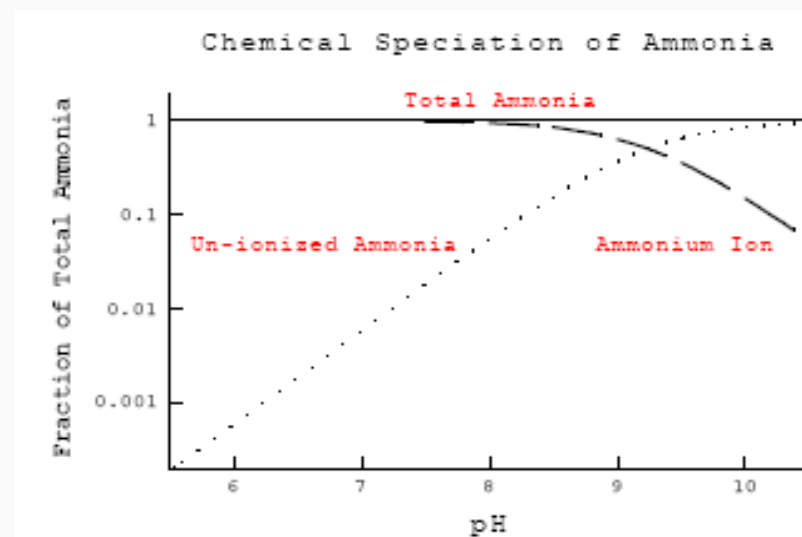


Ammonia Chemistry

- Ammonia primarily exists in two forms in aqueous solution: unionized ammonia (NH_3) and ammonium ion (NH_4^+)
 - Ammonium is more abundant at circumneutral pH and lower
- The instantaneous equilibrium reaction for ammonia is represented by following equation:



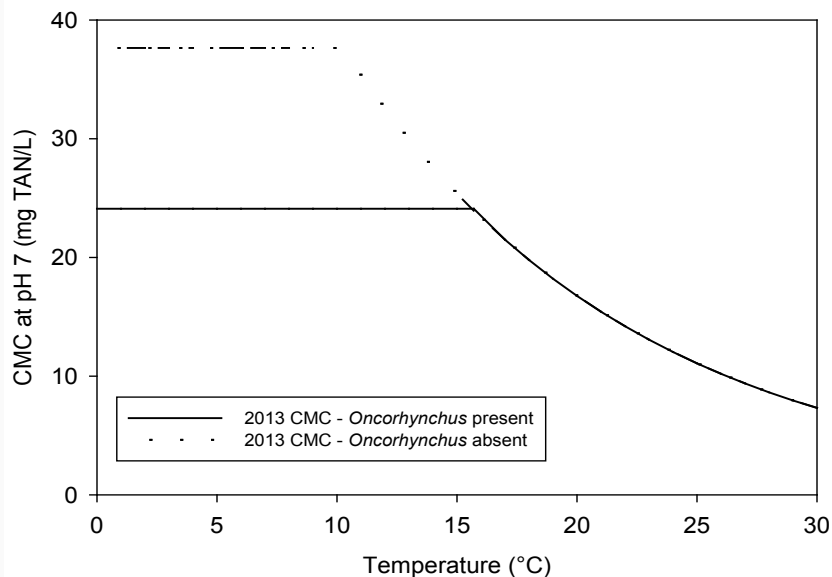
- As pH increases, the ratio of NH_3 to NH_4^+ increases
 - Chemical speciation plays the largest role in these effects because unionized ammonia (NH_3) is more toxic than ammonium ion



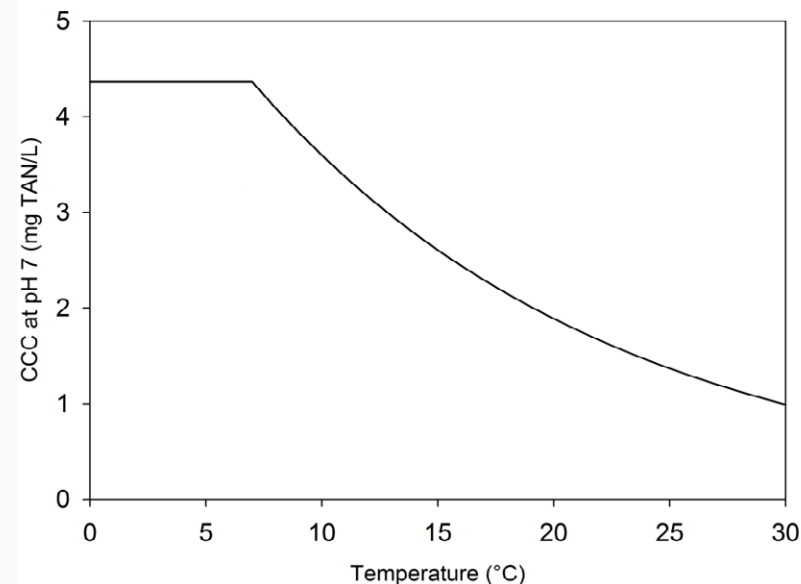


Ammonia Toxicity

- Ammonia toxicity is affected by pH and temperature
 - As pH increases, organisms are more sensitive to ammonia
 - As temperature increases, invertebrates are more sensitive to ammonia
 - Consequently the criteria (expressed as total ammonia nitrogen or TAN) vary as a function of pH and temperature based on an equation

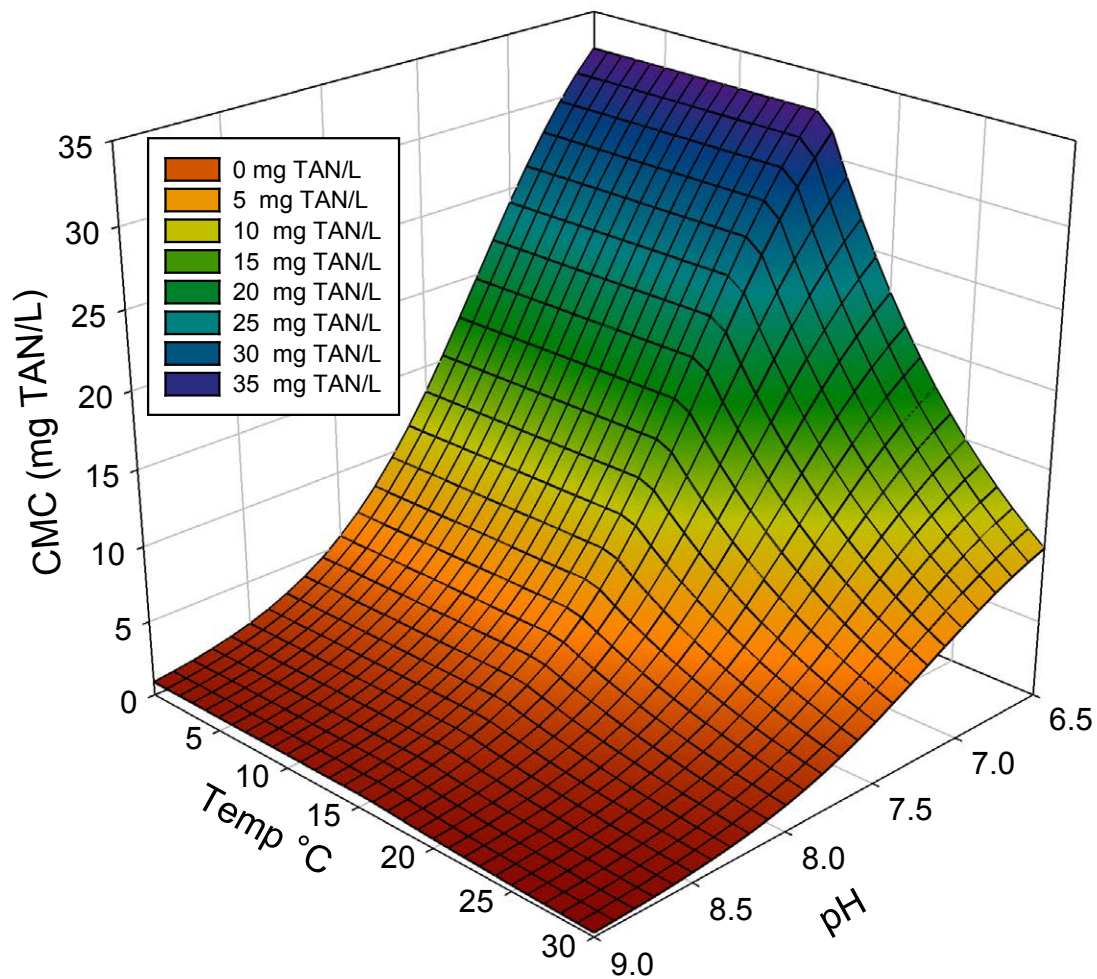


Acute criteria across temperature gradient (pH 7)



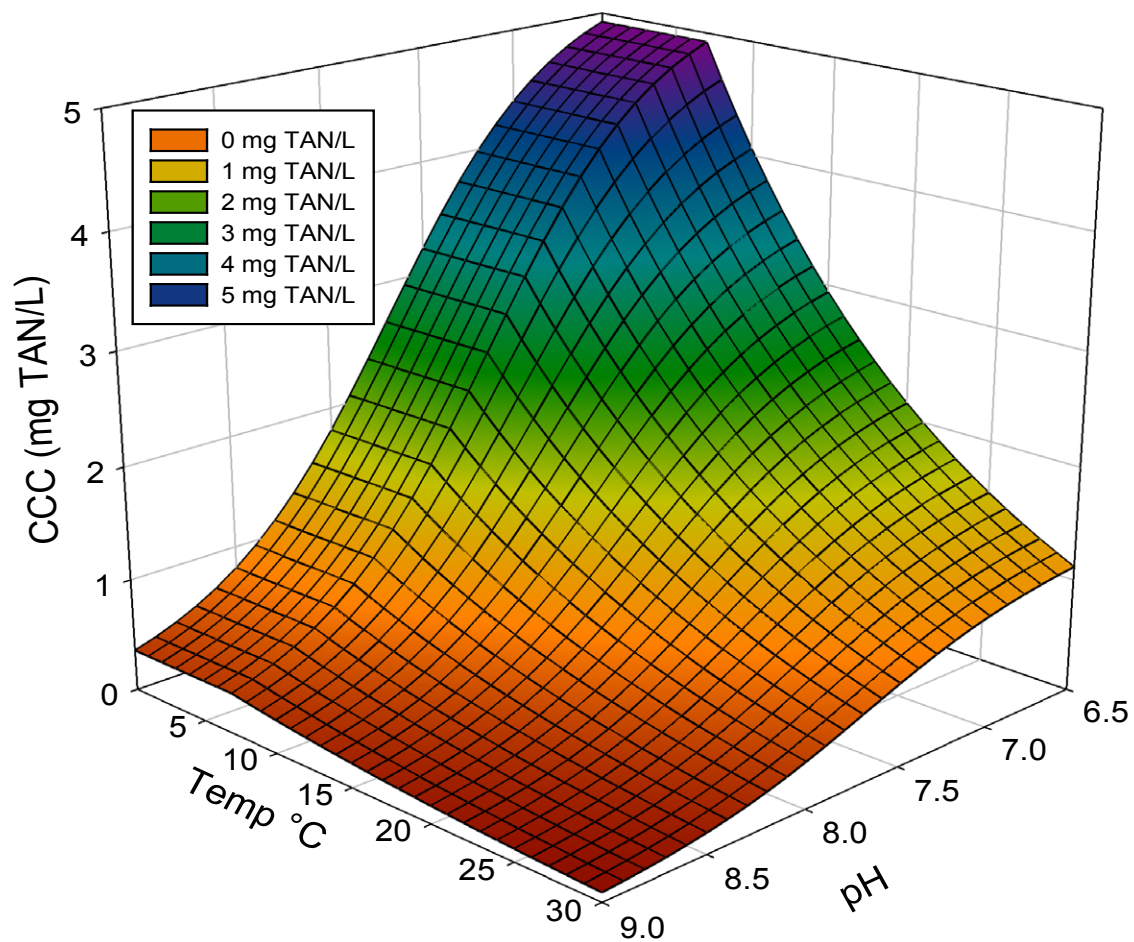
Chronic criteria across temperature gradient (pH 7)

2013 Ammonia CMC - Mussels and Oncorhynchus Present





2013 Ammonia CCC - Mussels Present and ELS Protection Necessary





Comparison 1999 to 2013 Ammonia ALC

- 1999 Criteria
 - Acute = 24 mg N/L at pH 7 (Salmonids most sensitive)
 - Chronic = 4.5 mg N/L at pH 7 and 20 ° C (Hyalella and fingernail clam most sensitive)

 - Also 1999 chronic criteria reflected the greater sensitivity of fish early life stages (ELS) than juvenile and adult stages to chronic toxicity of ammonia with site-specific criteria for waters with fish ELS present and absent

- 2013 Ammonia ALC reflects the sensitivity of freshwater mussels and non-pulmonate snails
 - Acute = 17 mg N/L at pH 7 and 20 ° C (Mussels most sensitive)
 - Chronic = 1.9 mg N/L at pH 7 and 20 ° C (Mussels most sensitive)

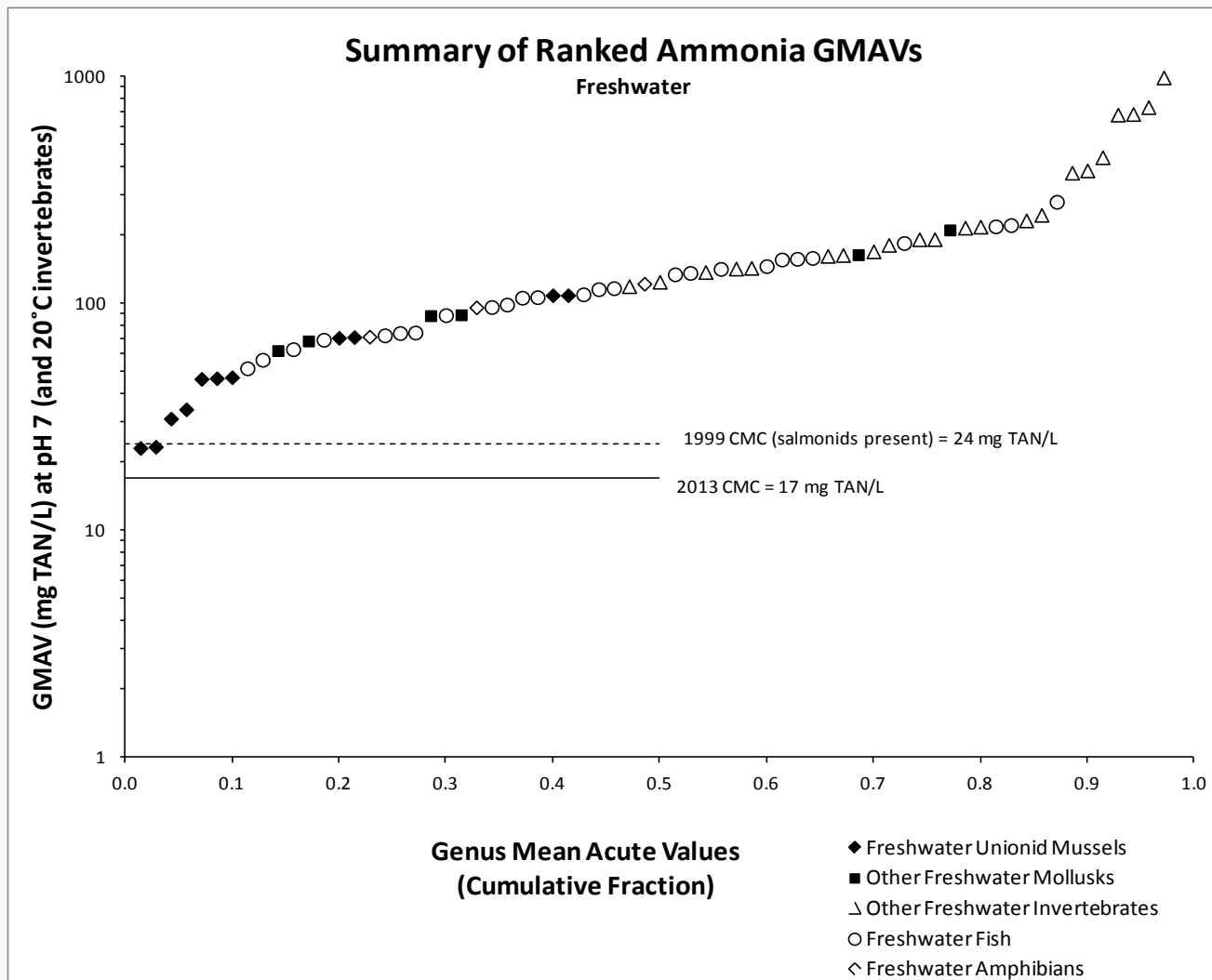


Duration and Frequency

- Duration for acute criterion is 1-hour average
- Duration for chronic ammonia criterion is a 30-day averaging period
- In addition, chronic concentration is not to exceed 2.5 times the CCC as a 4-day average within 30 days (e.g., 4.8 mg TAN/L at pH 7 and temperature 20 °C) more than once in 3 years on average
- Frequency for both acute and chronic criteria is not to be exceeded more than once in 3 years on average
 - Duration and frequency for 2013 ammonia criteria are the same as in 1999 and draft 2009 criteria



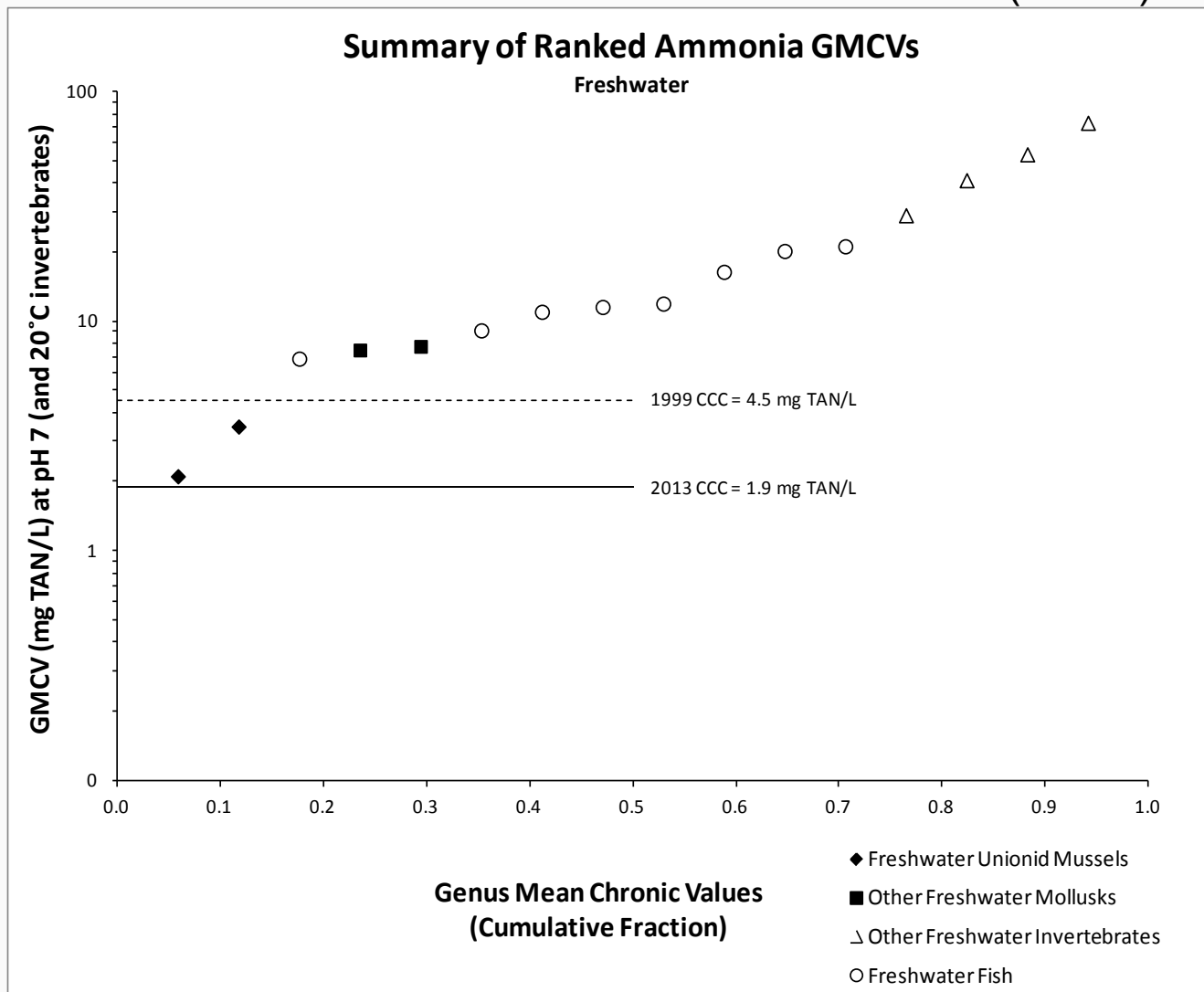
Ranked Freshwater Genus Mean Acute Values (GMAVs) with Criterion Maximum Concentrations (CMCs)



- 120 acute studies
- 69 Genera representing
 - 52 invertebrate sp.
 - 44 fish sp.
 - 4 amphibian sp.



Ranked Freshwater Genus Mean Chronic Values (GMCVs) with Criterion Continuous Concentrations (CCCs)



■ 28 chronic studies

■ 16 Genera representing
• 10 invertebrate sp.
• 11 fish sp.



Comparison of the Four Taxa Used to Calculate and Chronic Criteria in the 1999 Update, 2009 Draft and 2013 AWQC

1999 Update CCC Magnitude			2009 Draft Update CCC Magnitude			2013 Final CCC Magnitude	
Species	pH 8.0, T=25°C (mg TAN/L)	pH 7.0, T=20°C (mg TAN/L)	Species	pH 8.0, T=25°C (mg TAN/L)	pH 7.0, T=20°C (mg TAN/L)	Species	pH 7.0, T=20°C (mg TAN/L)
Fathead minnow, <i>Pimephales promelas</i>	3.09	7.503	Long fingernailclam, <i>Musculium transversum</i>	<2.260	7.552	Long fingernailclam, <i>Musculium transversum</i>	7.547
<i>Lepomis</i> sp. (Centrarchidae), includes: Bluegill sunfish, <i>L. macrochirus</i> , and Green sunfish, <i>L. Cyanellus</i>	2.85	6.92	<i>Lepomis</i> sp. (Centrarchidae), includes: Bluegill sunfish, <i>L. macrochirus</i> , and Green sunfish, <i>L. cyanellus</i>	2.852	6.924	<i>Lepomis</i> sp. (Centrarchidae), includes: Bluegill sunfish, <i>L. macrochirus</i> , and Green sunfish, <i>L. cyanellus</i>	6.92
Long fingernailclam, <i>Musculium transversum</i>	<2.26	7.547	Rainbow mussel, <i>Villosa iris</i>	<0.9805	3.286	Rainbow mussel, <i>Villosa iris</i>	3.501
Amphipod, <i>Hyalella azteca</i>	<1.45	4.865	<i>Lampsilis</i> sp. (Unionidae), includes: Wavy-rayed lamp mussel, <i>L. fasciola</i> and Fatmucket, <i>L. siliquoidea</i>	<0.3443	1.154	<i>Lampsilis</i> sp. (Unionidae), includes: Wavy-rayed lamp mussel, <i>L. fasciola</i> and Fatmucket, <i>L. siliquoidea</i>	2.216
CCC	1.2	4.5	CCC	0.26	0.91	CCC	1.9



Criterion Duration	1999 AWQC Update Criteria Magnitude		2009 Draft AWQC Update Criteria ^c Magnitude		2013 AWQC Update Criteria Magnitude
	pH 8.0, (mg TAN/L)	pH 7.0, T=20°C (mg TAN/L)	pH 8.0, T=25°C (mg TAN/L)	pH 7.0, T=20°C (mg TAN/L)	pH 7.0, T=20°C (mg TAN/L)
Acute (1-hr average)	5.6 ^a	24 ^a	2.9	19	17
Chronic (30-d rolling average)	1.2	4.5 ^b	0.26	0.91	1.9*
*Not to exceed 2.5 times CCC or 4.8 mg TAN/L (at pH 7, 20°C) as a 4-day average within the 30-days, more than once in three years on average.					
Criteria frequency: Not to be exceeded more than once in three years on average.					

^a Salmonids present

^b Based on renormalization of data to pH 7 and 20°C

^c Mussels present



Example Table from Criteria Document Showing Temperature and pH-Dependent Values of the CCC (Chronic Criterion Magnitude)

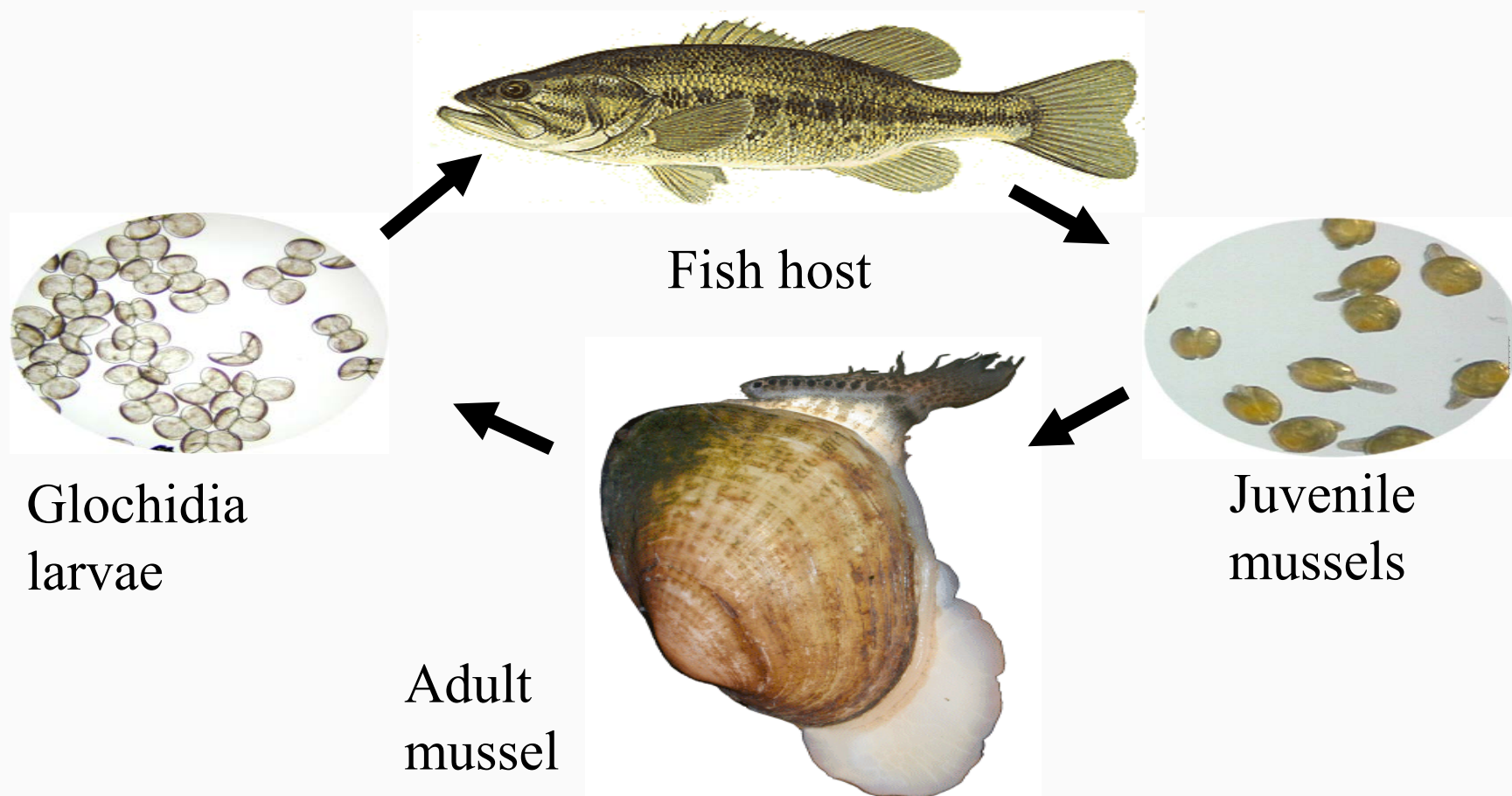
pH	Temperature (°C)													
	0-7	8	9	10	11	12	13	14	15	16	17	18	19	20
6.5	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.1	2.9	2.8	2.6	2.4	2.3	2.1
6.6	4.8	4.5	4.3	4.0	3.8	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1
6.7	4.8	4.5	4.2	3.9	3.7	3.5	3.2	3.0	2.8	2.7	2.5	2.3	2.2	2.1
6.8	4.6	4.4	4.1	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.3	2.1	2.0
6.9	4.5	4.2	4.0	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2.0
7.0	4.4	4.1	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.3	2.2	2.0	1.9
7.1	4.2	3.9	3.7	3.5	3.2	3.0	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8
7.2	4.0	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2.0	1.8	1.7
7.3	3.8	3.5	3.3	3.1	2.9	2.7	2.6	2.4	2.2	2.1	2.0	1.8	1.7	1.6
7.4	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2.0	1.8	1.7	1.6	1.5
7.5	3.2	3.0	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4
7.6	2.9	2.8	2.6	2.4	2.3	2.1	2.0	1.9	1.8	1.6	1.5	1.4	1.4	1.3
7.7	2.6	2.4	2.3	2.2	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1
7.8	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0
7.9	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.95	0.89
8.0	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0	0.94	0.88	0.83	0.78



2013 Update of ALC Reflects the Latest Scientific Knowledge

- In 2003 toxicity data for freshwater unionid mussels were published indicating that glochidia or larval mussels and juvenile mussels are more sensitive to ammonia than the organisms in the 1999 dataset
- In 2005, an ASTM protocol for toxicity testing of glochidia and juvenile freshwater mussels was approved
- Subsequent studies in 2011 on freshwater non-pulmonate (gill-bearing) snails demonstrate they are also sensitive to ammonia
- Scientifically acceptable freshwater snail and mussel data were included in the 2013 ammonia criteria

Unionid Freshwater Mussel Life History





Threatened and Endangered (Listed) Species Protection

- First explicit analysis of Listed Species in a criteria document

- 14 Federally-listed species represented in 2013 ammonia criteria dataset
 - Includes 5 listed freshwater mussel species
 - In the U.S. there are 297 species of freshwater unionid mussels, 72 of which are Federally-listed



Changes from Draft 2009 Criteria

- Updated literature review through October 2012
 - Includes additional data for freshwater unionid mussels and non-pulmonate snails
- One set of criteria applicable to all fresh water to protect the aquatic community as a whole, including sensitive mollusks which are present in nearly all fresh waters of the contiguous U.S.
- Removed data for 6 invasive species (e.g., *Corbicula*, New Zealand mudsnail) from the dataset – resulted in slight increase of acute criteria
 - 2013 has no invasive species data in acute or chronic ammonia dataset



Changes from Draft 2009 Criteria (cont'd)

- Renormalized data to pH 7 and temperature 20° C as more representative of surface waters and discharges
 - Toxicity effects relationship between pH and temperature remains the same
 - Re-evaluated pH and temperature relationship for appropriateness and confirmed
- Reformatted criteria document to reflect EPA's Guidelines for Ecological Risk Assessment
- 2013 criteria values differ from those proposed in 2009 draft (acute slightly lower, chronic slightly higher) largely due to availability of new toxicity data on mussels



Freshwater Unionid Mussels

- Glochidia (larval mussels) data included in 2013 acute dataset to calculate CMC based on new study/recommendation re: appropriate test duration (glochidia data not used in 2009)
 - Required at least 90% control survival at the end of 24-hour exposure to accept test data for the 2013 ammonia criteria
 - Glochidia are not consistently more sensitive than juvenile mussels to ammonia
- Most sensitive species in acute dataset are 7 genera of mussels (GMAVs ranked #1-7)



Non-Pulmonate Snails

- New 28-day toxicity USGS study (2011) – peer reviewed and data used in development of chronic criteria magnitude
- Snail (*Fluminicola spp.*) genus mean chronic value or GMCV ranked #5 in chronic sensitivity



1985 ALC Guidelines – 8 Minimum Data Requirements Fulfilled for 2013 Acute and Chronic Criteria

1. The family Salmonidae in the class Osteichthyes
2. A second family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species (e.g., bluegill, channel catfish, etc.)
3. A third family in the phylum Chordata (may be in the class Osteichthyes or may be an amphibian, etc.)
4. A planktonic crustacean
5. A benthic crustacean
6. An insect
7. A family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca, etc.)
8. A family in any order of insect or any phylum not already represented



Additional Minimum Data Requirements (MDRs) Fulfilled for 2013 Chronic Criterion (improvement over 2009 Draft)

- Fish
 - **Salmonid (*Oncorhynchus* sp.)** chronic data included to calculate GMCV
 - Fulfills chronic MDR #1
 - Ranked #9 GMCV in chronic sensitivity
- Benthic Crustacean
 - **Amphipod (*Hyalella azteca*)** now included in acute and chronic datasets based on new research re: water chemistry and feeding necessary for healthy test organisms
 - Fulfills chronic MDR #5
 - Ranked #13 GMCV in chronic sensitivity
- Insects
 - **Stonefly** chronic data included to calculate GMCV
 - Fulfills chronic MDR #6
 - Ranked #16 (least sensitive) GMCV in chronic sensitivity



External Peer Review & Public Comment

- EPA conducted an external peer review of the 2009 draft ammonia criteria document
 - The 2013 criteria document reflects edits based on 2009 draft peer review
 - Response to comments document available online
- EPA received public comment on the 2009 draft ammonia criteria document
 - Approximately 50 comments were received in docket for the 2009 draft generally concerning science policy and implementation issues
 - 2013 criteria document addresses the comments
 - Response to comments document available online
- EPA conducted external peer review of snail studies
 - Response to comments document for this peer review available online



Supporting Documents

- Revised Deletion Process for the Site-Specific Recalculation Procedure for Aquatic Life Criteria
 - Where a state can demonstrate, on a site-specific basis, that mussels are not present (and that there are no related species of similar sensitivity for which mussels serve as a surrogate), the Recalculation Procedure may be used to delete mussel species from the national criteria dataset to better represent the species at the site.



Flexibilities for States Applying the EPA's Ammonia Criteria Recommendations

- **Resident species recalculation procedure** to develop site-specific criteria
- **Variations** – If the designated use and criteria for a particular waterbody or segment are unattainable under 40 CFR § 131.10(g) immediately or within a limited period of time because a discharger cannot meet its new ammonia water quality-based effluent limits (WQBELs), the state may grant a **discharger-specific variance**, as long as the variance is consistent with the CWA and implementing regulations
- **Revision to Designated Uses** - WQS regulation at 40 CFR § 131.10(g) provides that “[s]tates may remove a designated use... or establish sub-categories of a use if the [s]tate can demonstrate that attaining the designated use is not feasible...” because of at least one of the six specified factors
- **Dilution Allowances** - A dilution allowance is typically expressed as the flow of a river or stream, or a portion thereof, that is allowed to mix with and dilute effluent before WQC must be met
- **Compliance Schedules** may be appropriate for ammonia where the permitting authority (which is the state in most cases) determines that a compliance schedule is appropriate under the circumstances and that the discharger can ultimately meet its new ammonia WQBELs by a date certain in the future (as soon as possible) but requires time to install treatment technology or implement other controls necessary to meet the new WQBELs



Technical Support Document for conducting and Reviewing Freshwater Mussel Occurrence Surveys for the Development of Site-specific Water Quality Criteria for Ammonia

- The methods document is broken into three parts:
 - Part A describes information obtained from several data collection efforts - the information focuses on methods for determining mussel presence/absence as well as data collection, frequency of data updates, and data storage locations
 - Part B summarizes commonly used mussel sampling methods and provides a basic overview of the considerations, techniques, and limitations of the methods, including real-life examples
 - Part C provides a simple checklist of key elements that should be considered for evaluating the scientific soundness of a proposed survey methodology for determining mussel presence/absence



Thank you!

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