Acute toxicity of ammonia to freshwater mussels: How new data and emerging data quality guidelines affect data synthesis

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What we'll cover

- Summary of 2003 mussel ammonia dataset
  - Data quality guidelines
  - Results
- How ammonia dataset is affected by new guidance and new data
- Glance at mussel copper dataset

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Building the 2003 dataset: Why did we do it?

- Wade ('91) and Goudreau ('93) indicate mussel sensitivity to ammonia, several follow-up studies
- North Carolina has 7 threatened and endangered mussels but no water quality standard for ammonia
- USFWS wanted a synthesis of existing data to help with NPDES permit review

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Building the 2003 dataset: How did we do it?

- Toxline, AQUIRE, contacted researchers
- Tests had to have $\geq$ 80% control survival, report an LC50 or EC50, measure ammonia values, report supporting water quality data
- Ammonia tox data normalized to total ammonia, as N, at pH 8 (consistent w/ 1999 criteria revision)
- Calculated GMAVs

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2003 Dataset

Rainbow (*Villosa iris*)	Goudreau '93
	Scheller '97
	Mummert et al. '03
Paper pondshell (*Utterbackia imbecillis*)	Wade '91
	Keller '00
	Black '01
Giant floater (*Pyganodon grandis*)	Scheller '97
Green floater (*Lasmigona subviridis*)	Black '01
Atlantic pigtoe (*Fusconaia masoni*)	Black '01
Pheasantshell (*Actinonaias pectorosa*)	Keller '00
Cumberland moccasinshell (*Medionidus conradicus*)	Keller '00
Fatmucket (*Lampsilis siliquoidea*)	Myers-Kinzie '98
Plain pocketbook (*Lampsilis cardium*)	Newton '02
Wavy-rayed lampmussel (*Lampsilis fasciola*)	Mummert et al. '03

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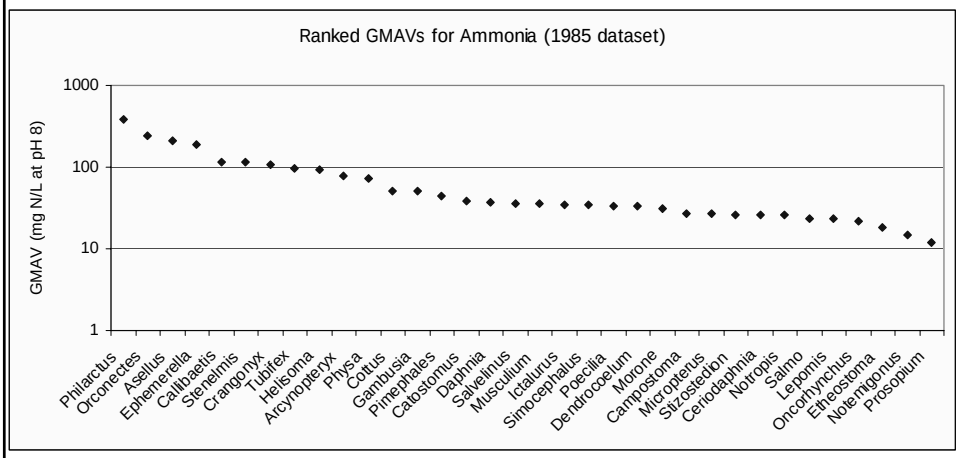
Ammonia GMAVs from 1999 Criteria Document (1985 dataset)



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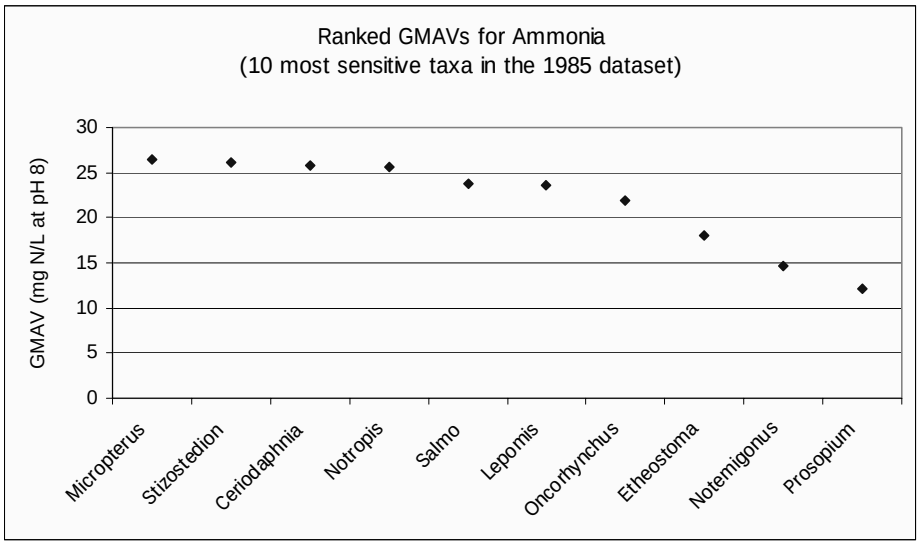
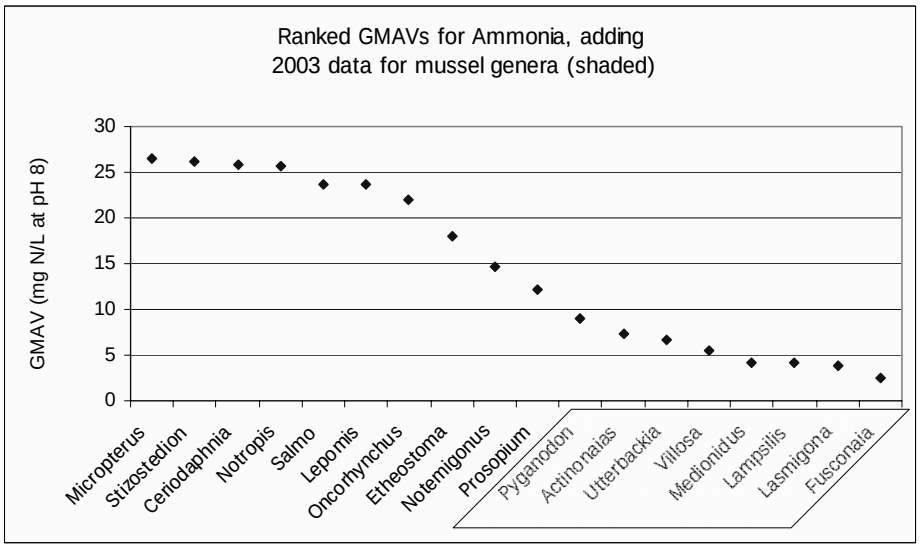

Ranked GMAVs for Ammonia
(10 most sensitive taxa in the 1985 dataset)
GMAV (mg N/L at pH 8)
30
25
20
15
10
5
0
Micropterus
Stizostedion
Ceriodaphnia
Notropis
Salmo
Lepomis
Oncorhynchus
Etheostoma
Notemigonus
Prosopium

7


Ranked GMAVs for Ammonia, adding
2003 data for mussel genera (shaded)
GMAV (mg N/L at pH 8)
30
25
20
15
10
5
0
Micropterus
Stizostedion
Ceriodaphnia
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Salmo
Lepomis
Oncorhynchus
Etheostoma
Notemigonus
Prosopium
Pyganodon
Actinonaias
Utterbackia
Villosa
Medionidus
Lampsilis
Lasmigona
Fusconaia

8

All data and steps discussed so far are in:

Augspurger T, AE Keller, MC Black, WG Cope and FJ Dwyer. 2003. Water quality guidance for protection of freshwater mussels (Unionidae) from ammonia exposure. *Environ Toxicol Chem* 22: 2569-2575.

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What's new since the ET&C Paper?

Since 2003, there have been additional tests and development of the ASTM standard

We compared the 2003 dataset to those you'd get by applying the ASTM standard to: 1) the 2003 dataset (2003 w/ASTM)

2) 2005 dataset (2005 w/ASTM)

[new data are provisional]

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Dataset	Tests	Labs	Species	Genera	Ranks
2003	30	7	10	8	1- 8
2003 w/ASTM	21	6	7	6	1-5, 7
2005 w/ASTM (provisional)	50	7	13	9	1- 6, 8, 9

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What dropped-out with application of ASTM standard?

1) 48-h glochidia exposures for *A. pectorosa* (1) and *M. conradicus* (1)

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What dropped-out with application of ASTM standard?

1) 48-h glochidia exposures for *A. pectorosa* (1) and *M. conradicus* (1)

2) Tests with control survival of 80 to 89% for *U. imbecillis* glochidia (2), *V. iris* juveniles (2), *F. masoni* glochidia (1), *L. siliquoidea* juveniles (1), *L. cardium* juveniles (1) and *L. fasciola* juveniles (1)

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Data are reliable

Data are robust

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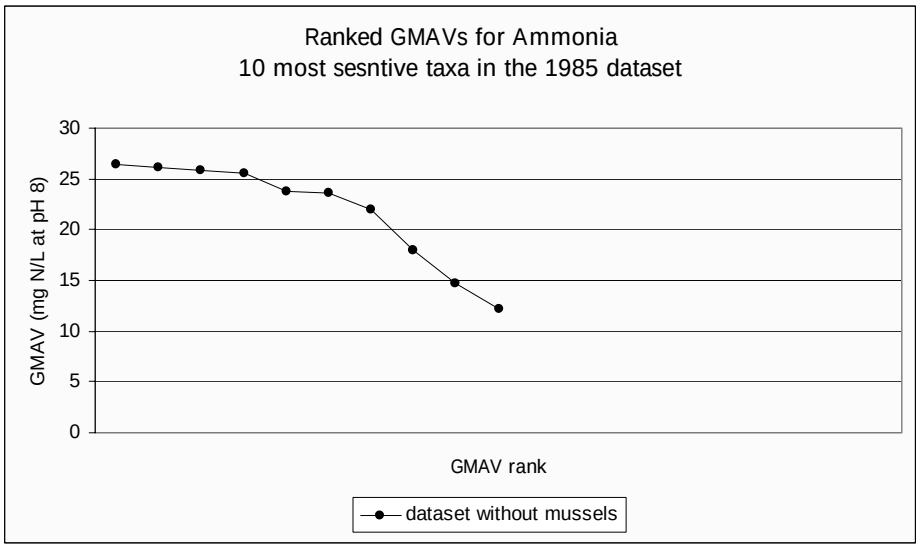

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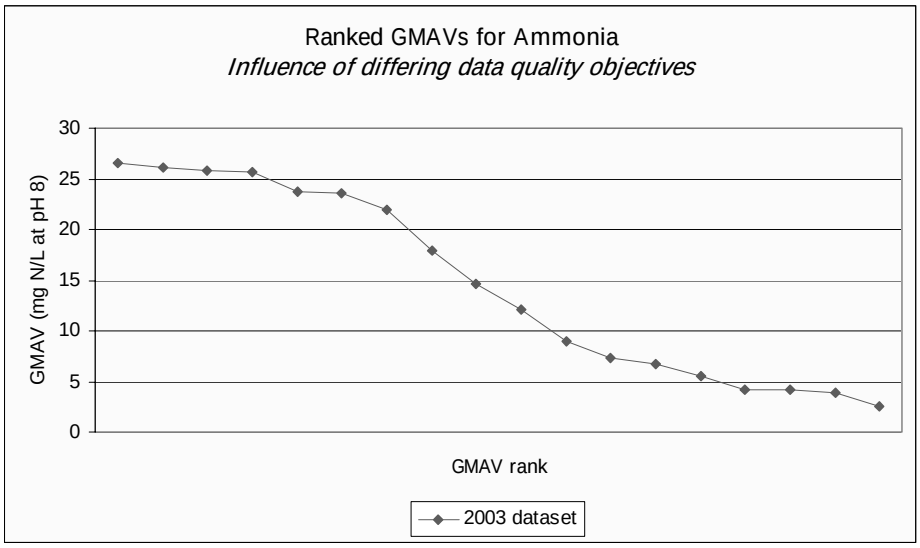
Ranked GMAVs for Ammonia
Influence of differing data quality objectives
GMAV (mg N/L at pH 8)
30
25
20
15
10
5
0
GMAV rank
2003 dataset

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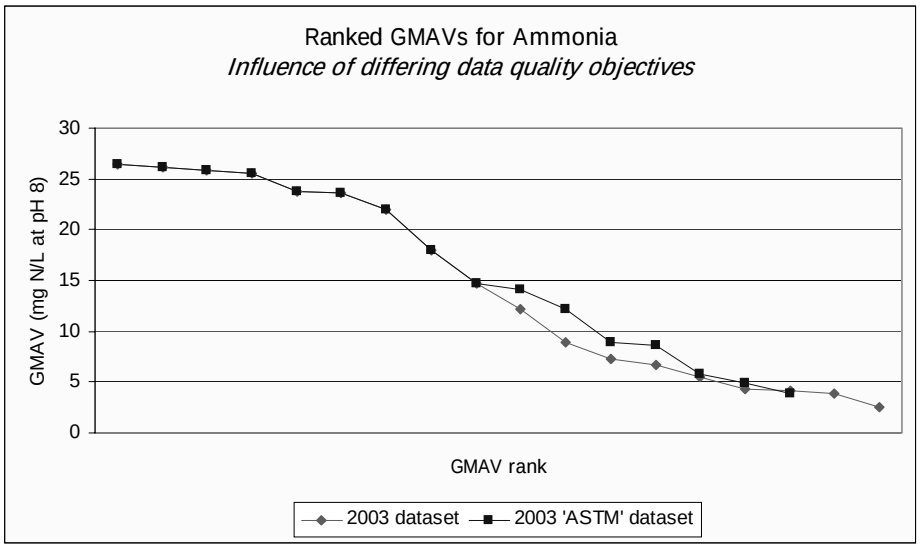
Ranked GMAVs for Ammonia
Influence of differing data quality objectives
GMAV (mg N/L at pH 8)
30
25
20
15
10
5
0
GMAV rank
2003 dataset
2003 'ASTM' dataset

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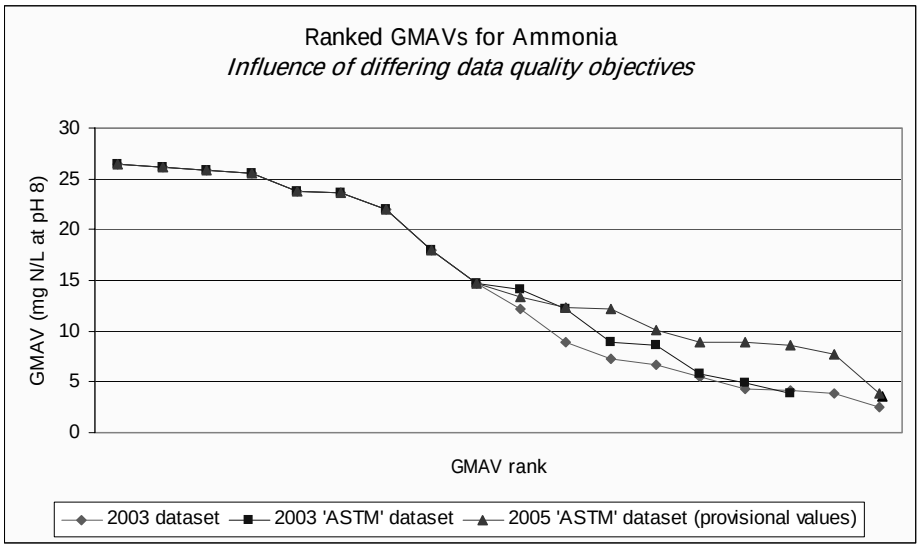

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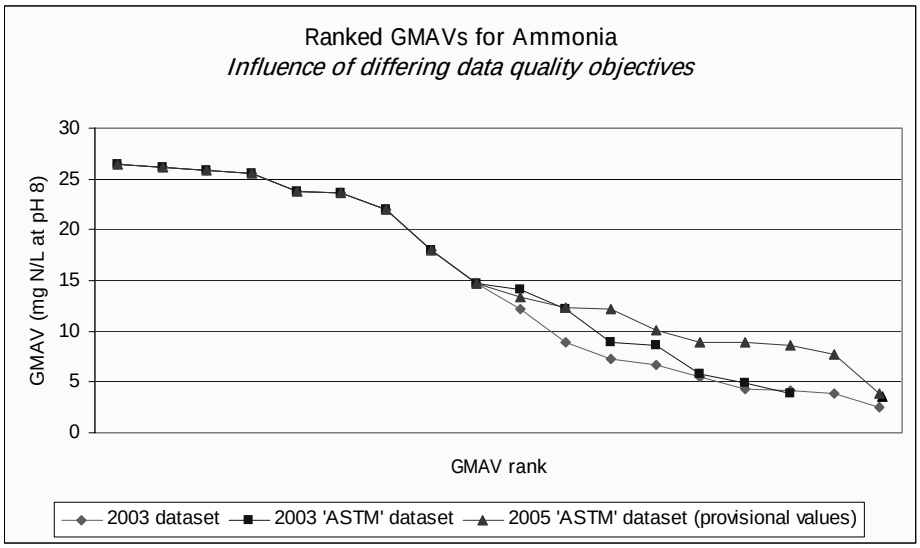

All GMAVs less than 10 mg/L on this slide are for mussels

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What's it mean?

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What's it mean?

- Federal agencies, States, Tribes and others may employ different data quality objectives, depending on need
- Mussel toxicity data for ammonia are reliable and mussels routinely rank among the more sensitive organisms to ammonia
- **Data should be useful for water quality criteria, water quality standards, permit limits, clean-up values, toxicity reference values, or other ammonia toxicity guidelines**

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Copper data for mussels

217 tests in database of 24 to 96-hr EC50s and LC50s

126 of those meet test duration recommendations of ASTM (96-hr juvenile, 24-hr glochidia unless species life history indicates longer is appropriate)

115 of those 126 met $\geq$ 90% control survival criteria (20 species in 14 freshwater mussel genera)

See March et al. at SETAC '05

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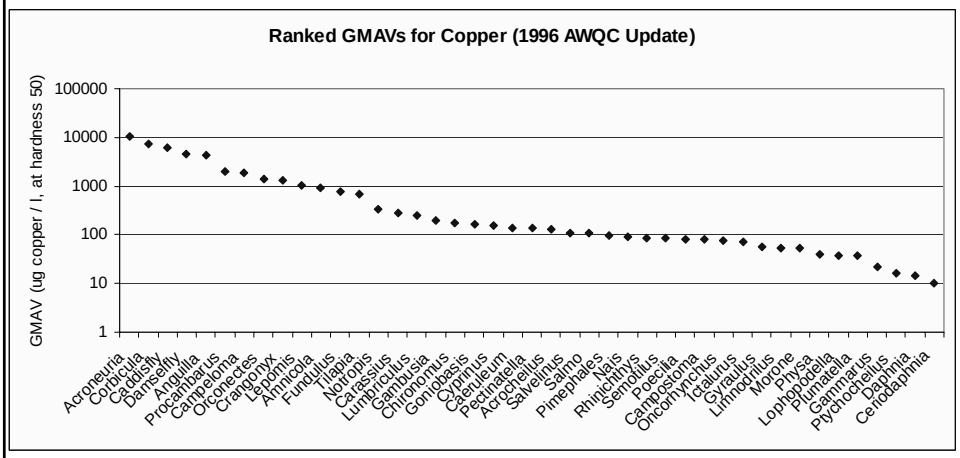
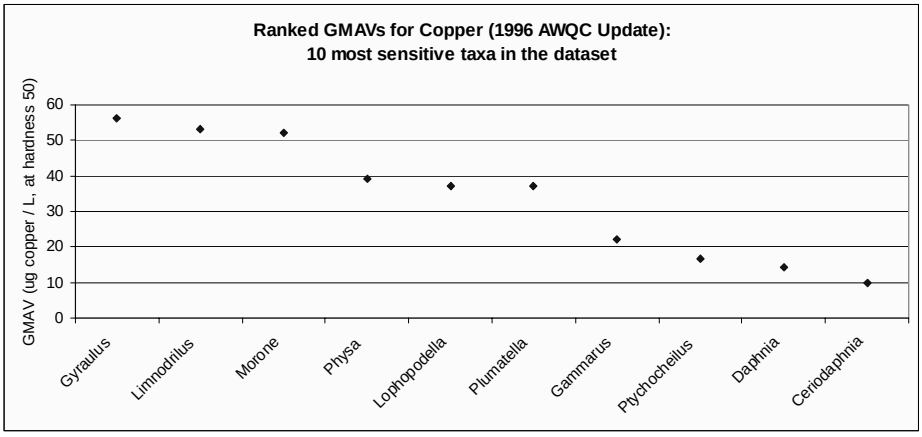

Ranked GMAVs for Copper (1996 AWQC Update)
GMAV (ug copper / l, at hardness 50)
100000
10000
1000
100
10
1
Acroneuria
Corbicula
Cladisfly
Damselfly
Anguilla
Procambarus
Campeloma
Oncorhynchus
Crangonyx
Lepomis
Ahnicola
Fundulus
Tilapia
Notropis
Carassius
Lumbriculus
Gambusia
Chironomus
Gomphosis
Cyprinus
Caenuleum
Pectinatella
Acrocheilus
Salvelinus
Salmo
Pimephales
Nais
Rhinichthys
Semotilus
Poecilla
Campostoma
Oncorhynchus
Ictalurus
Gyraulus
Limnodrilus
Morone
Physa
Lophopodella
Plumatella
Gammarus
Ptychocheilus
Daphnia
Ceriodaphnia

25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60
50
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Limnodrilus
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Physa
Lophopodella
Plumatella
Gammarus
Ptychocheilus
Daphnia
Ceriodaphnia

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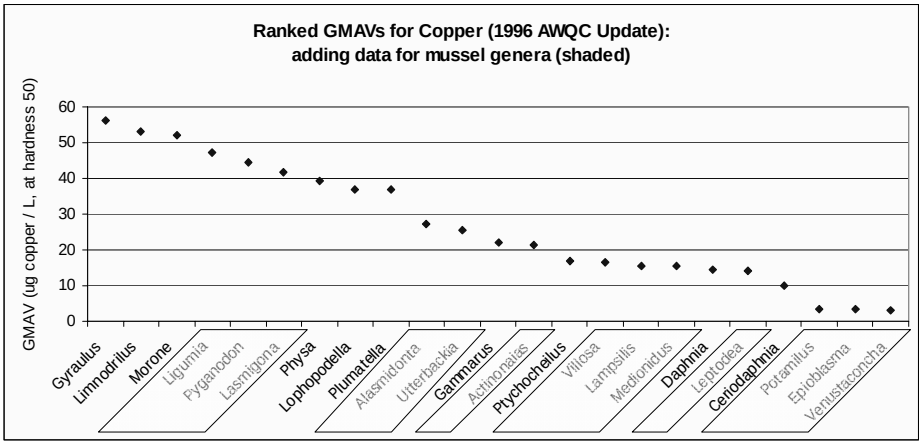
Ranked GMAVs for Copper (1996 AWQC Update):
adding data for mussel genera (shaded)
GMAV (ug copper / L, at hardness 50)
60
50
40
30
20
10
0
Gyraulus
Limnodrilus
Morone
Ligumia
Pyganodon
Lasmigona
Physa
Lophopodella
Plumatella
Alasmidonta
Utterbacka
Gammarus
Actinonaias
Ptychocheilus
Villosa
Lampsilis
Medionidus
Daphnia
Leptodea
Ceriodaphnia
Potamilus
Epioblasma
Venustaconcha

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