Proposed Update of Freshwater Cadmium Water Quality Criteria

Jamie Heisig-Mitchell
VAMWA

April 29, 2009

Background

- EPA issued an update in 2001 to the Cadmium criteria promulgated in 1984
- Since that time, there have been numerous studies adding to the body of knowledge regarding cadmium toxicity in freshwater organisms

Recent Updates/Literature Reviews

- 2004: Chadwick Environmental Consultants
- 2006: USGS
- 2008: GEI Consultants (formerly CEC)

Options

- Revise cadmium criteria based on EPA 2001 Cadmium update
- Revise cadmium criteria based on USGS 2006 report
- Revise cadmium criteria based on GEI 2008 report
- Recalculate using literature provided by USGS and GEI reports

Resulting Criteria

HARDNESS (mg/L)	25	50	100
Current CMC	0.82	1.8	3.9
EPA 2001 CMC	0.52	1.03	2.01
CEC 2004 CMC	0.79	1.4	2.6
USGS 2006 CMC	0.69	1.2	2.2
GEI 2008 CMC	0.74	1.4	2.5
CEC 2004 CMC - Commercially Impt (CI)	0.51	0.93	1.7
USGS 2006 CMC – CI	0.42	0.75	1.3
GEI 2008 CMC - CI	0.51	0.93	1.7
Current CCC	0.38	0.66	1.1
EPA 2001 CCC	0.09	0.15	0.25
CEC 2004 CCC	0.15	0.25	0.42
USGS 2006 CCC	0.24	0.37	0.55
GEI 2008 CCC	0.15	0.26	0.43

Differences – Hardness Correction

	ACUTE CALCULATION
EPA	$e^{1.0166\{\ln(hardness)\}-3.924}$
USGS-CI	$e^{0.8368\{\ln(hardness)\}-3.5602}$
GEI	$e^{0.9151\{\ln(hardness)\}-3.249}$
GEI - CI	$e^{0.9151\{\ln(hardness)\}-3.624}$
	CHRONIC CALCULATION
EPA	$e^{0.7409\{\ln(hardness)\}-4.719}$
USGS	$e^{0.6247\{\ln(hardness)\}-3.384}$
GEI	$e^{0.7998\{\ln(hardness)\}-4.426}$

Differences – Hardness Correction

ACUTE	
USGS	Added amphipod and bull trout data for 2 new species. Used new data for an additional 5 species.
GEI	Added data for *O. mykiss* and *S. trutta* (2 new species). Used juvenile and fry data for fathead minnow.

	Pooled Slope	R^2
EPA 2001	1.0166	0.97
USGS 2006	0.8368	0.97
GEI 2008	0.9151	0.69

Differences – Hardness Correction

CHRONIC	
USGS	Added 23 additional data points to EPA data set (19 from 4 new species). Did not use fathead minnow data.
GEI	Added 5 additional data points to EPA data set (4 from 1 new species – *O. mykiss*).

	Pooled Slope	R^2
EPA 2001	0.7409	0.99
USGS 2006	0.6247	0.99
GEI 2008	0.7998	0.72

Differences – Species/Genera

	Species	Genera
Acute		
EPA 2001	66	55
USGS 2006	69 (2 new in 4 most sensitive)	57
GEI 2008	70 (1 new in 4 most sensitive)	58
Chronic		
EPA 2001	21	16
USGS 2006	28 (3 new in 4 most sensitive)	21 (2 new in 4 most sensitive)
GEI 2008	22 (1 new in 4 most sensitive)	17 (1 new in 4 most sensitive)

4 Most Sensitive - Acute

EPA (GMAV, SMAV)	USGS (GMAV, SMAV)	GEI (GMAV, SMAV)
1. *S. trutta* (1.613,1.613)	1. *O. clarki* (2.02,1.50)	1. *S. fontinalis* (1.91,<1.76)
2. *S. fontinalis* (<1.963,1.791)	2. *S. confluentus* (2.13,2.13)	2. *C. bairdi* (2.16,2.16)
3. *M. saxatilis* (2.925,2.925)	3. *S. trutta* (2.61,2.61)	3. *S. trutta* (2.88,2.88)
4. *O. mykiss* (3.836,2.108)	4. *C. bairdi* (2.61,2.56)	4. *M. saxatilis* (3.16,3.16)

Differences – New Data (Acute)

USGS	GEI
Added approximately 60 studies to overall species database.	Added 21 studies to overall species database
Added approximately 19 studies and 51 data points to four most sensitive species (most for *Oncorhynchus*) – 2 new genuses and 3 new species (*Cottus* (2 spp) and *Salvelinus clarki*)	Added 2 studies and 2 data points to four most sensitive species - 1 new genus and species (*Cottus bairdi*)

4 Most Sensitive - Chronic

EPA (GMCV, SMCV)	USGS (GMCV, SMCV)	GEI (GMCV, SMCV)
1. *H. azteca* (0.2747,0.2747)	1. *H. azteca* (0.33,0.33)	1. *H. azteca* (0.26,0.26)
2. *D. magna* (<0.3974,<0.3974)	2. *C. bairdi* (0.84,0.84)	2. *C. bairdi* (1.07,1.07)
3. *O. mykiss* (2.443,1.308)	3. *G. fasciatus* (1.00,1.00)	3. *D. magna* (1.33,0.49)
4. *C. tentans* (2.804,2.804)	4. *S. confluentus* (1.25,0.77)	4. *O. mykiss* (2.31,1.05)

Differences – New Data (Chronic)

USGS	GEI
Added approximately 37 studies to overall species database.	Added 10 studies to overall species database
Added approximately 11 studies and 13 data points to four most sensitive species – 2 new genuses (*Cottus* and *Gammarus*)	Added 2 studies and 2 data points to four most sensitive species – 1 new genus (*Cottus*)

Recalculation Combining USGS and GEI

HARDNESS (mg/L)	25	50	100
Current CMC	0.82	1.8	3.9
EPA 2001 CMC	0.52	1.03	2.01
CEC 2004 CMC	0.79	1.4	2.6
USGS 2006 CMC	0.69	1.2	2.2
GEI 2008 CMC	0.74	1.4	2.5
USGS/GEI CMC	0.68	1.2	2.2
USGS/GEI CCC	0.24	0.37	0.55
Current CCC	0.38	0.66	1.1
EPA 2001 CCC	0.09	0.15	0.25
CEC 2004 CCC	0.15	0.25	0.42
USGS 2006 CCC	0.24	0.37	0.55
GEI 2008 CCC	0.15	0.26	0.43

Deviations from Guidelines

- USGS
  - Flow-through, renewal, and static tests all given equal priority
  - Did not accept test results based on unmeasured concentrations
  - Used shorter-term chronic tests if results were more sensitive or similar in sensitivity to life cycle tests