



Revision of Molybdenum Aquatic Life Water Quality Standard

Water Quality Planning Regulation
R186-08

Regulatory Background

- Current Nevada standard is 19 $\mu\text{g}/\text{L}$ (NAC 445A.144)
 - Derived in California RWQCB report for the San Joaquin River
 - Based on toxicity data for three species and national background Mo concentration
 - Not calculated using EPA methods – Not based primarily on toxicity data as required
- No EPA national aquatic life criteria
 - Many states have no aquatic life WQC for Mo

Derivation of Current Mo Standard

Species	Effect Level (µg/L)	Citation
rainbow trout	120	Birge et al., 1980
narrow-mouthed toad	960	Birge, 1978
<i>Daphnia magna</i>	1150	Kimball manuscript
Geometric Mean Effect Level:	510	

Geometric mean of effects level (510 µg/L) and national ambient background concentration (0.68 µg/L) = **19 µg/L**

Evaluation of Molybdenum Aquatic Life Standard

- Review all relevant Mo toxicity studies
- Evaluate aquatic life toxicity data
 - Substantiate current standard
 - or
 - Develop revised water quality standard

Acute Test Data

Rank	Species	Common Name	Acute Effect Level (mg Mo/L)
15	<i>Ictalurus punctatus</i>	channel catfish	10,000.0000
14	<i>Chironomus tentans</i>	midge	7,533.3000
13	<i>Lepomis macrochirus</i>	bluegill	6,790.0000
12	<i>Gammarus fasciatus</i>	scud	3,940.0000
11	<i>Crangonyx pseudogracilis</i>	isopod	2,650.0000
10	<i>Oncorhynchus mykiss</i>	rainbow trout	2,269.4034
9	<i>Daphnia magna</i>	cladoceran	2,218.0871
8	<i>Oncorhynchus nerka</i>	kokanee salmon	2,000.0000
8	<i>Catostomus commersoni</i>	white sucker	2,000.0000
7	<i>Catostomus latipinnis</i>	flannelmouth sucker	1,940.0000
6	<i>Girardia dorotocephala</i>	flatworm	1,225.6000
5	<i>Ceriodaphnia dubia</i>	cladoceran	1,015.0000
4	<i>Oncorhynchus kisutch</i>	coho salmon	1,000.0000
4	<i>Oncorhynchus tshawytscha</i>	chinook salmon	1,000.0000
3	<i>Pimephales promelas</i>	fathead minnow	253.8110
2	<i>Euglena gracilis</i>	protistan	72.3000
1	<i>Tubifex tubifex</i>	tubificid worm	28.9100

Chronic Test Data

Rank	Species	Common Name	Chronic Effect Level (mg Mo/L)
5	<i>Oncorhynchus mykiss</i>	rainbow trout	866.0254
4	<i>Pimephales promelas</i>	fathead minnow	163.5427
3	<i>Daphnia magna</i>	cladoceran	97.0183
2	<i>Ceriodaphnia dubia</i>	cladoceran	60.4380
1	<i>Catostomus commersoni</i>	white sucker	1.7000

Review Aquatic Life Toxicity Data

- Laboratory toxicity test results indicated higher thresholds to molybdenum
- Current molybdenum standard based on limited toxicity data
- Sufficient toxicity data available to use EPA standard method for revised criteria development

*Guidelines for Deriving Numerical National
Water Quality Criteria for the Protection of
Aquatic Organisms and their Uses*
(EPA 1985)

- Screening criteria for toxicity test data
- Minimum data requirements for developing criteria
- Procedures for calculating criteria

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Acute Criterion Derivation

Rank	Genus	GMAV (mg/L)	LN GMAV	(LN GMAV) ²	P = R/(N+1)	p ^{0.5}
4	<i>Ceriodaphnia</i>	1,015.0000	6.9226	47.9230	0.2857	0.5345
3	<i>Pimephales</i>	253.8110	5.5366	30.6538	0.2143	0.4629
2	<i>Euglena</i>	72.3000	4.2808	18.3255	0.1429	0.3780
1	<i>Tubifex</i>	28.9100	3.3642	11.3178	0.0714	0.2673
		Sum	20.1042	108.2200	0.7143	1.6427

Sample Size (N) = 13

$$S^2 = \frac{\sum((LN\ GMAV)^2) - \left(\frac{(\sum(LN\ GMAV))^2}{4}\right)}{\sum(P) - \left(\frac{(\sum(\sqrt{P}))^2}{4}\right)} = 180.7081 \quad S = \sqrt{S^2} = 13.4428$$

$$L = \left(\sum(LN\ GMAV)\right) - \frac{(S(\sum(\sqrt{P})))}{4} = -0.4944 \quad A = S(\sqrt{0.05}) + L = 2.5114$$

$$FAV = e^A = 12.3232$$

$$\frac{FAV}{2} = \frac{12.3232}{2} = 6.1616$$

**Criteria Maximum Concentration (CMC) =
Acute Criterion = 6.16 mg Mo/L**

Chronic Criterion

- Too few chronic toxicity data to develop criterion via methodology used to derive acute criterion
- Derive criterion by determining an acute-chronic ratio (ACR)

ACR Derivation

<i>Species</i>	Acute Value (mg/L)	Chronic Value (mg/L)	ACR	Species Mean ACR
<i>Ceriodaphnia dubia</i>	1015.0	76.9	13.2	13.2
<i>Pimephales promelas</i>	644.2	163.5	3.9	3.9
<i>Daphnia magna</i>	1727.8	153.8	11.2	22.9
<i>Daphnia magna</i>	2847.5	61.2	46.5	
<i>Oncorhynchus mykiss</i>	2269.4	866	2.6	2.6
Final ACR				7.5

Chronic Criterion Calculation

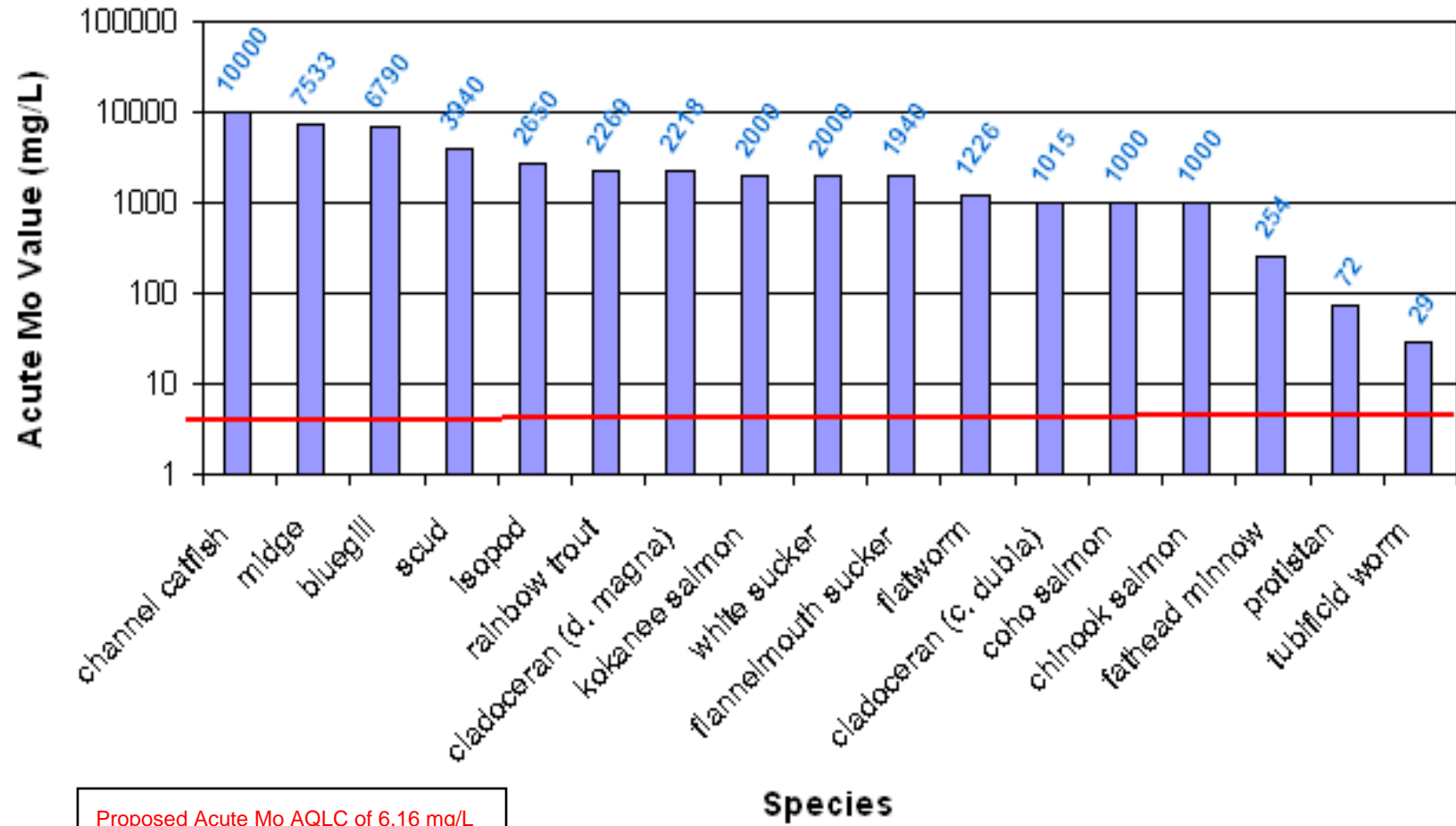
Final Acute Value (FAV) \div ACR = Final Chronic Value (FCV)

FAV (12.32 mg Mo/L) \div ACR (7.5) = FCV (1.65 mg Mo/L)

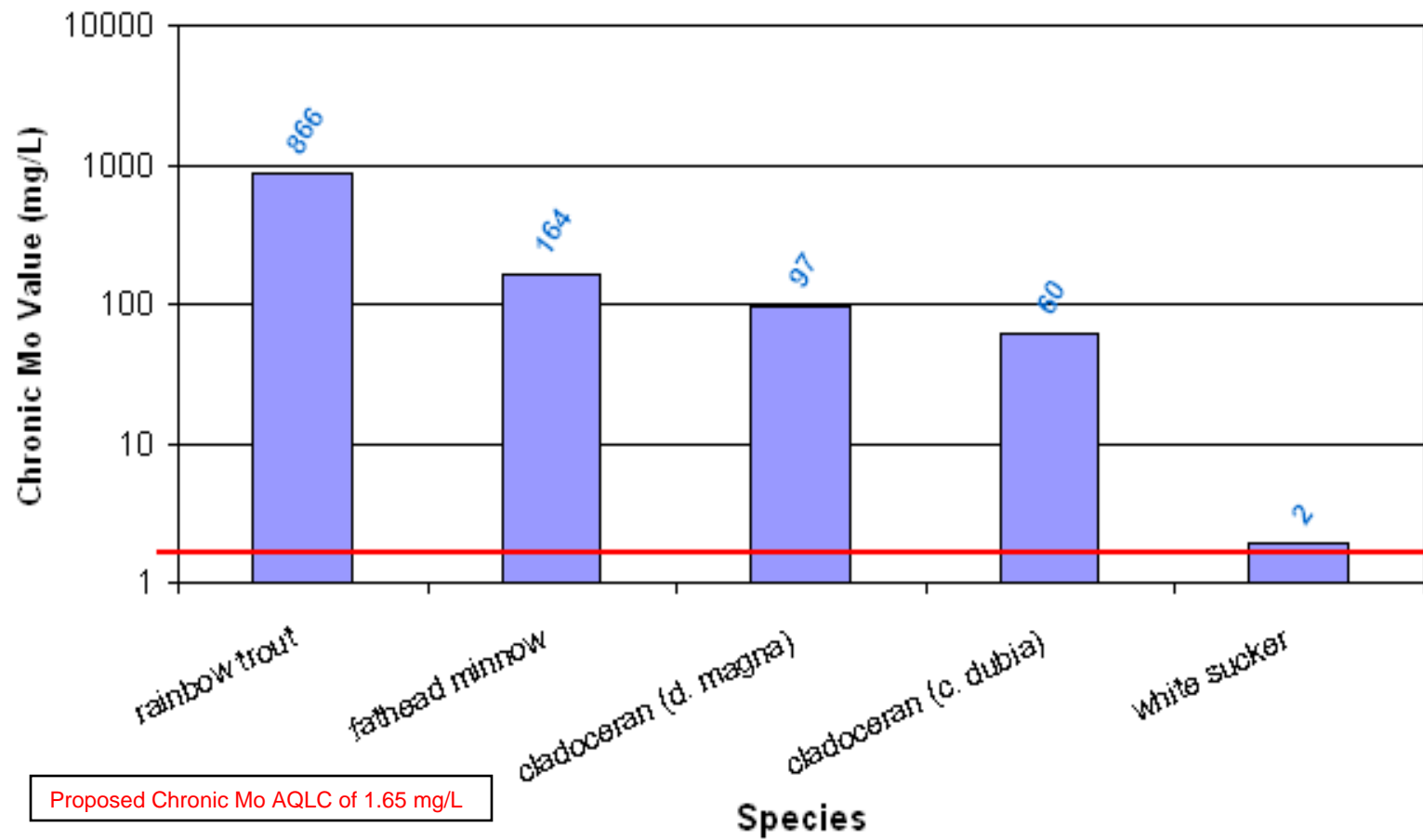
FCV = Criteria Continuous Concentration (CCC) = Chronic Criterion

Chronic Criterion for Molybdenum = 1.65 mg/L

Acute Toxicity Values



Chronic Toxicity Values



Summary

- Molybdenum aquatic life criteria developed based on current toxicity data and EPA methods
- Proposed criteria are well below values observed to have no effect in lab studies
- Proposed criteria appropriate as state-wide molybdenum water quality standards

1-hour average 6,160 µg/l

96-hour average 1,650 µg/l

Proposed Regulation Revisions (NAC 445A.144)

- Replace existing molybdenum aquatic life standard with 1-hr average of 6,160 $\mu\text{g/l}$ and 96-hr average of 1,650 $\mu\text{g/l}$
- Revise Section 1 language to allow for site-specific water body standards
- Reference origin revised molybdenum standard, and editorial change regarding location of iron irrigation standard

