

# Comparison of the acute toxicity of ammonia and copper to freshwater mussels and surrogate species

Ning Wang and Chris Ingersoll

U.S. Geological Survey, Columbia, MO

USEPA Mussel Toxicity Testing Workshop  
Chicago, IL, August 23 and 24, 2005



# Study objective

Evaluate the acute sensitivity of glochidia and juvenile mussels to copper and ammonia compared to commonly-tested surrogate species

# Five commonly-tested surrogate species



*Daphnia magna*



*Ceriodaphnia dubia*



*Hyaella azteca*



*Pimephales promelas*



*Oncorhynchus mykiss*

# Conditions for acute toxicity test with daphnids and amphipod (USEPA 1993; ASTM 2005)

Test species: *D. magna*, *C. dubia*, or *H. azteca*

Test type: Static

Chemicals: Copper sulfate or ammonia chloride

Test duration: 48 h

Temperature: 20±1°C

Test solution volume: 40 ml

Age of organism: <24 h for daphnids;

About 8 d for amphipod

# organisms/chamber: 5

# replicates/concentration: 4

Feeding: None

Dilution water: ASTM hard (170 mg/L as CaCO<sub>3</sub>, pH 8.3)

Dilution: Control and 5 concentrations  
(dilution factor=0.5)

Endpoint: Survival

Acceptability: >90% survival in control

# Conditions for acute toxicity test with fish (USEPA 1993; ASTM 2005)



**Test species:** Fathead minnow (FHM) and rainbow trout (RBT)

**Test type:** Static-renewal

**Chemicals:** Copper sulfate or ammonia chloride

**Test duration:** 96 h

**Temperature:**  $20 \pm 1^\circ\text{C}$  for FHM;  $12 \pm 1^\circ\text{C}$  for RBT

**Test solution volume:** 0.5 L for FHM; 4 L for RBT

**Renewal of solution:** After 48 h

**Age of organism:** 2 d for FHM; about 20 d for RBT

**# organisms/chamber:** 10

**# replicates/concentration:** 2

**Feeding:** FHM: add *Artemia* nauplii 2 h before solution renewal at 48 h; RBT: no feeding

**Dilution water:** ASTM hard (170 mg/L as  $\text{CaCO}_3$ , pH 8.3)

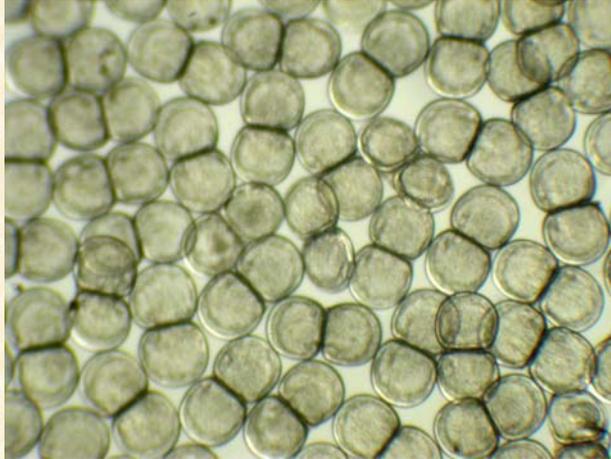
**Endpoint:** Survival

**Acceptability:**  $>90\%$  survival in control

# Isolating glochidia from a female mussel



# Conditions for acute toxicity test with glochidia



Test species: 11 mussel species

Test type: Static

Chemicals: Copper sulfate or ammonia chloride

Test duration: 24, 48 h

Temperature:  $20 \pm 1^\circ\text{C}$

Dilution water: ASTM hard (170 mg/L, pH 8.3)

Dilution: Control and 5 concentrations

Acceptability:  $>90\%$  survival in control

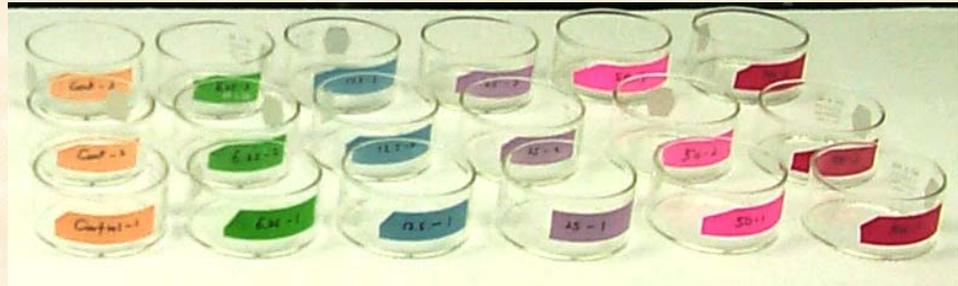
Test solution volume: 100 ml

Age of organism:  $<2$  h old

# organisms/chamber: about 1000

# replicates/concentration: 3

Endpoint: Survival (shell closure with NaCl)



# Conditions for acute test with juvenile mussels



Test species: 6 mussel species

Test type: Static renewal

Chemicals: Copper sulfate or ammonia chloride

Test duration: 96 h

Temperature:  $20 \pm 1^\circ\text{C}$

Dilution water: ASTM hard (170 mg/L, pH 8.3)

Dilution: Control and 5 concentrations

Acceptability: >90% survival in control

Test solution volume: 40 ml

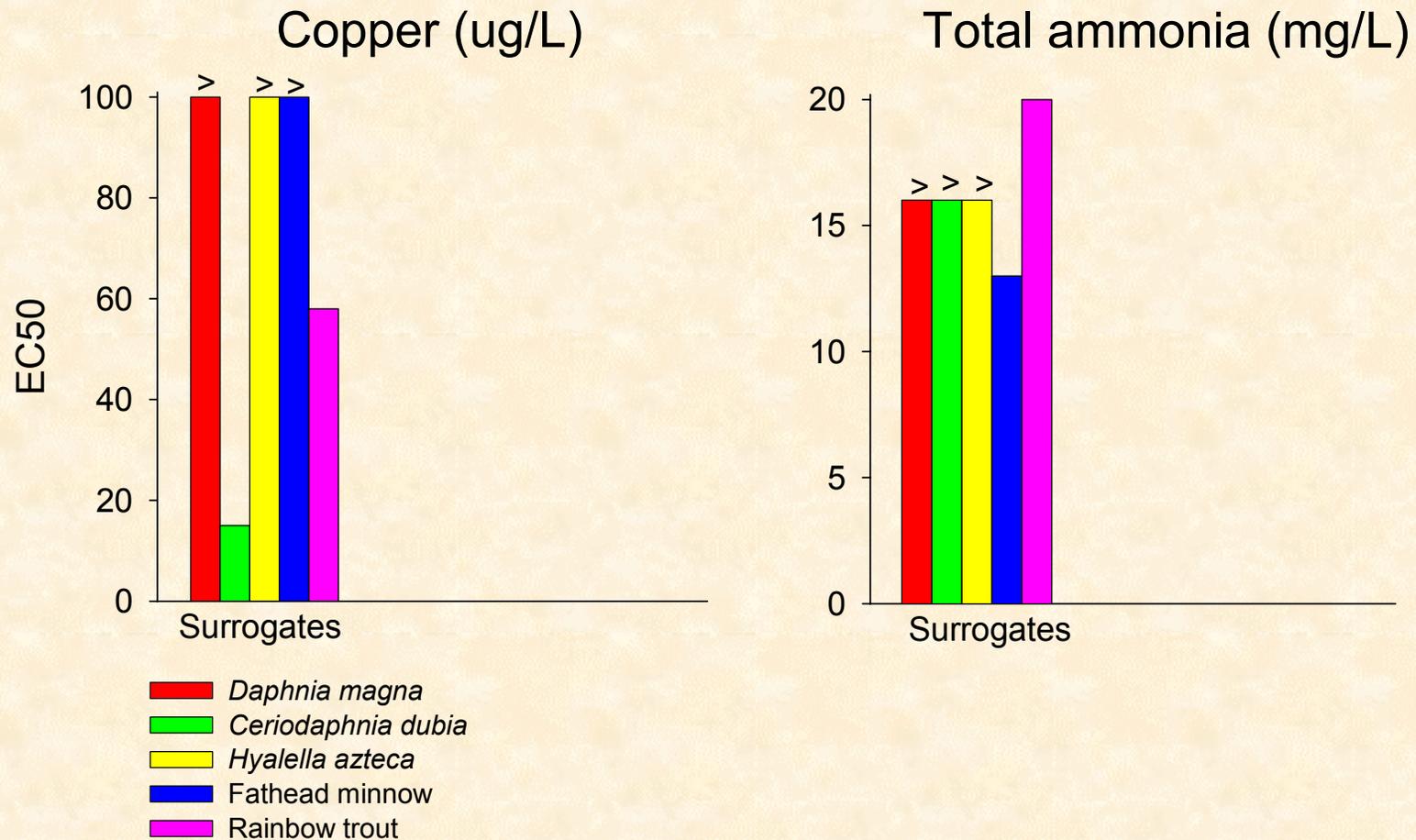
Age of organism: <5-d

# organisms/chamber: 5

# replicates/concentration: 4

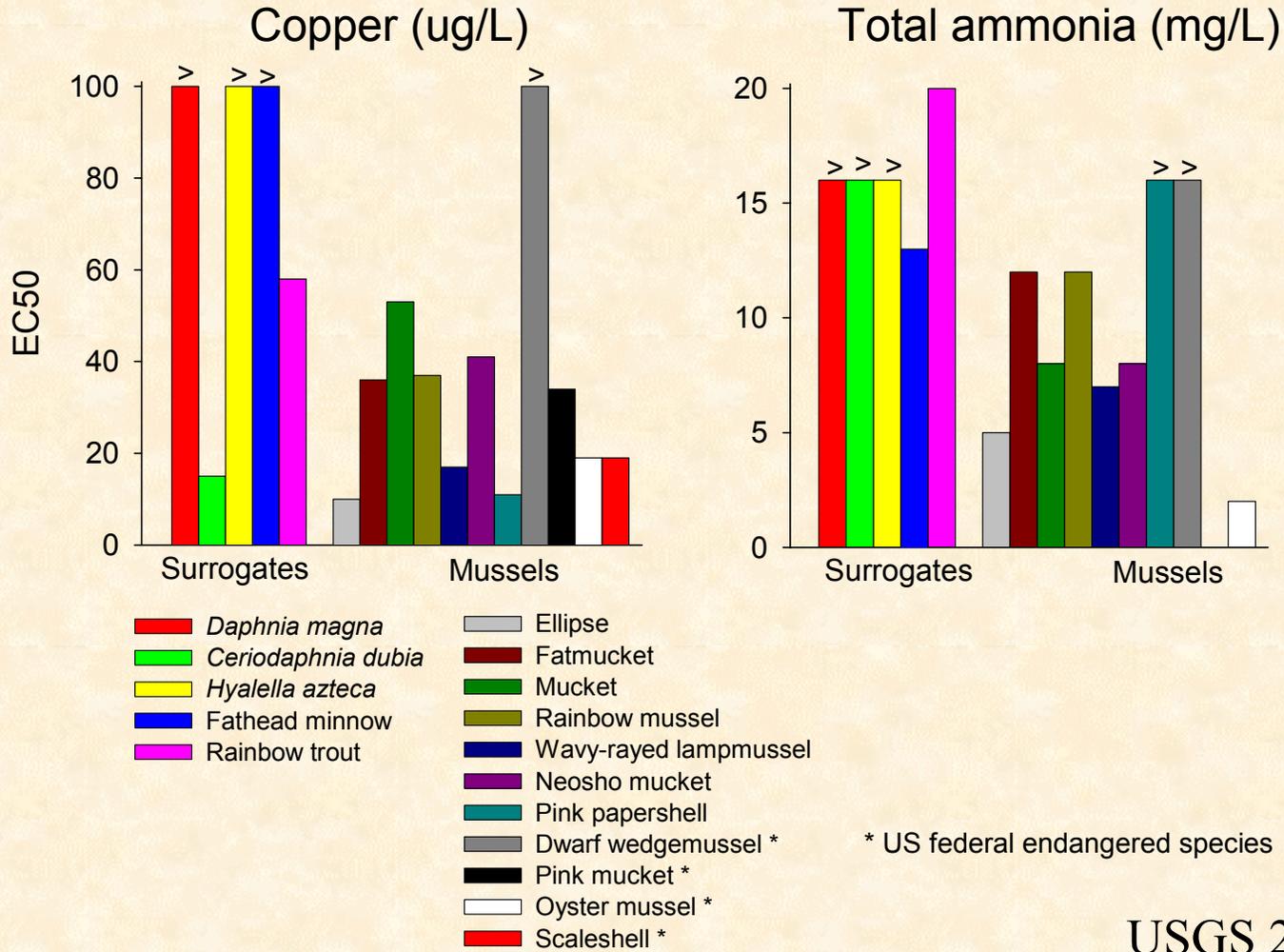
Endpoint: Survival (foot movement)

# 48- or 96-h EC50s of copper and ammonia for five surrogate species



USGS 2005

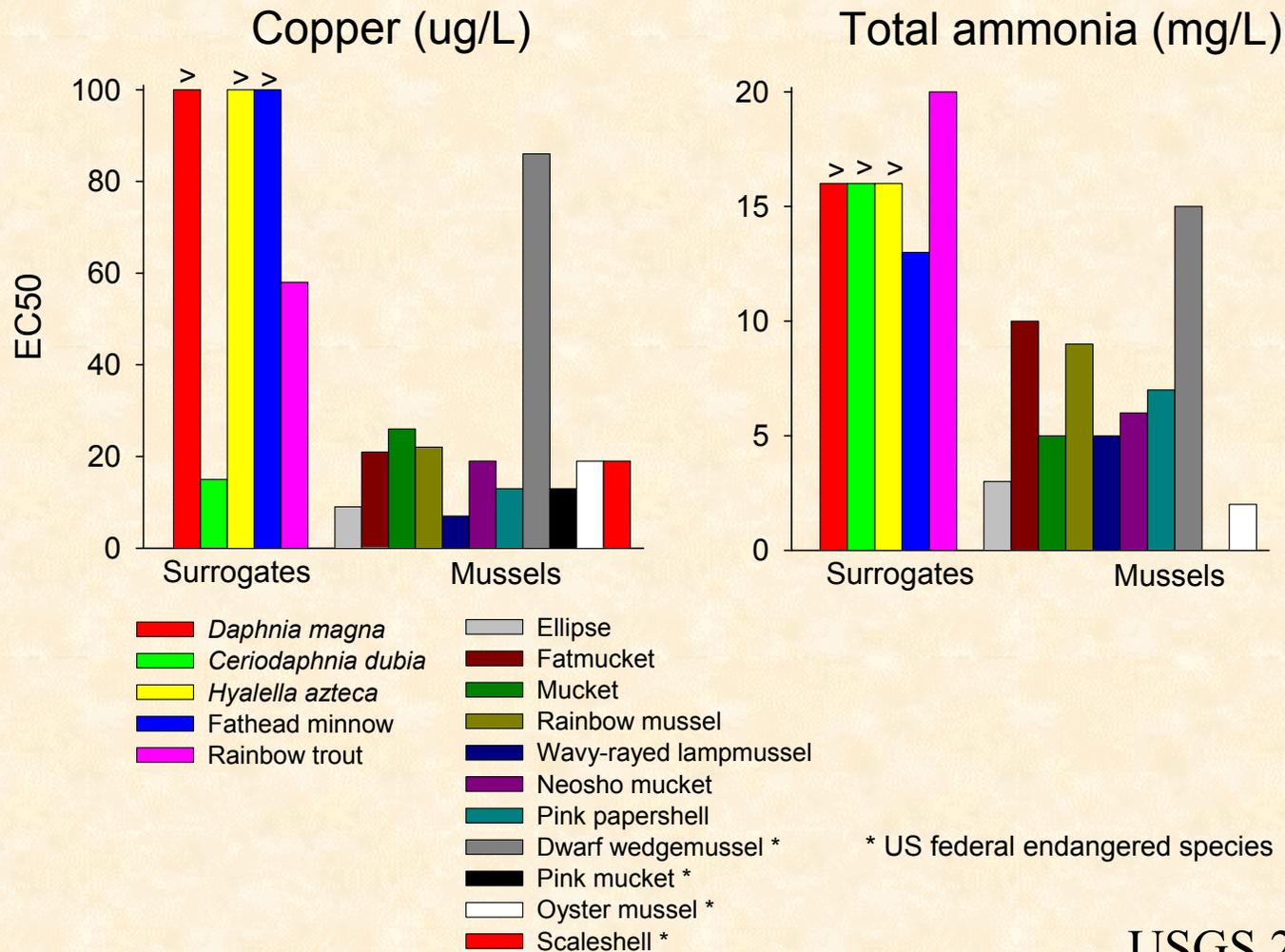
# 24-h EC50s of copper and ammonia for glochidia of 11 mussel species, compared to 48- or 96-h EC50s for surrogates



USGS 2005

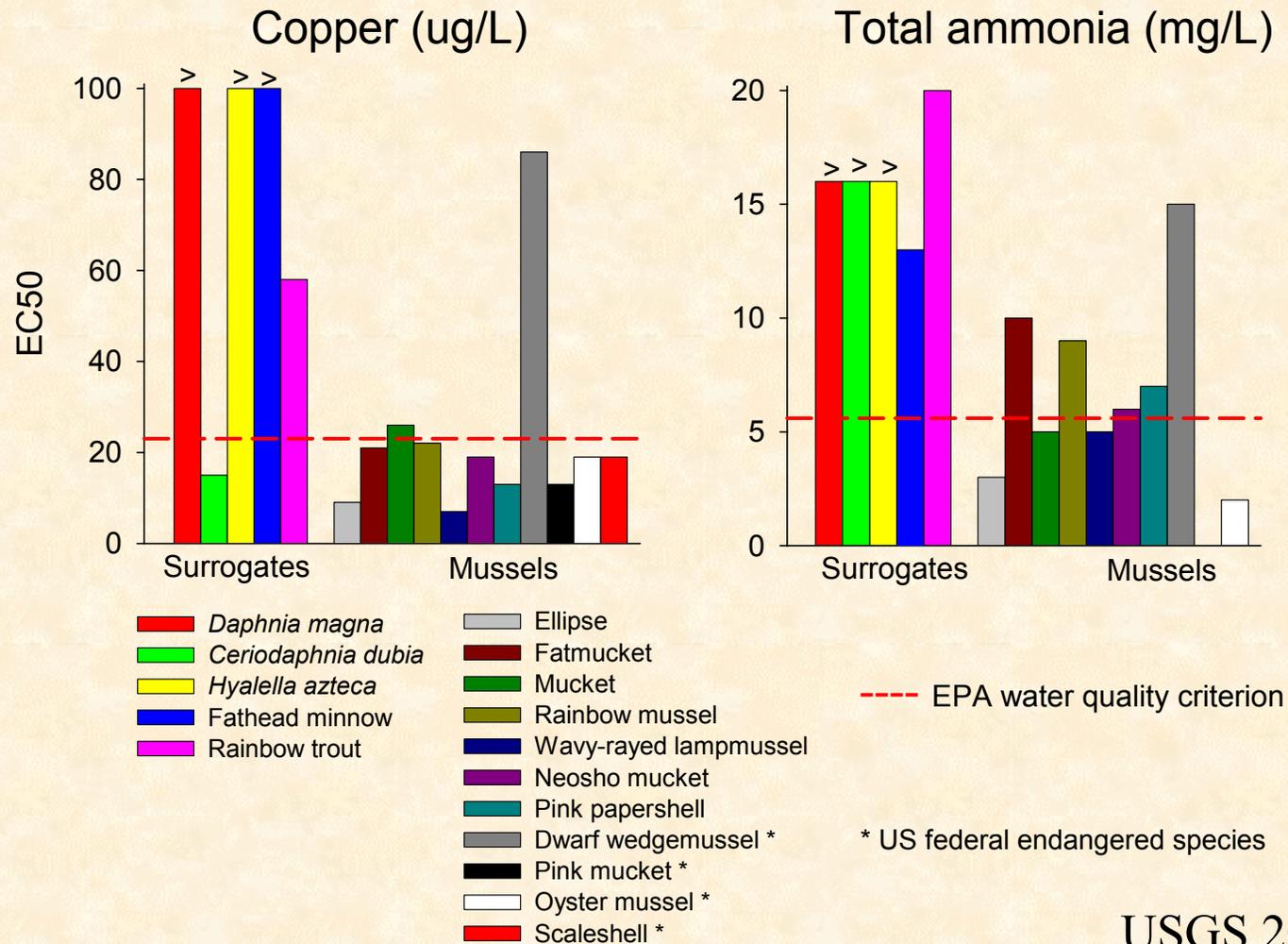


# 48-h EC50s of copper and ammonia for glochidia of 11 mussel species, compared to 48- or 96-h EC50s for surrogates



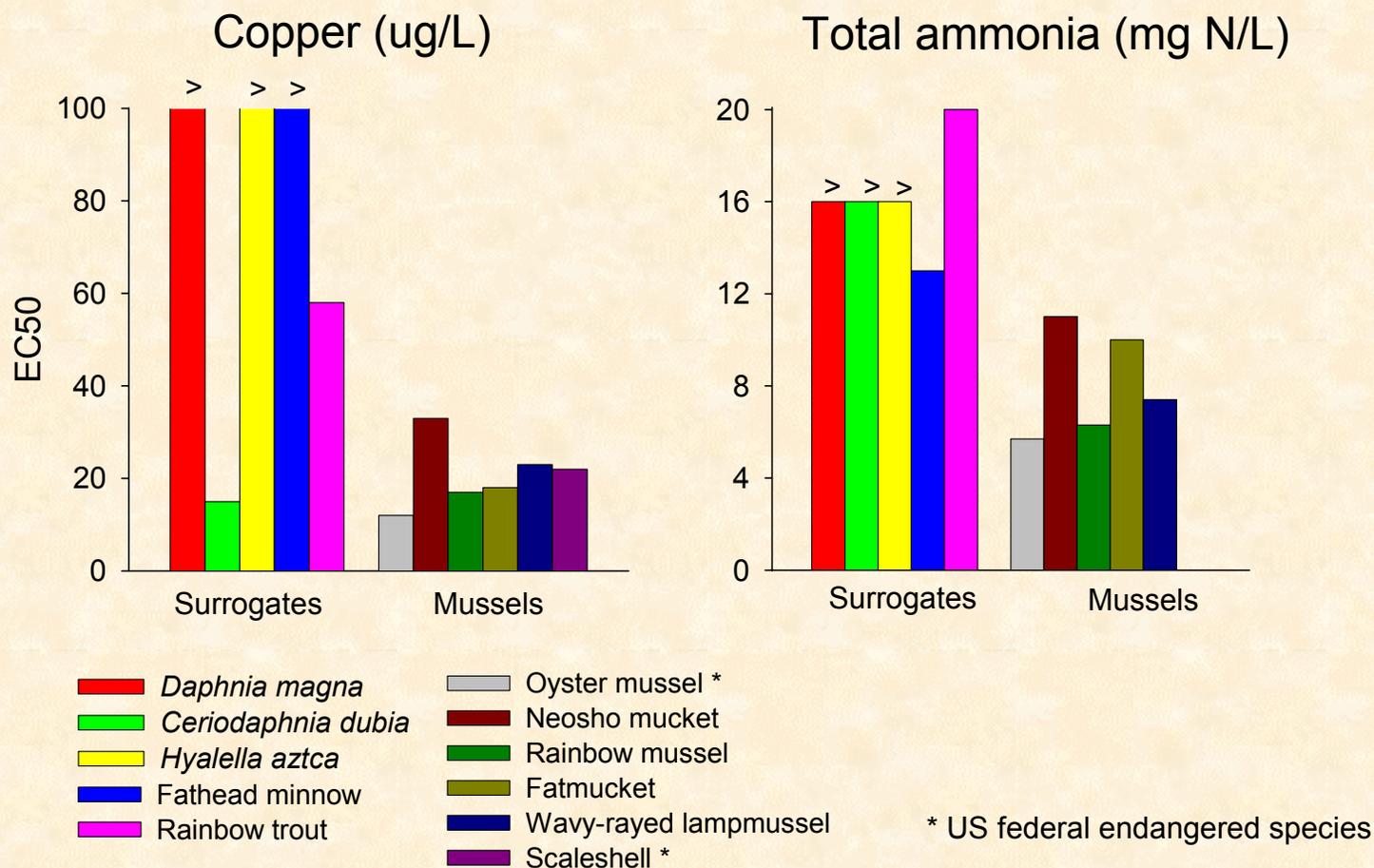
USGS 2005

# 48-h EC50s of copper and ammonia for glochidia of 11 mussel species, compared to 48- or 96-h EC50s for surrogates



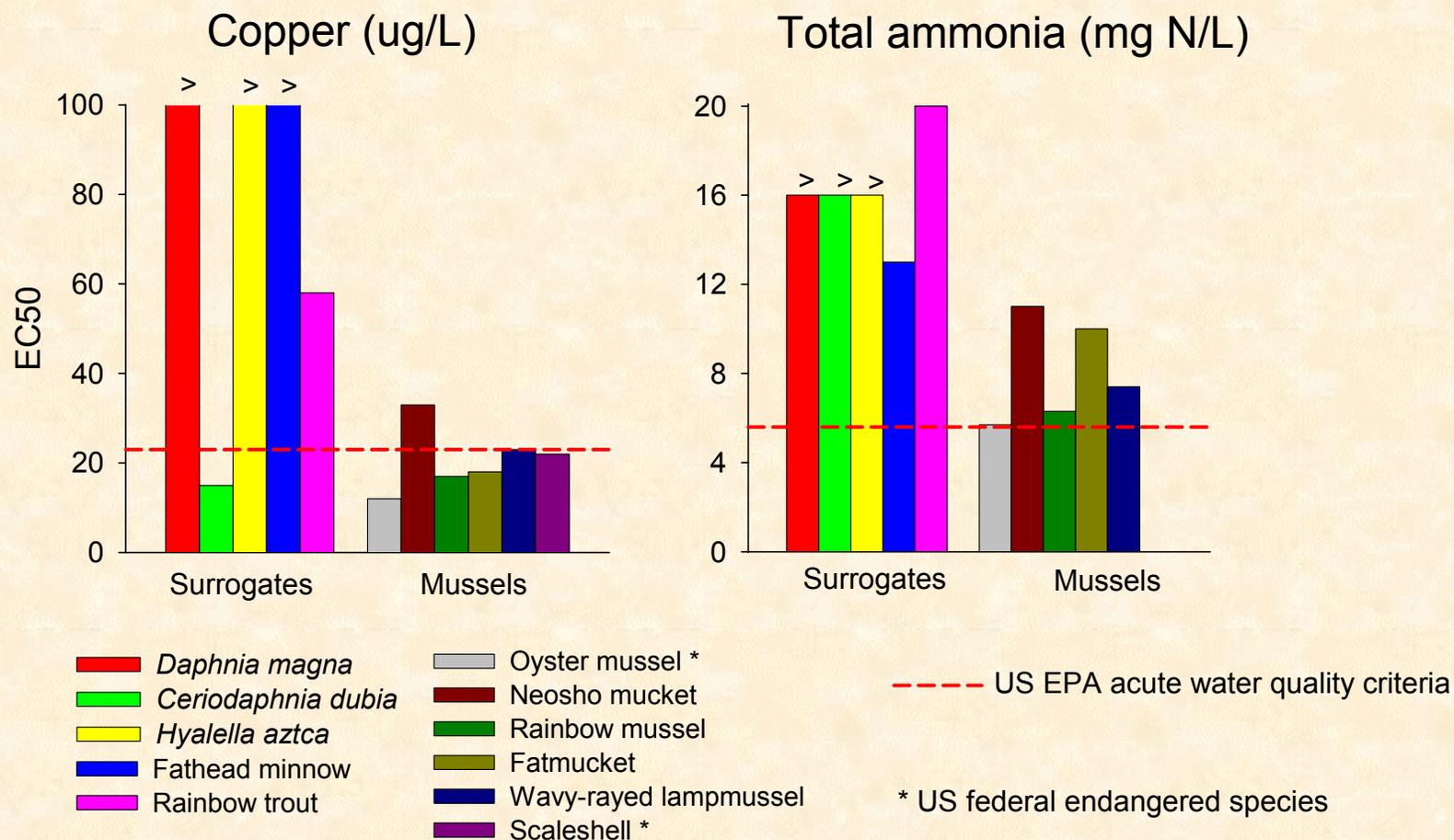
USGS 2005

# 96-h EC50s of copper and ammonia for newly-released juvenile mussels, compared to 48- or 96-h EC50s for surrogates



USGS 2005

# 96-h EC50s of copper and ammonia for newly-released juvenile mussels, compared to 48- or 96-h EC50s for surrogates



USGS 2005

# Conclusions

- Glochidia and newly-released juvenile mussels were more sensitive to ammonia than surrogate organisms
- *Ceriodaphnia dubia*, glochidia, and newly-released juvenile mussels were more sensitive to copper than the other surrogate organisms
- The acute effect concentrations of copper and ammonia for mussels are frequently at or below current EPA WQC