Ambient Water Quality Criteria: Protectiveness of Threatened and Endangered (T&E) Species and Aquatic-dependent Wildlife

David DeForest[1], Robert Gensemer[2], Carrie Claytor[2], Steven Canton[2], Robert Santore[1]

[1] Windward Environmental

[2] GEI Consultants

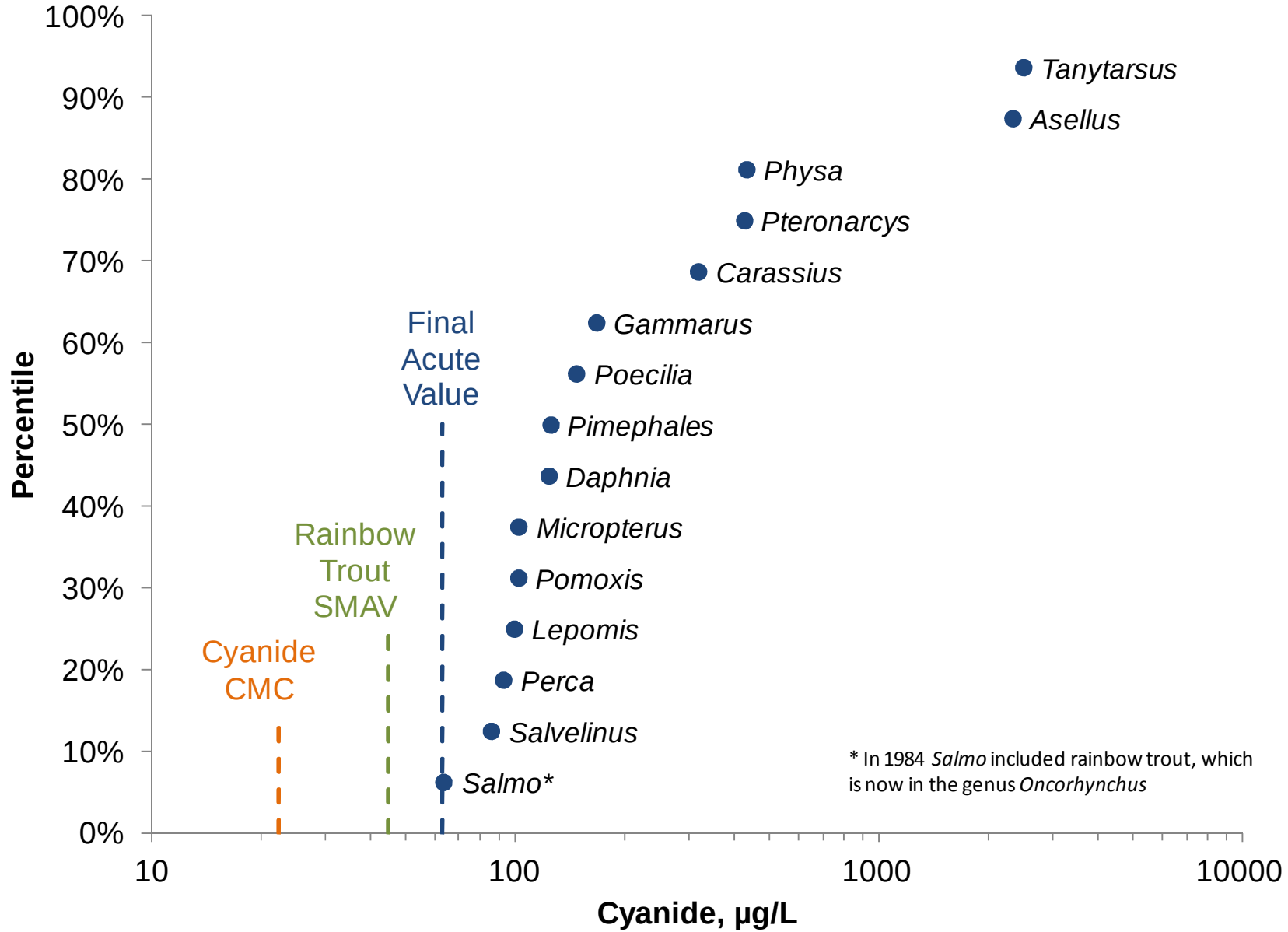
Outline

- Current EPA guidance on AWQC and T&E species
- Example: Cyanide AWQC and protectiveness of T&E species and aquatic-dependent wildlife
- Summary and further considerations

1985 AWQC Guidelines

- "…if the Species Mean Acute Value of a commercially or recreationally important species is lower than the calculated Final Acute Value, then that Species Mean Acute Value replaces the calculated Final Acute Value in order to provide protection for that important species"

Freshwater AWQC for Cyanide



EPA's Water Quality Standards Handbook

- "A critical species is a species that is commercially or recreationally important at the site, a species that exists at the site and is listed as threatened or endangered under section 4 of the Endangered Species Act, or a species for which there is evidence that the loss of the species from the site is likely to cause an unacceptable impact on a commercially or recreationally important species, a threatened or endangered species, the abundances of a variety of other species, or the structure or function of the community."

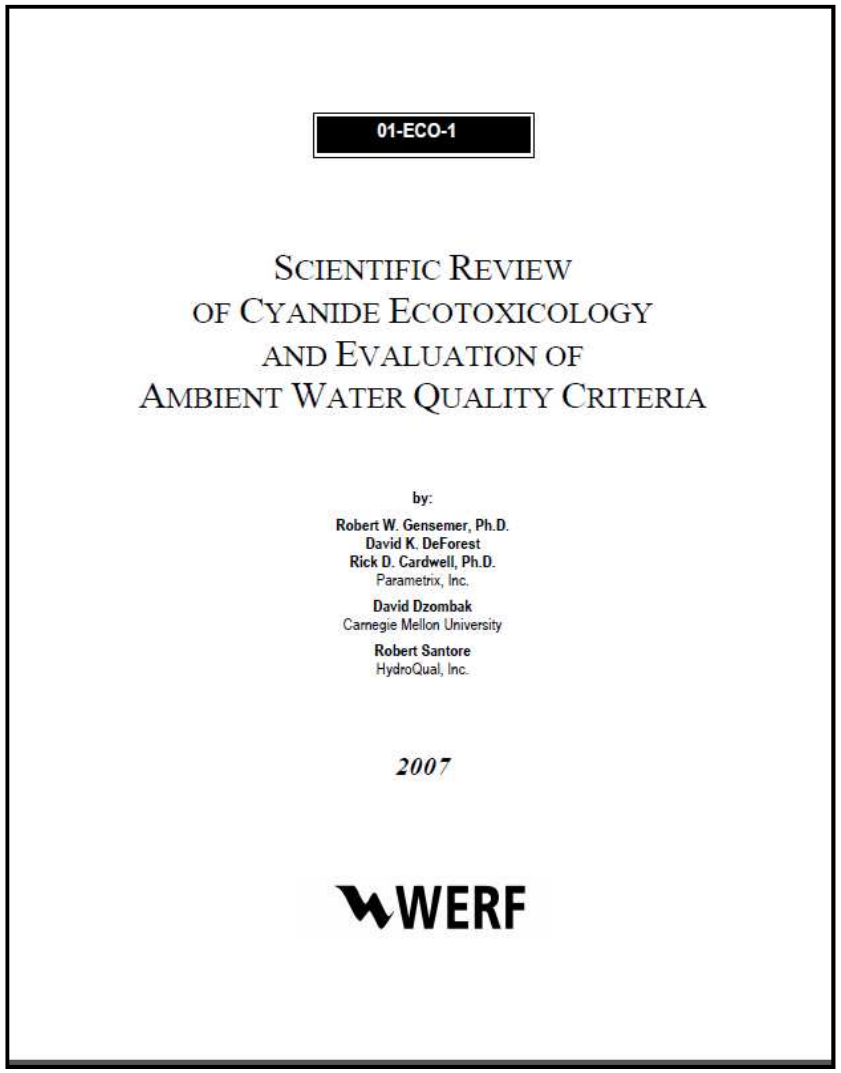
Freshwater AWQC for Ammonia

- Explicitly evaluates whether AWQC are protective of “listed” T&E species
- Acute criterion dataset – 12 listed species
- Chronic criterion dataset – 3 listed species
  - Plus 3 other studies with supporting chronic toxicity information

Draft Freshwater AWQC for Selenium

- “An EC10 based on only one partial response would not ordinarily be included in the chronic data set, but there are supporting data that suggest the federally-listed threatened species green sturgeon is also sensitive to selenium…This species [white sturgeon]…is listed as endangered in specific locations, such as the Kootenai River white sturgeon in Idaho and Montana. The white sturgeon is also a taxonomic surrogate for other freshwater sturgeon species (e.g., shovelnose sturgeon) that are threatened or endangered."

Example of Aquatic Life T&E Evaluation for Cyanide



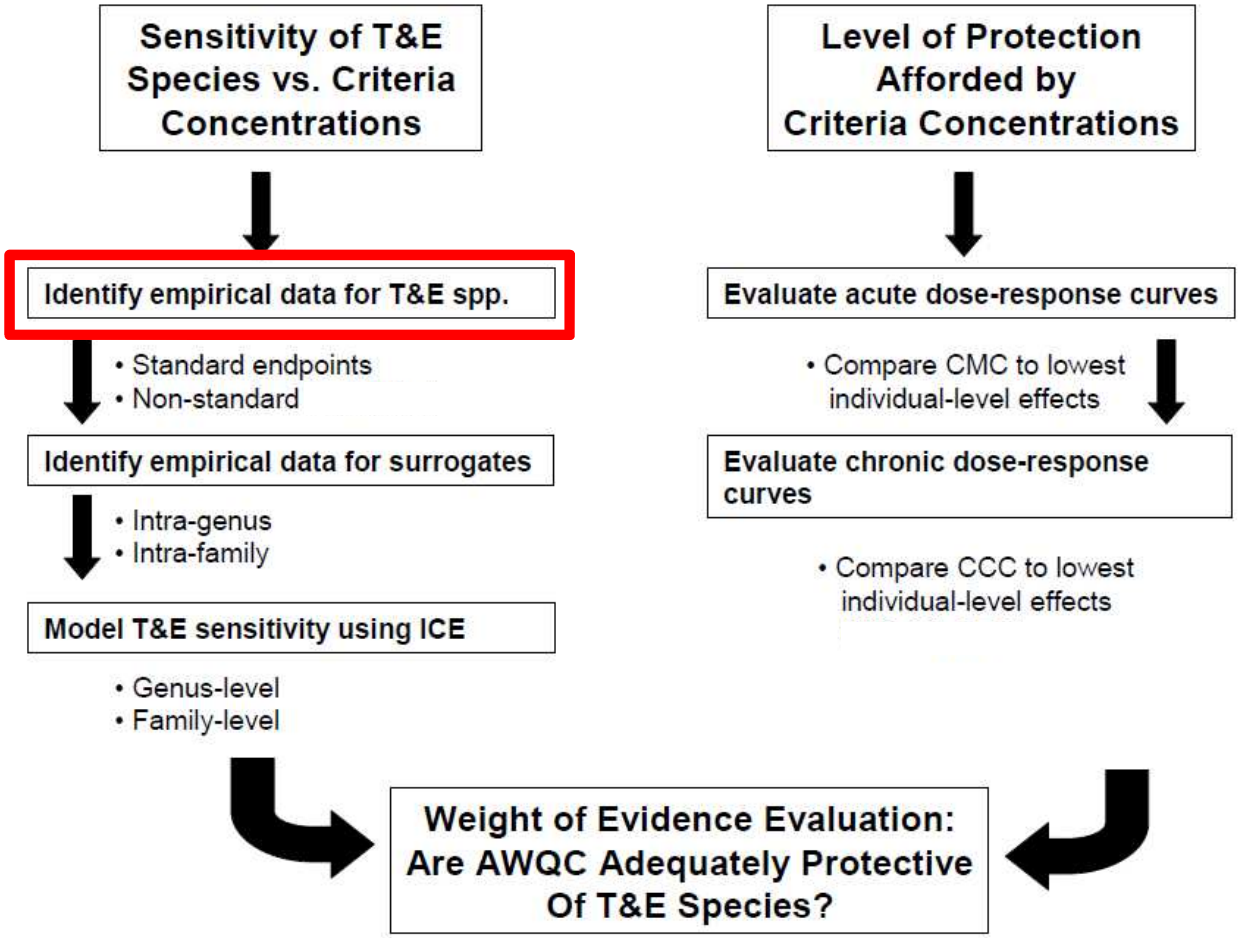
- Updated cyanide toxicity database
- Proposed updates to cyanide AWQC
- Evaluated protectiveness of:
  - T&E aquatic life
  - Aquatic-dependent wildlife

Cyanide Criteria

Exposure	EPA Criteria (1984)	Proposed Update
Acute	22 µg/L	23 µg/L
Chronic	5.2 µg/L	4.8 µg/L

- Fish more sensitive than invertebrates
  - Amphibian data lacking
- Evaluation focused on T&E fish species

Cyanide T&E Evaluation Framework

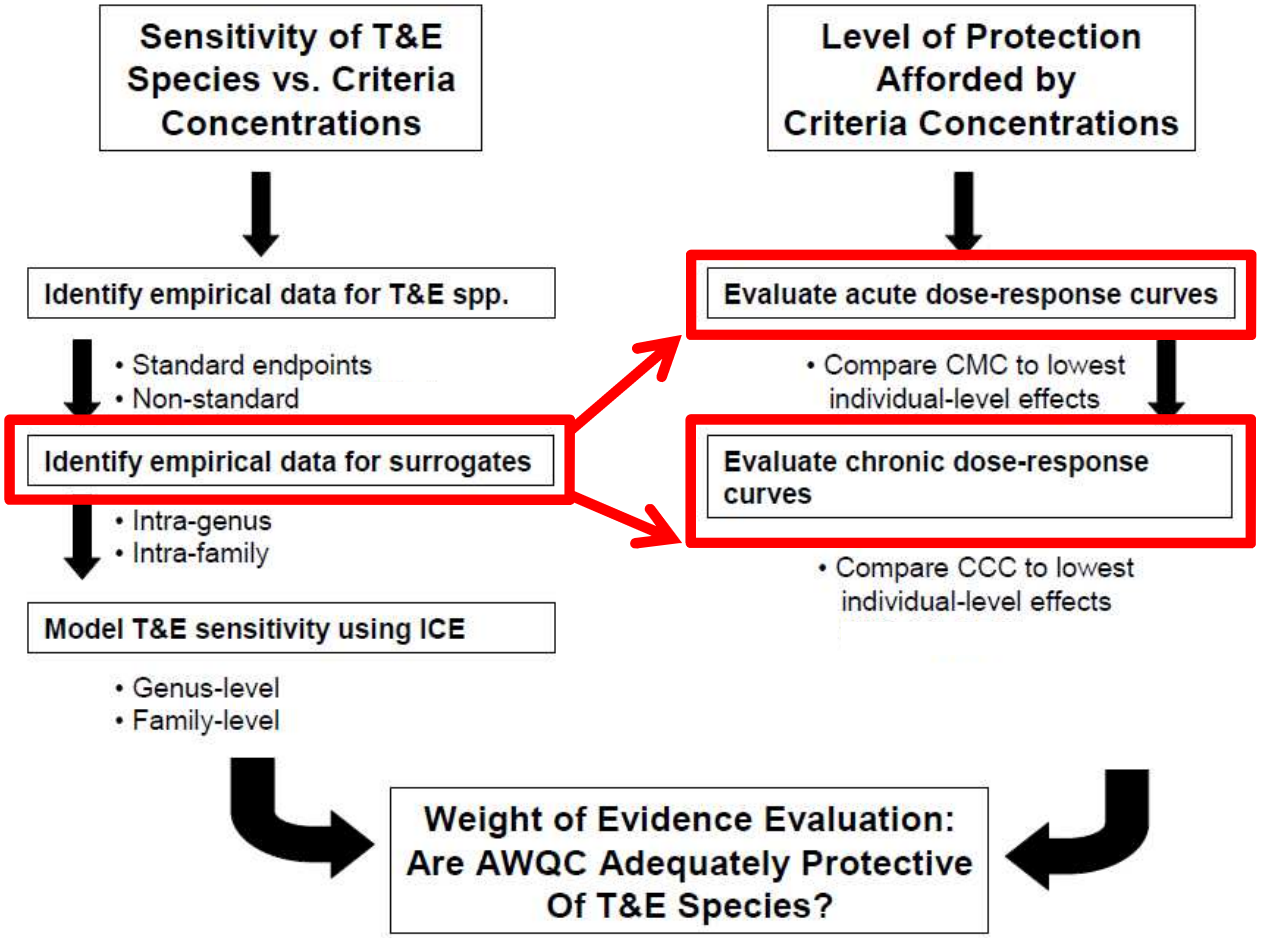


Cyanide Toxicity Data for T&E Fish Species

Species	Exposure Duration	Effect	Conc. (µg CN/L)	Reference
O. kisutch	24 d	Growth reduction	80	Leduc 1966
O. kisutch	194 h	Reduced ability to swim against current	Control (8.72 min) 10 (3.80 min) 30 (1.85 min) 50 (1.45 min)	Broderius 1970
O. tshawytscha	2 mo	Reduced biomass	20	Negilski 1973

Proposed updated acute criterion = 23 µg/L
Proposed updated chronic criterion = 4.8 µg/L

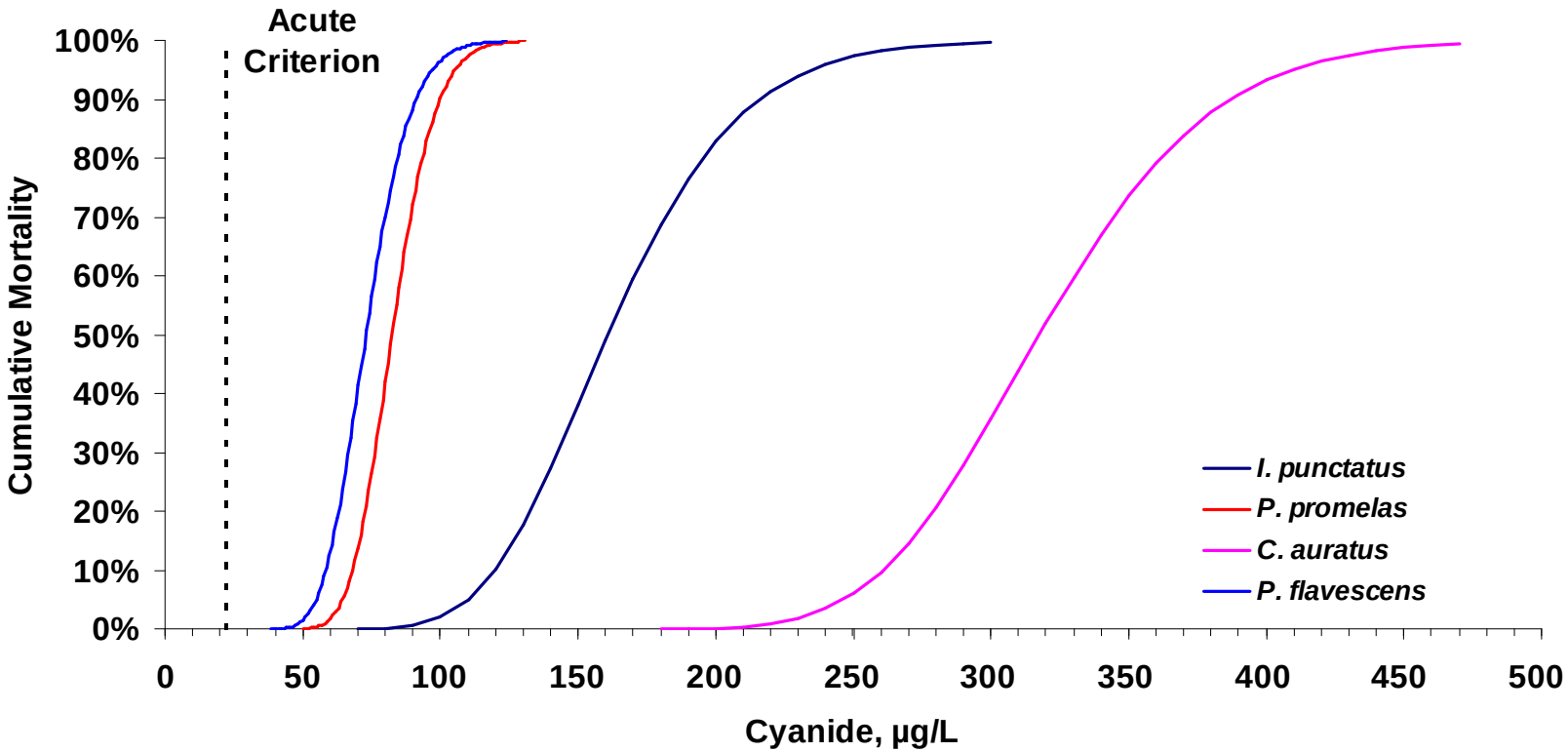
Cyanide T&E Evaluation Framework



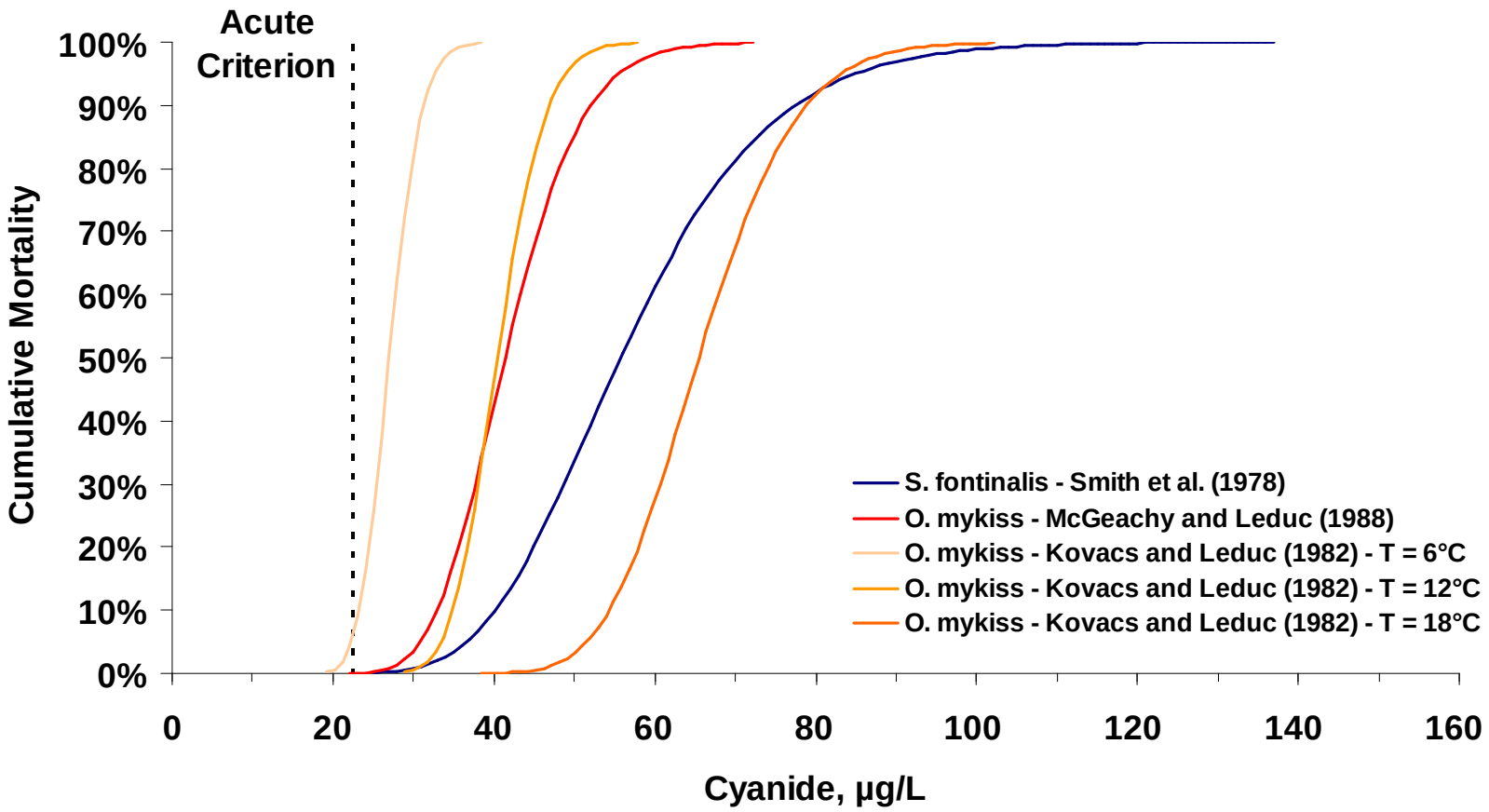
Cyanide Toxicity Data for T&E Surrogate Fish Species

T&E Family	Types of Fish	Species With CN Toxicity Data Available
Ictaluridae	Catfish	*Ameiurus melas* (black bullhead); *Ictalurus punctatus* (channel catfish)
Amblyopsidae	Cavefish	None
Cyprinidae	Chub, dace, shiner, pikeminnow, woundfin	*Carassius auratus* (goldfish); *Pimephales promelas* (fathead minnow); *Rhinichthys atratulus* (blacknose dace); *Notemigonus crysoleucas* (golden shiner)
Catostimidae	Cui-ui, suckers	None
Percidae	Darters	*Perca flavescens* (yellow perch)
Poecilidae	*Gambusia*	*Poecilia reticulata* (guppy)
Gobiidae	Goby	None
Cyprinodontidae	Poolfish, pupfish, springfish	None
Salmonidae	Salmon, trout	*Oncorhynchus mykiss* (rainbow trout); *Salmo salar* (Atlantic salmon); *Salvelinus fontinalis* (brook trout)
Cottidae	Sculpin	None
Gasterostidae	Stickleback	*Gasterosteus aculeatus* (threespine stickleback)
Acipenseridae	Sturgeon	None

Cyanide Toxicity Data for T&E Surrogate Fish Species: Acute Toxicity

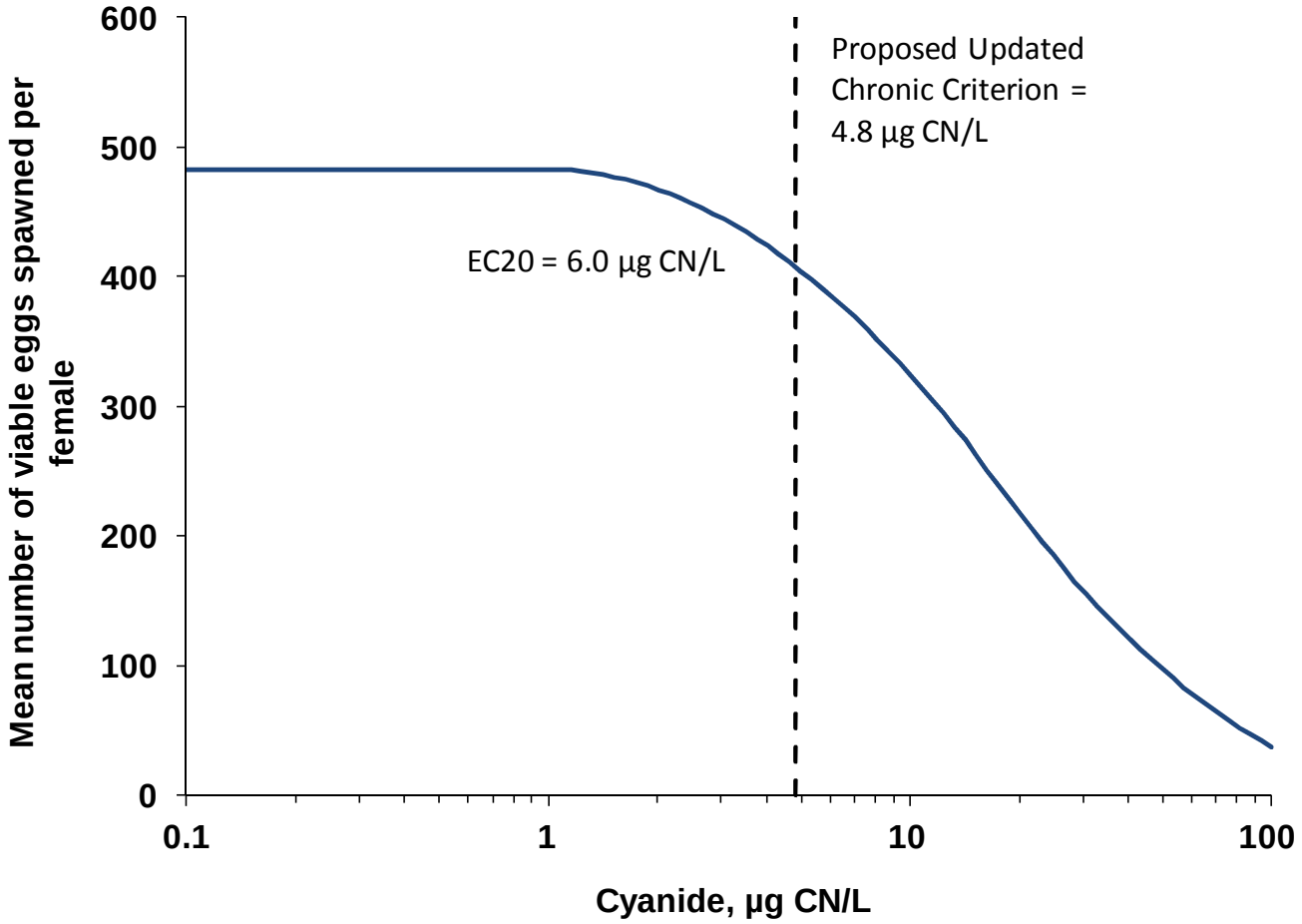


Cyanide Toxicity Data for T&E Surrogate Fish Species: Acute Toxicity for Salmonids



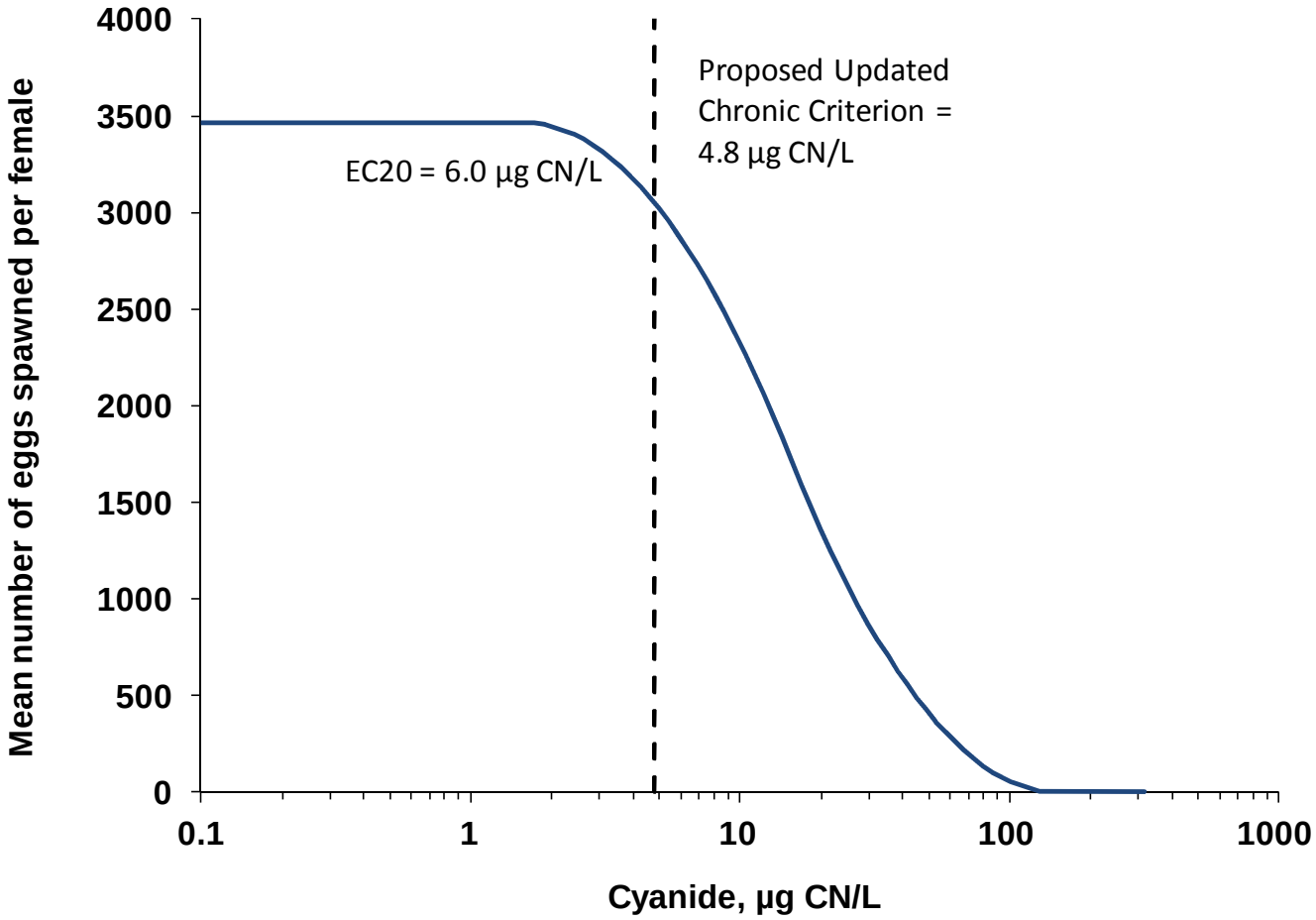
Cyanide Toxicity Data for T&E Surrogate Fish Species: Chronic Toxicity

S. fontinalis
Family: Salmonidae

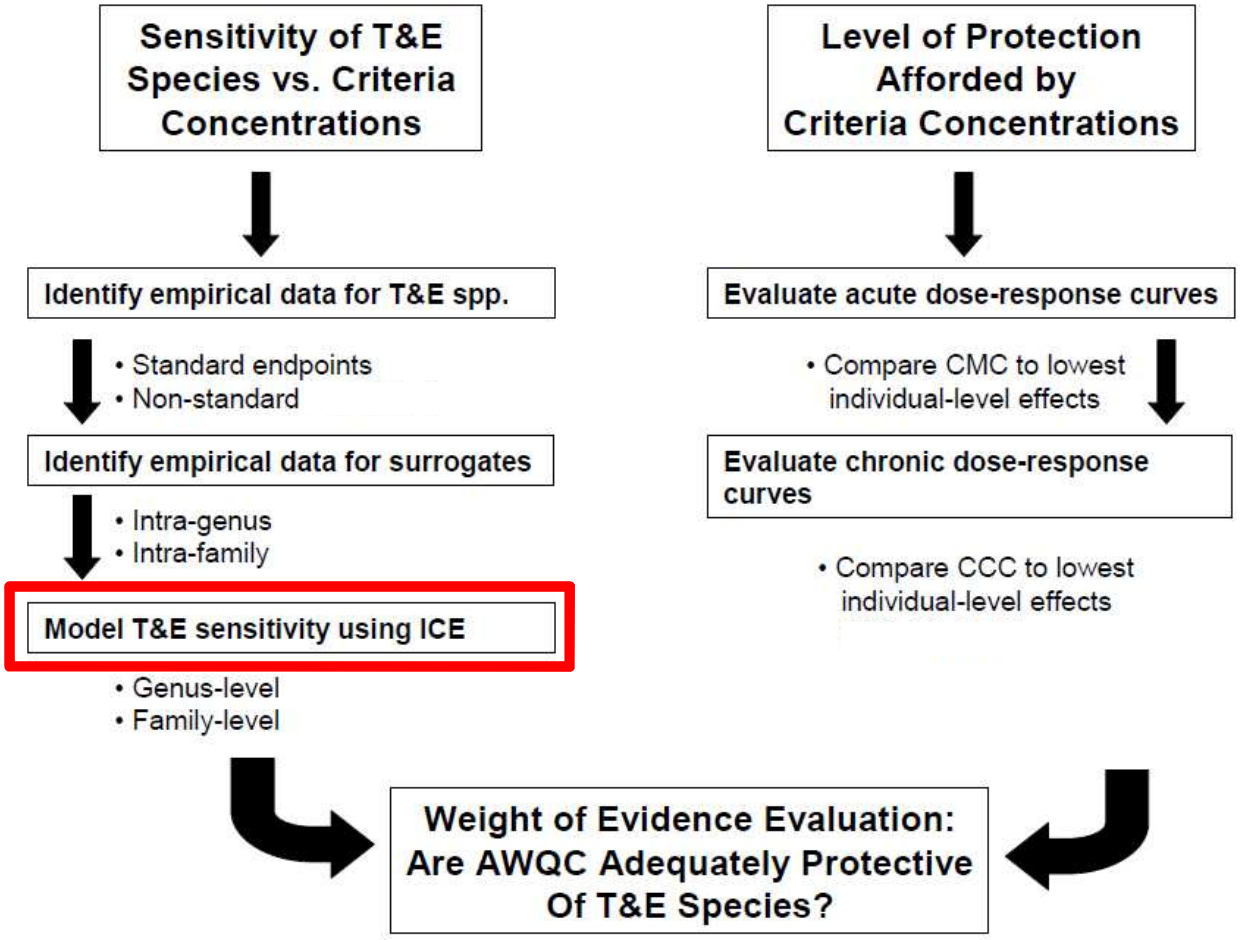


Cyanide Toxicity Data for T&E Surrogate Fish Species: Chronic Toxicity

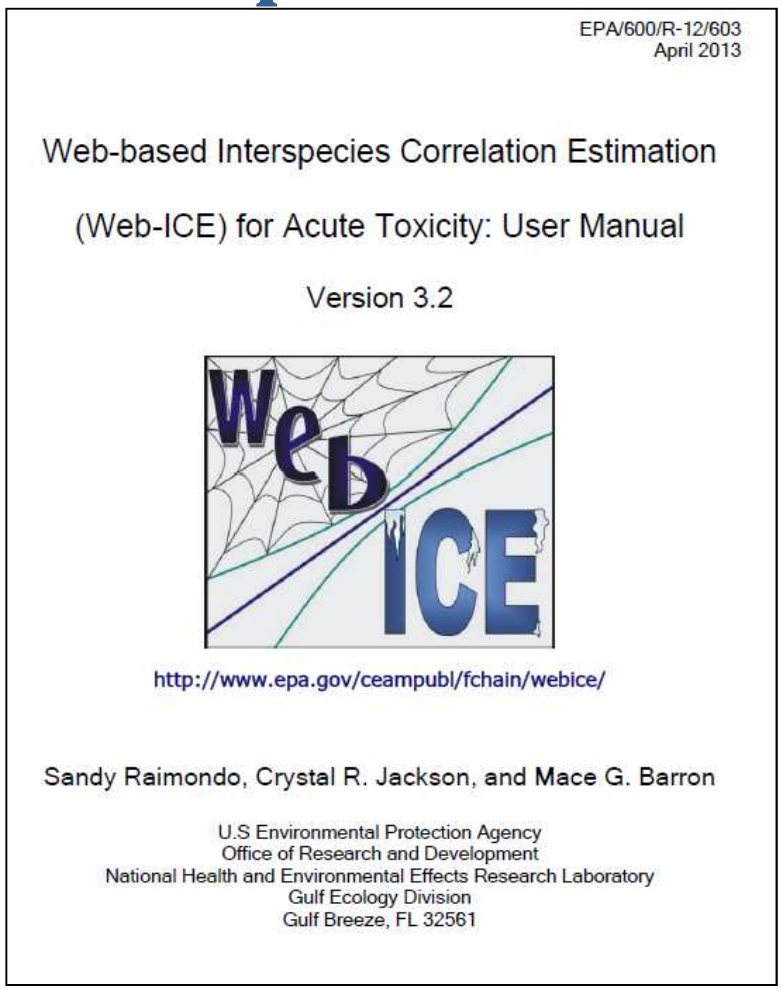
P. promelas
Family: Cyprinidae



Cyanide T&E Evaluation Framework



Cyanide Toxicity Data for T&E Surrogate Fish Species: ICE Model



EPA/600/R-12/603
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Web-based Interspecies Correlation Estimation

(Web-ICE) for Acute Toxicity: User Manual

Version 3.2

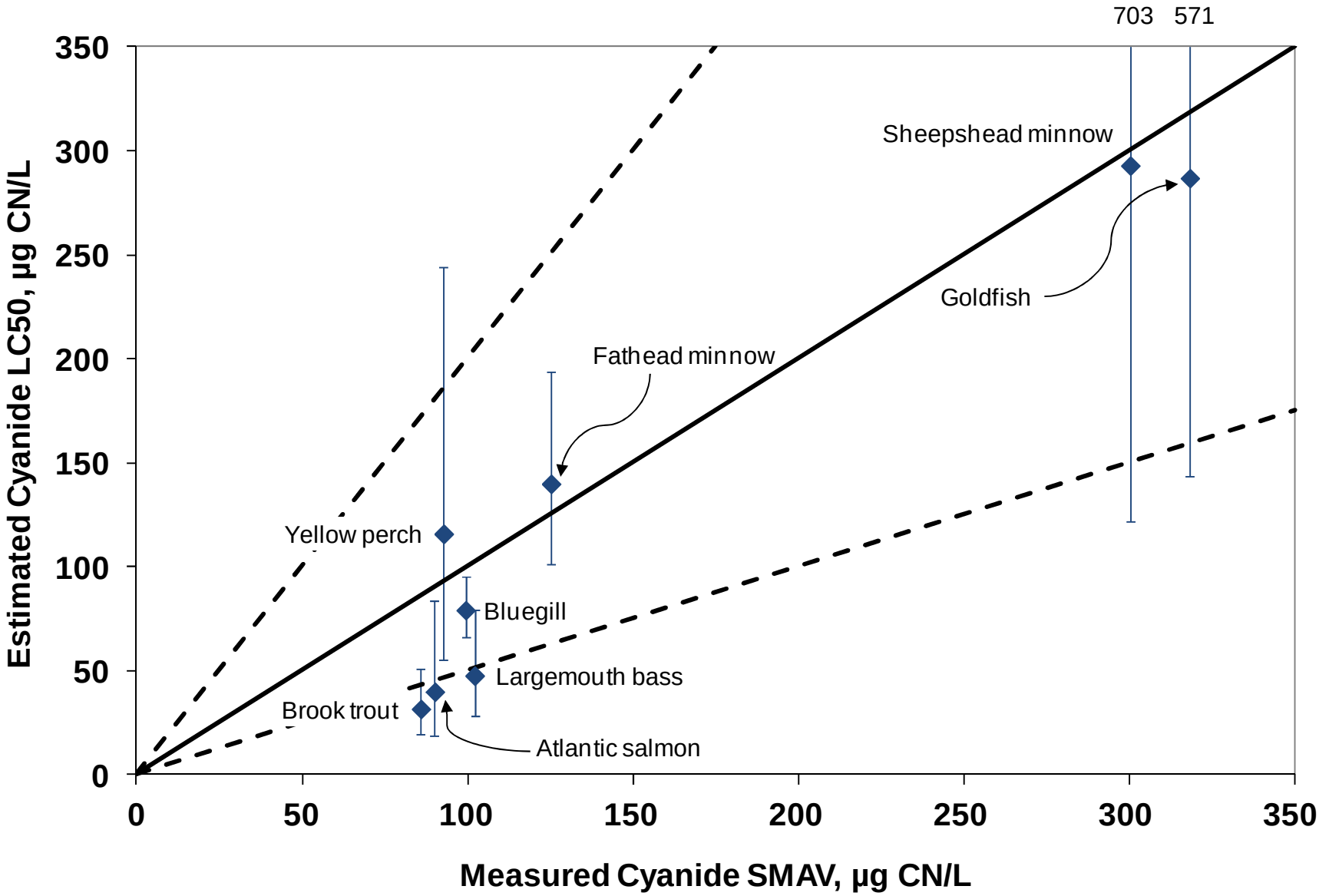
http://www.epa.gov/ceampubl/fchain/webice/

Sandy Raimondo, Crystal R. Jackson, and Mace G. Barron

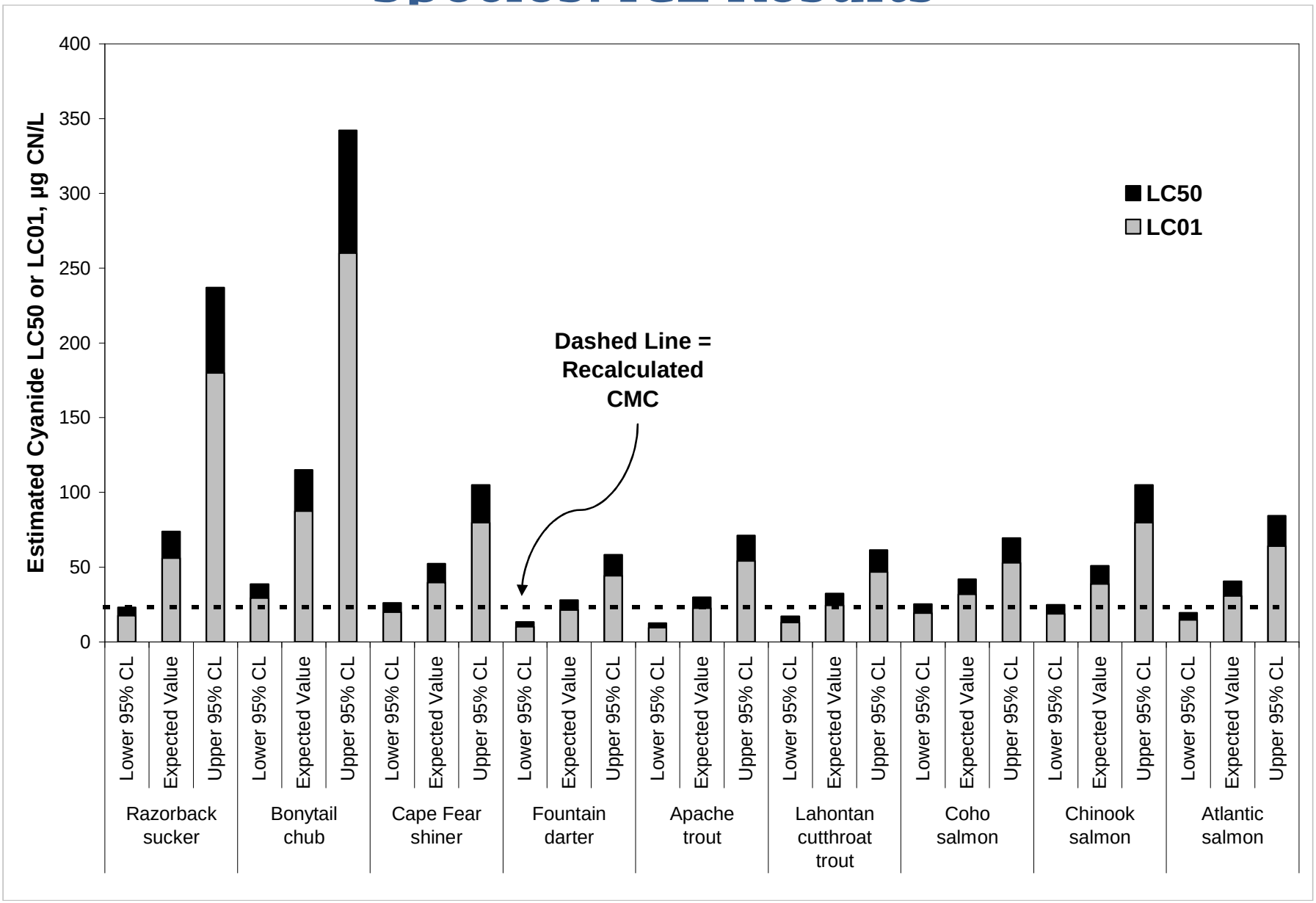
U.S Environmental Protection Agency
Office of Research and Development
National Health and Environmental Effects Research Laboratory
Gulf Ecology Division
Gulf Breeze, FL 32561

Estimates “the acute toxicity (LC50/LD50) of a chemical to a species, genus, or family with no test data (the predicted taxon) from the known toxicity of the chemical to a species with test data (the surrogate species)”

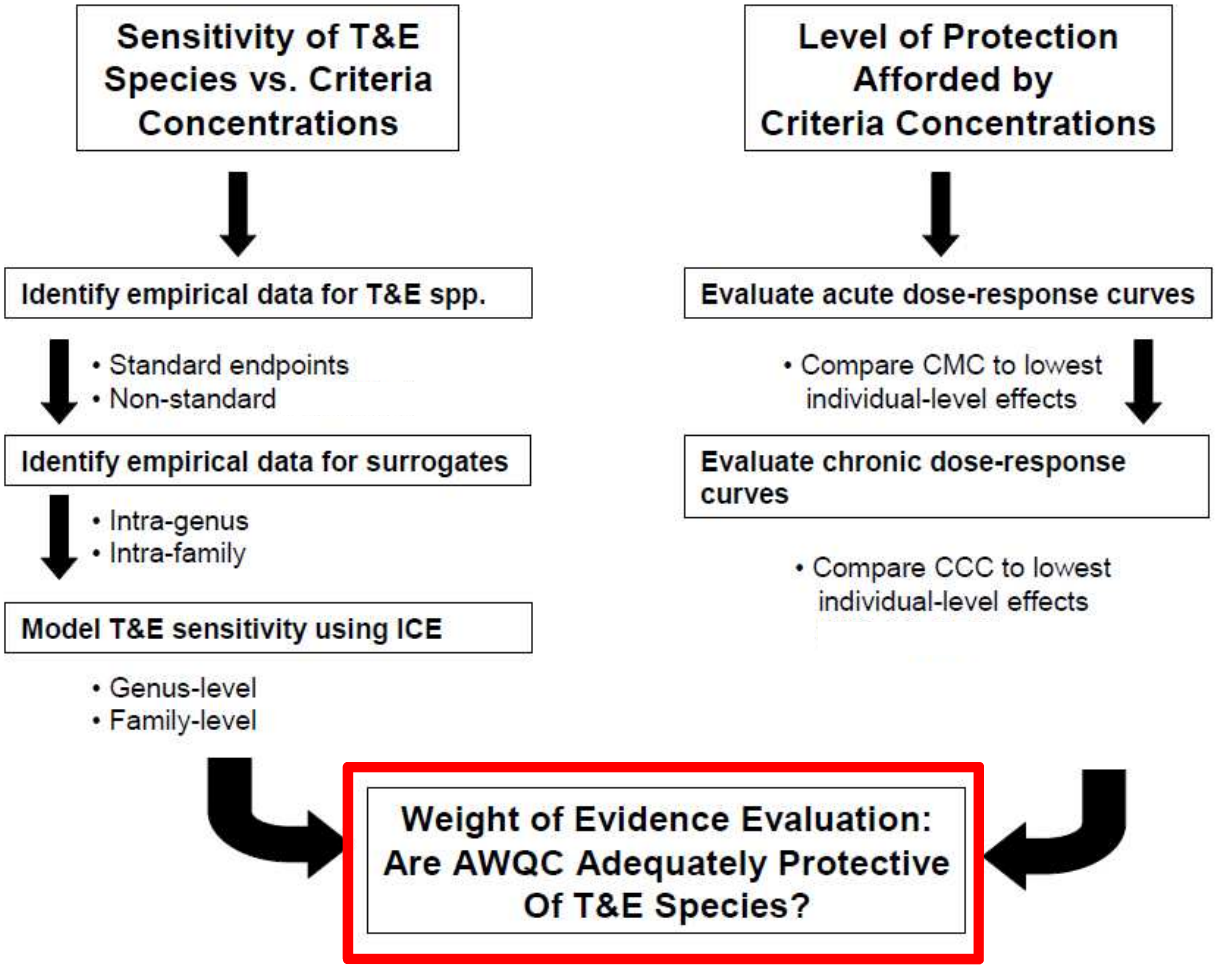
Measured vs. Estimated Cyanide Toxicity Data Using ICE



Cyanide Toxicity Data for T&E Surrogate Fish Species: ICE Results



Cyanide T&E Evaluation Framework



Cyanide T&E Evaluation Conclusions

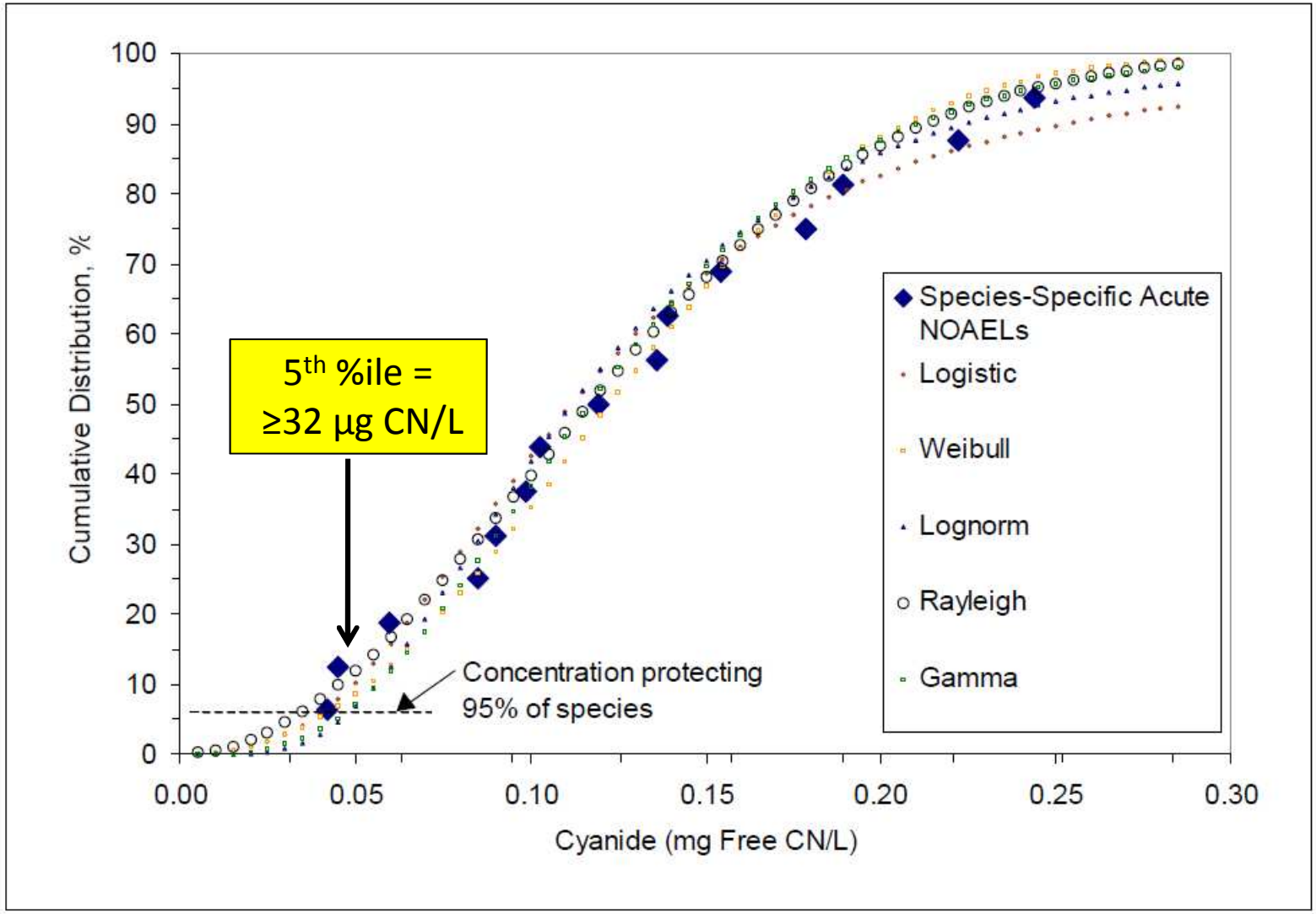
- Chronic criterion appears protective of certain sublethal endpoints for salmon
- Acute toxicity data for surrogate species suggest that T&E species are adequately protected
- Chronic cyanide toxicity data for surrogate species suggest there could be low levels of effects at the chronic criterion, although these were statistically insignificant
- ICE model corroborates the test data showing the rainbow trout SMAV ÷ 2 to be protective of salmonids, percids, cyprinids, and ictalurids, and predicts it will also protect cyprinodontids
- Removal of coldwater species in Recalculation Procedure should be done with caution because those species could be surrogates for other T&E species

Example of Aquatic-dependent Wildlife Evaluation for Cyanide

Risk-based Evaluation for Wildlife

- Problem Formulation
  - Sublethal cyanide doses rapidly metabolized and excreted
  - Critical exposure pathway = surface water ingestion
- Exposure Characterization
  - Compile BW and WIR information for suite of birds and mammals
- Effects Characterization
  - Safe cyanide dose = 0.01 mg CN/kg_{BW}-d
- Risk Characterization
  - Evaluate protectiveness of cyanide AWQC

Risk-based Evaluation for Wildlife (cont.)



Summary and Further Considerations

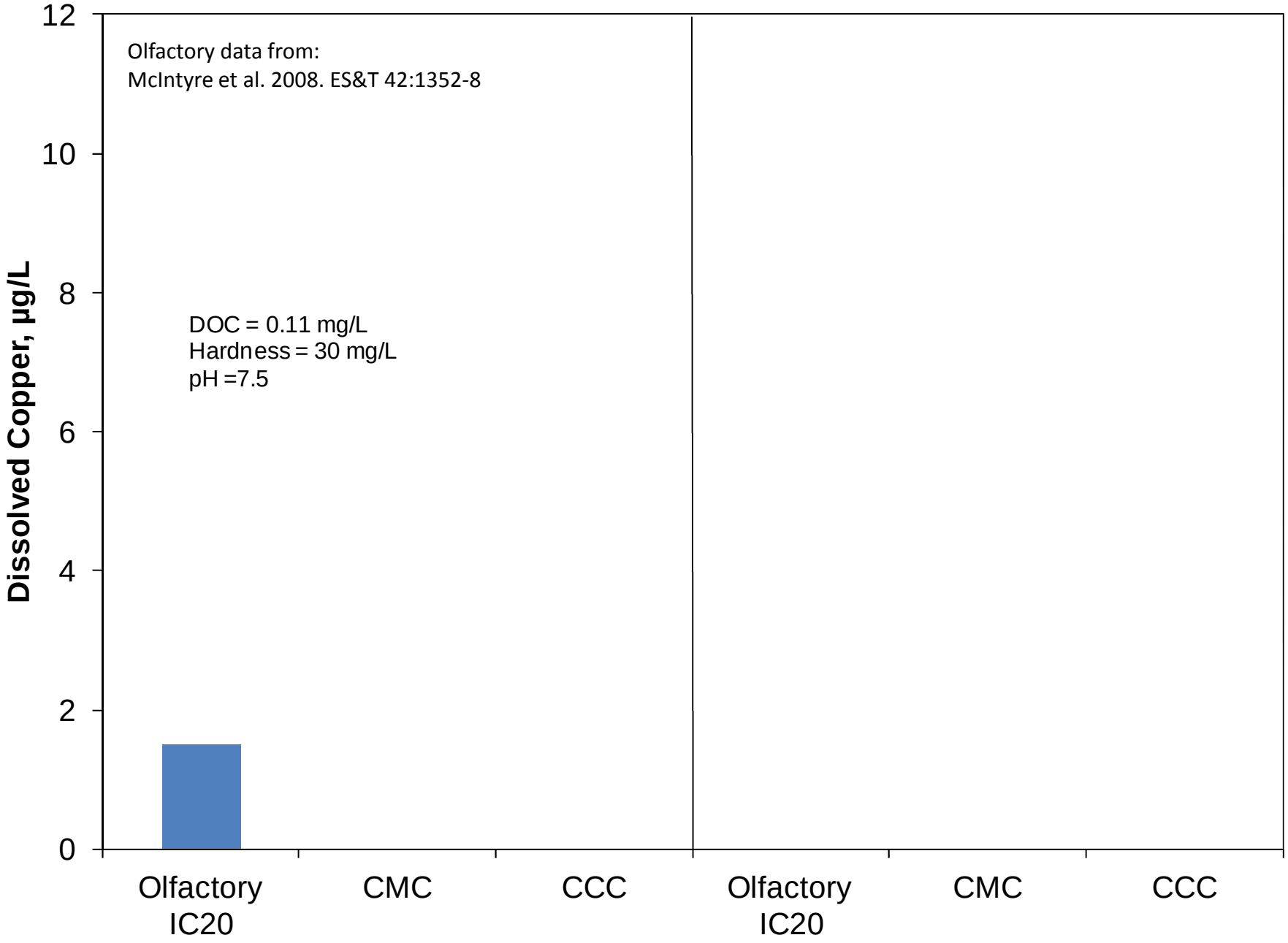
Incorporate Risk-based Framework for T&E Evaluations in AWQC Documents

- EPA already moving toward this
- Use existing EPA guidance and tools to evaluate whether aquatic life AWQC are protective of T&E species
  - Ecological risk assessment guidance
  - ICE model
  - Bioavailability models (e.g., biotic ligand model)
- Should additional toxicity endpoints be considered for T&E species?
  - Document state-of-the-science and methodology for evaluation in analysis plan
  - Support T&E consultations and site-specific criteria development

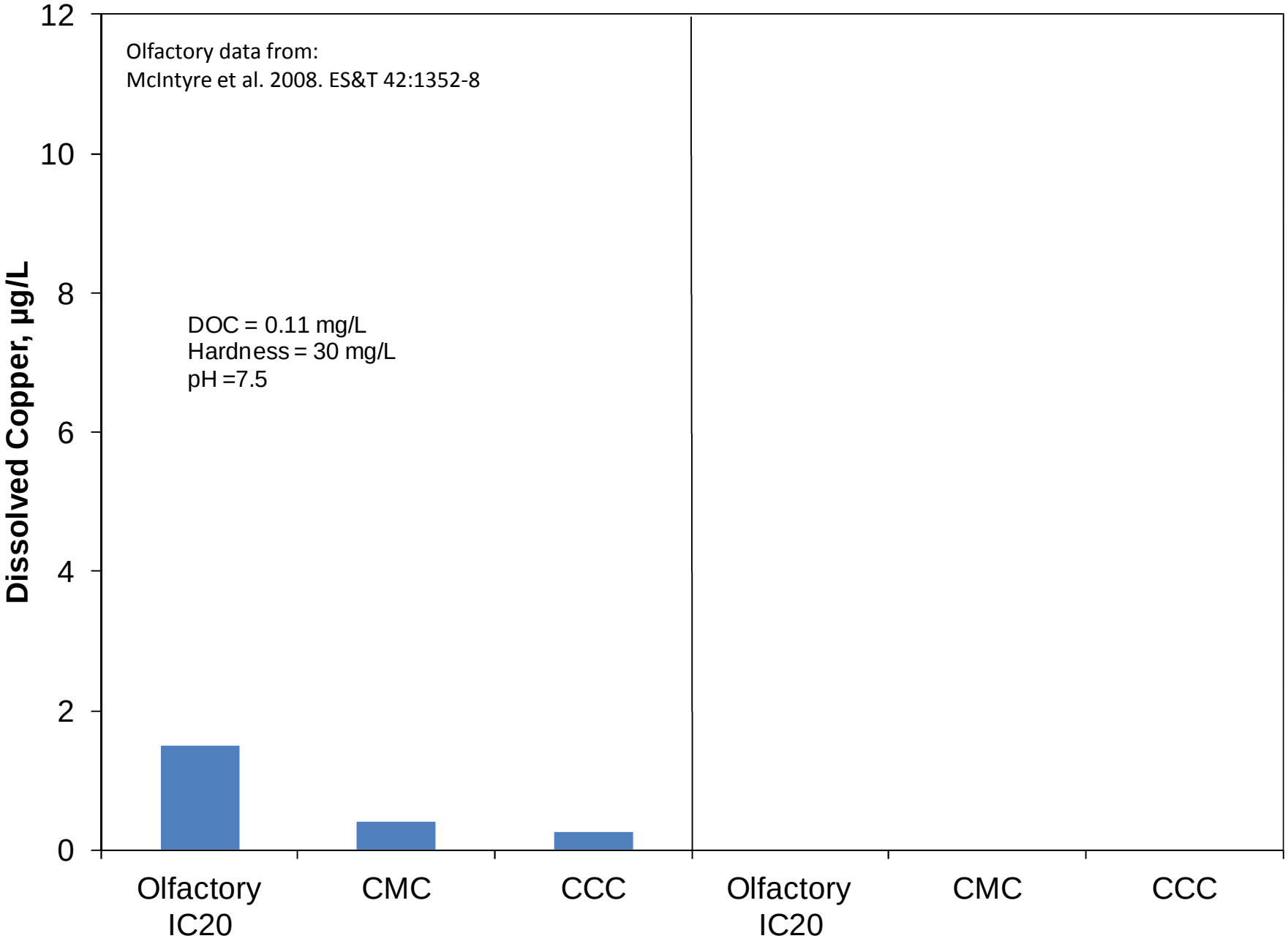
Example: Copper and Olfactory Impairment in Listed Pacific Salmon

- EPA's recommended freshwater AWQC for copper based on biotic ligand model (BLM)
  - BLM accounts for bioavailability of copper over wide range of water chemistry conditions
- Concerns that copper AWQC are not protective against olfactory impairment in listed fish species (e.g., salmon)
  - Copper bioavailability generally not accounted for in olfactory protectiveness evaluations

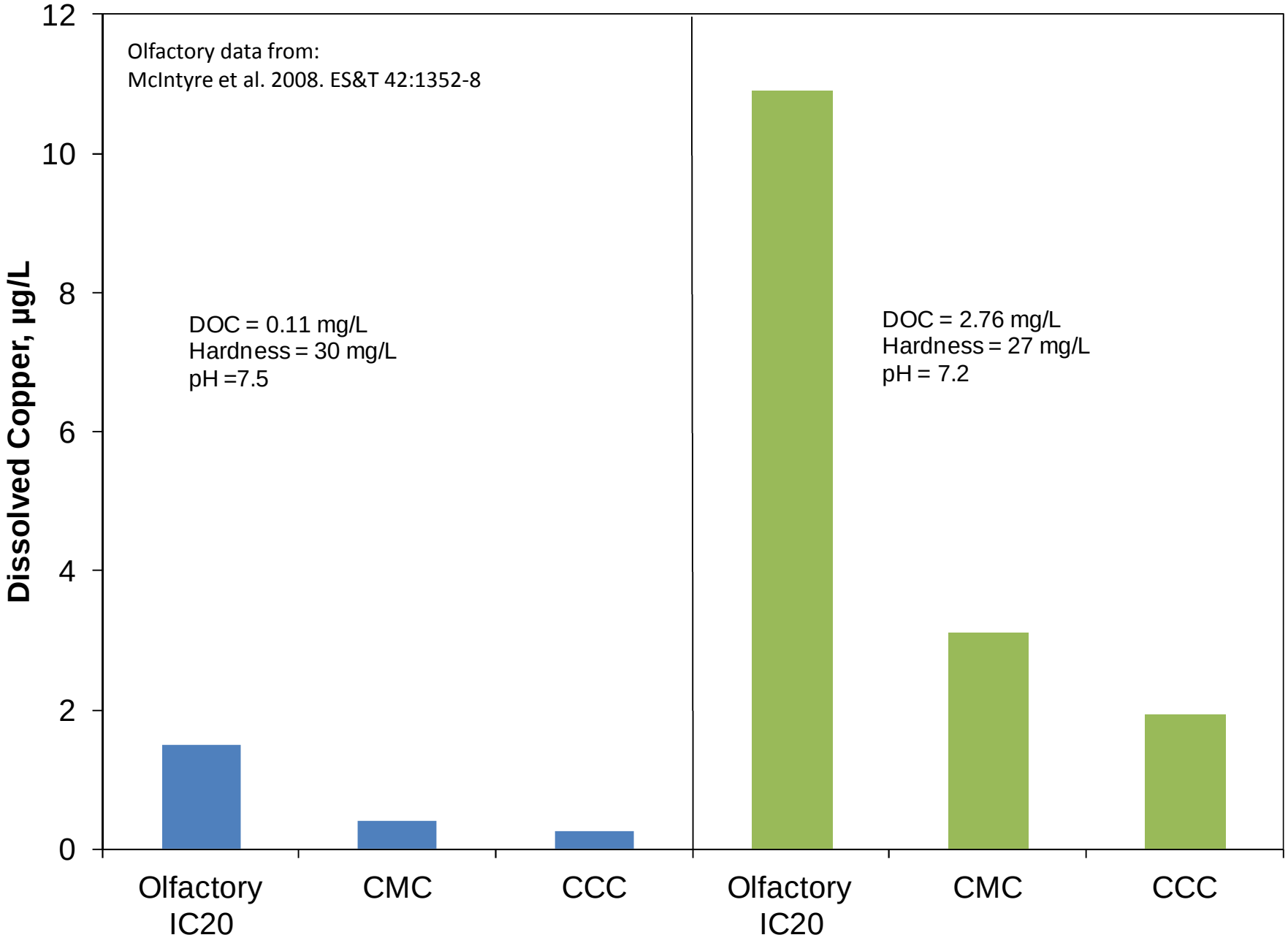
Copper AWQC and Olfactory Impairment



Copper AWQC and Olfactory Impairment



Copper AWQC and Olfactory Impairment



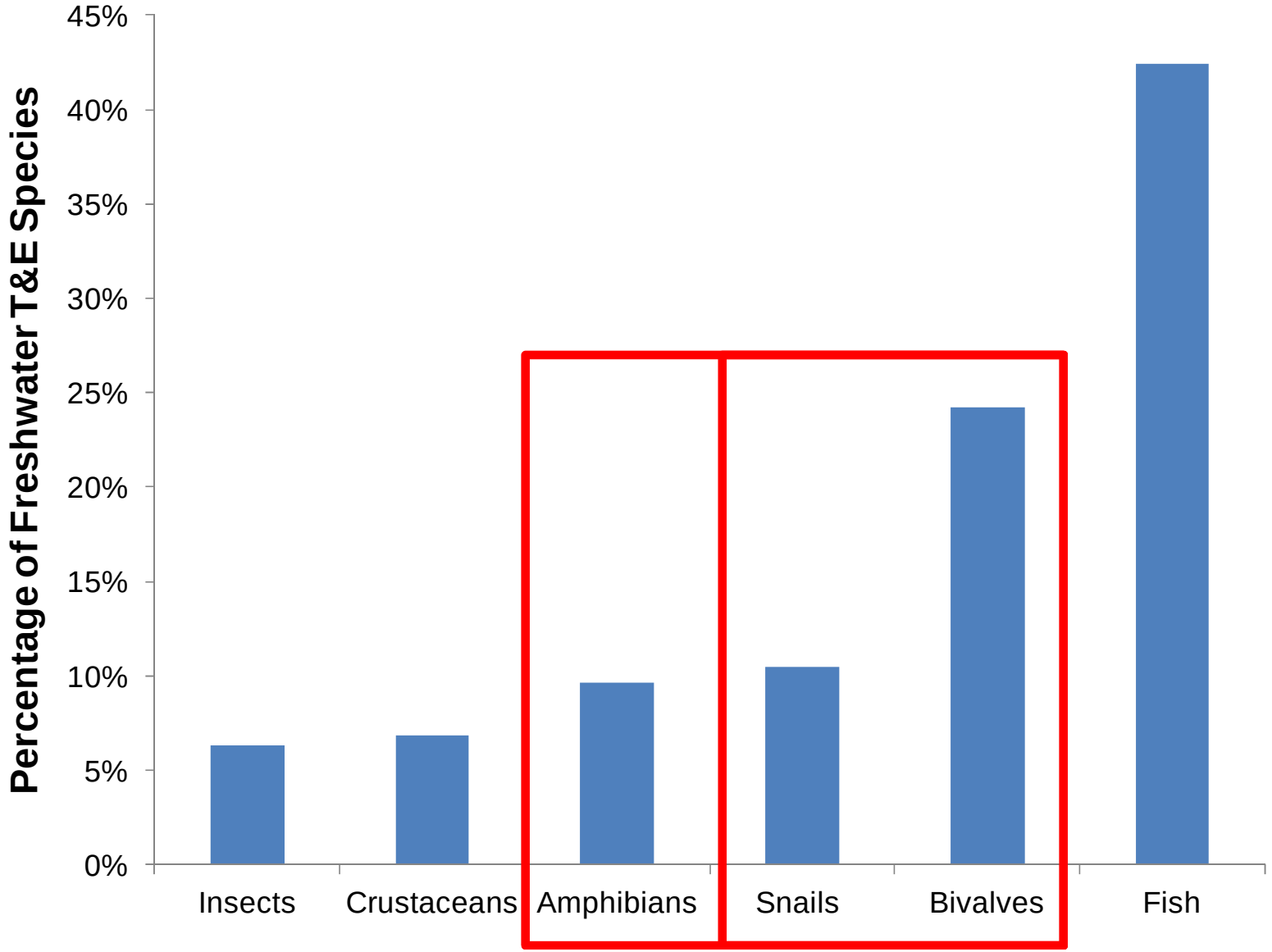
Numeric Criteria and T&E Species Sensitivity

- No evidence that T&E species are inherently more sensitive to chemical stressors than non-T&E species
- Continue to develop aquatic life AWQC designed to be protective of aquatic communities
- Expand minimum phylogenetic diversity requirements?

Current Minimum Data Requirements?

Requirement
Family Salmonidae in the class Osteichthyes
Second family in the class Osteichthyes, preferably a commercially or recreational important species (e.g., bluegill, channel catfish, etc.)
Third family in the phylum Chordata (may be in the class Osteichthyes or may be an amphibian, etc.)
Planktonic crustacean (e.g., cladocerans, copepod, etc.)
Benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish, etc.)
Insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge, etc.)
Family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca, etc.)
Family in any order of insect or any phylum not already represented

Freshwater T&E Species by Organism Group



Numeric Criteria and T&E Species Sensitivity (cont.)

- Expand minimum phylogenetic diversity requirements to include mussels, snails, and/or amphibians
  - Maybe?
  - Or question whether mussels, snails, and/or amphibians are expected to be relatively sensitive to a given class of contaminants
- If relevant, this could help ensure protection of aquatic communities and closely related T&E species

How Low is Low Enough?

- Lower and lower numbers can always be derived, but what is defensible?
- Statistical endpoints?
  - EC20? EC10? EC01?
- Level of protection?
  - 5^{th} percentile? Lower percentile?

Recommendations for Guideline Revisions

- Explicitly recommend risk-based framework and available tools for T&E protectiveness evaluations
  - To the extent practical, incorporate T&E evaluations directly into AWQC documents that reflect the state-of-the-science
- Explicitly recommend effects endpoints and statistical endpoints