

Sensitivity of Lamprey Ammocoetes to Six Chemicals

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Background

- Impacts to resident fish are being evaluated as part of the baseline ecological risk assessment (BERA) in Portland Harbor
- Lamprey ammocoetes were selected to represent native detritivorous fish in the BERA
- Early stages of the BERA used surrogate species to evaluate risks to lamprey

Issue

- Use of surrogates introduced uncertainty
 - Lamprey have a unique life history and are only distantly related to other fish species being evaluated
- Most toxicity data for lamprey are based on lampricides
- Sensitivity study was conducted to address this data gap

Study Objectives

- Establish ammocoete collection and handling techniques
- Develop exposure system for the flow-through tests
- Perform range-finding toxicity tests for chemicals with different modes of action
- Perform definitive flow-through test for each chemical to derive LC50s
- Evaluate relative sensitivity of ammocoetes

Approach

- Study performed in two phases
- Phase 1
 - Modified sampling methods
 - Refined laboratory husbandry
 - Conducted acute range-finding tests
 - Investigated the effect of temperature
- Phase 2
 - Completed range-finding tests
 - Conducted definitive test

Target Chemicals

- Tested six chemicals representing different modes of toxicity
 - Pentachlorophenol (oxidative phosphorylation uncoupler)
 - Copper (gill dysfunction)
 - Diazinon (acetylcholinesterase inhibitor)
 - Aniline (polar narcosis)
 - Naphthalene (narcosis)
 - Lindane (central nervous system interference)

Collection Sites

Collected ammocoetes (most likely Pacific lamprey [*Entosphenus tridentatus*]) from four Oregon coastal rivers

- Trask River (Southeast of Tillamook)
- Nestucca River (Near Pacific City)
- Siletz River (Southeast of Lincoln City)
- Alsea River (East of Waldport)

Field Collection Techniques

- Electroshocking used two different pulse rates—one to drive ammocoetes out of sediment and another to stun
- Ammocoetes were held in chilled site water and sediment for transport to laboratory

Electroshocking



Handling and Transport



Laboratory Handling Parameters

- 50 organism per tank
 - 26 L water; 7 to 9 cm of commercial sand
- Dechlorinated, aerated municipal water
 - Flow-through plus daily batch replacement
- Distressed animals were discarded
- Holding temperature \approx field conditions
 - Acclimated organisms over 2 to 4 weeks
- Organisms were not fed
- 16:8 photoperiod

Laboratory Holding Tank



Exposure System

- Stock solutions were prepared based on chemical form and solubility
- Diluter was designed to deliver 0.5 dilution series
- Test chambers were continuously supplied

Test Conditions

- 96-hr exposure
- Flow-through
- Test concentrations confirmed daily
- 10 organisms per replicate; 5 replicates
- Well-oxygenated
- Soft water
- 17 ± 0.8 °C
- No light (except during daily measurements)

Data Analysis

- Effect levels calculated based on mortality
- LC50s calculated using probit or trimmed Spearman-Kärber methods
- No effect/lowest effect calculated based on EPA 2002

EPA. 2002. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. EPA-821-R-02-012.

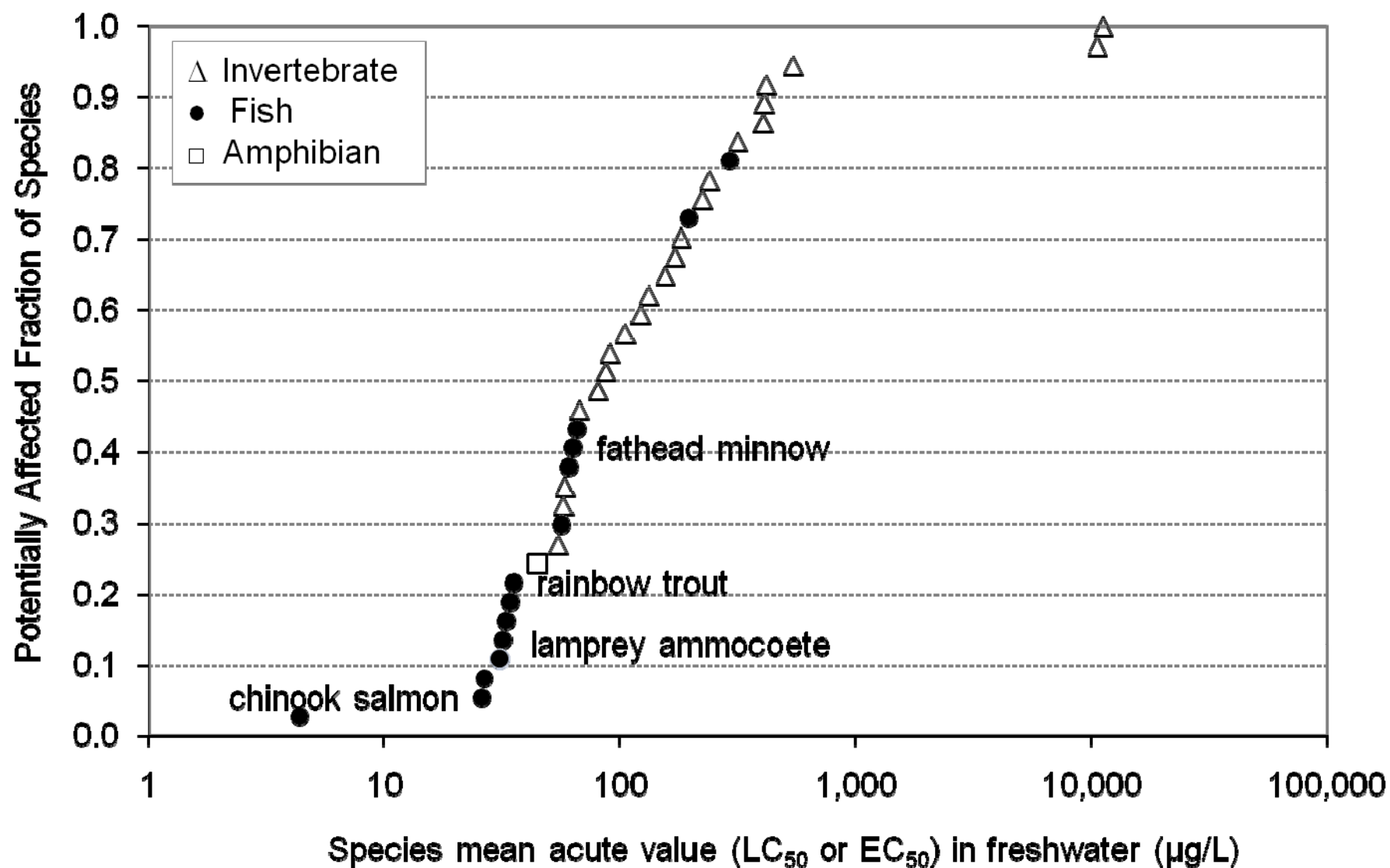
LC50s for Ammocoetes

- Pentachlorophenol 31 $\mu\text{g/L}$
- Copper (as copper sulfate) 46 $\mu\text{g/L}$
- Diazinon 8.9 $\mu\text{g/L}$
- Aniline 430 $\mu\text{g/L}$
- Naphthalene 10 $\mu\text{g/L}$ (50% mortality occurred in highest test concentration)
- Lindane > 2.68 $\mu\text{g/L}$ (highest test concentrations elicited 12.5% mortality)

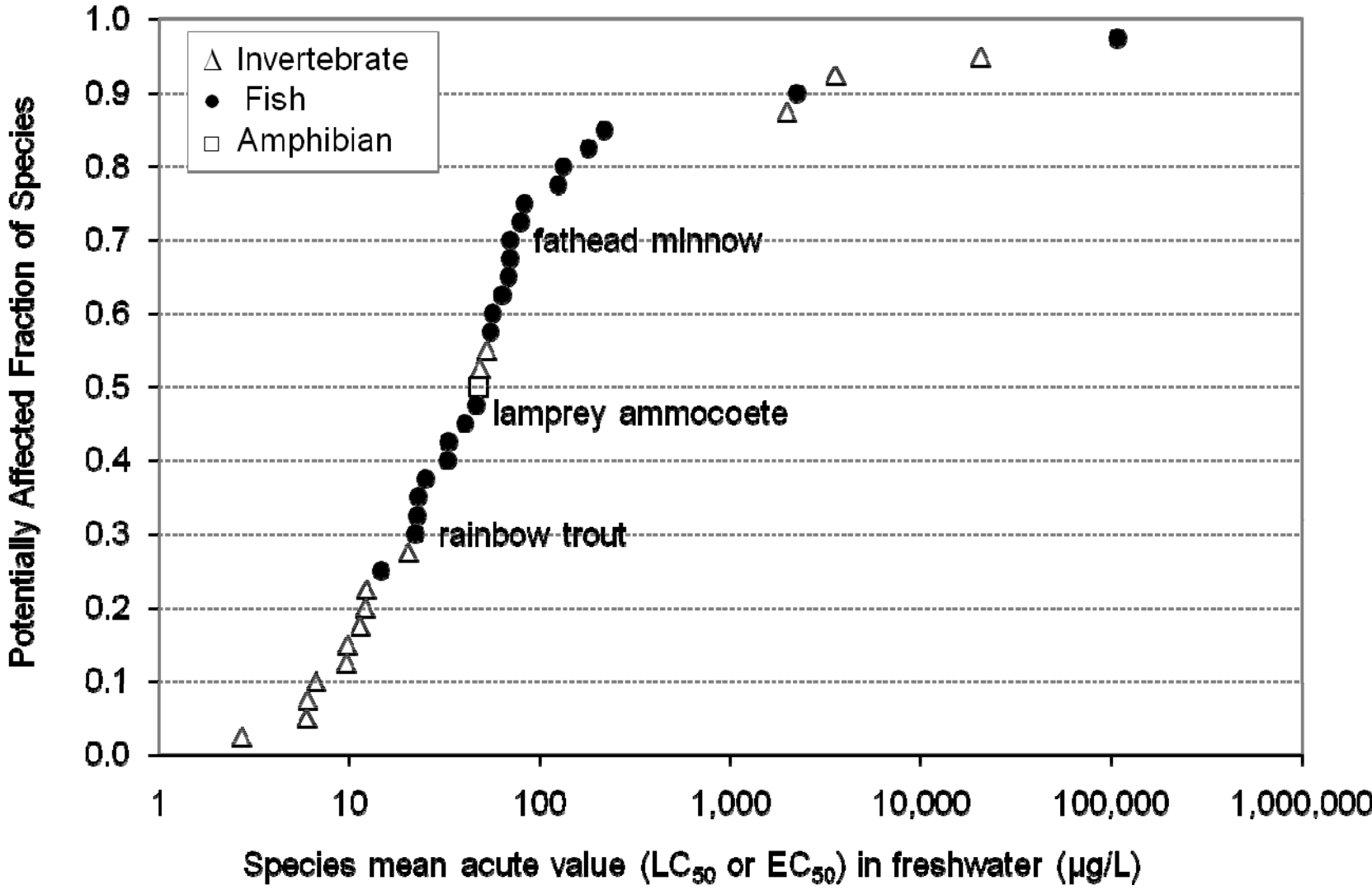
Relative Sensitivity

- Relative sensitivity of ammocoetes was evaluated using a species-sensitivity distribution (SSD)
- LC50s for multiple species (fish, invertebrates, and amphibians) were plotted against cumulative probability that a species will be affected at a given concentration

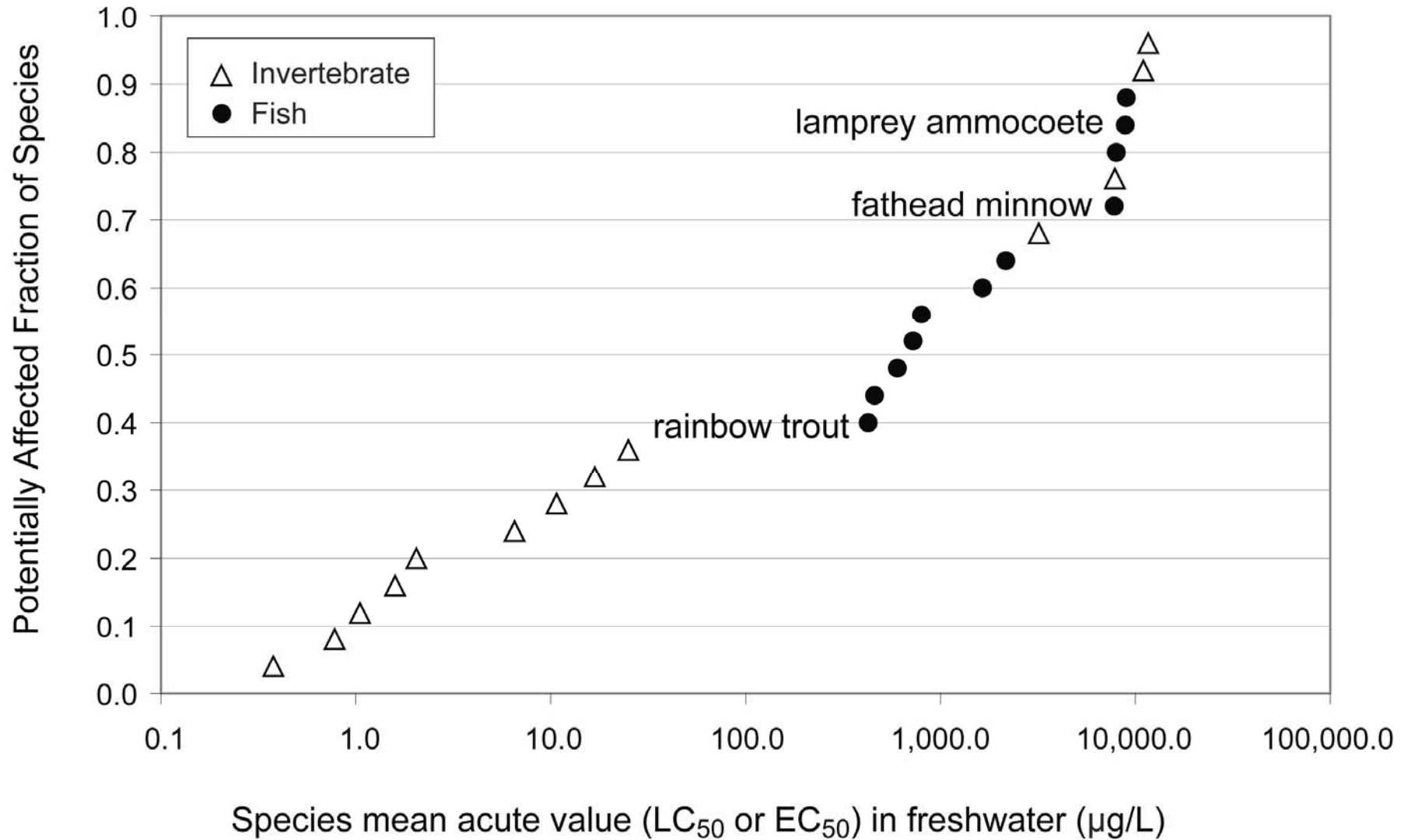
SSD for Pentachlorophenol



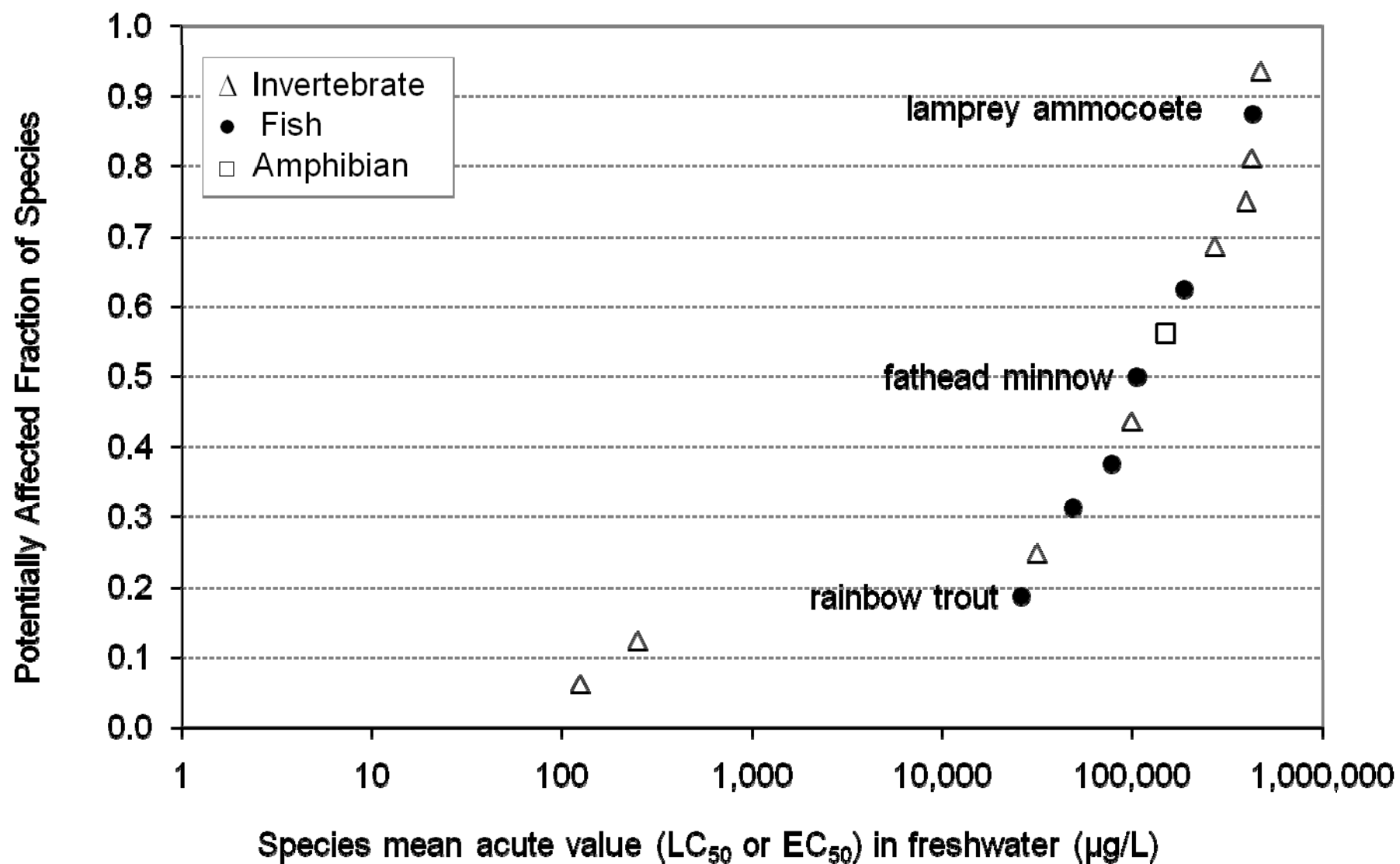
SSD for Copper



SSD for Diazinon



SSD for Aniline



Ammocoete Relative Sensitivity

- Relatively sensitive to pentachlorophenol (15th percentile of SSD)
 - Same mode of action as successful lampricide
- Mid-range sensitivity to copper (46th percentile of SSD)
- Insensitive to diazanon and aniline (72nd and 92nd percentiles of SSD, respectively)
- Relatively insensitive to naphthalene
- Insensitive to lindane

Conclusion

The use of surrogate species in the BERA for the Portland Harbor Superfund site provides adequate protection of lamprey ammocoetes in the Lower Willamette River.

Acknowledgements

This work was funded by the Lower Willamette Group. The manuscript represents the work of the authors and does not represent the position of the Lower Willamette Group or its members.

Andersen HB, RS Caldwell, J Toll, T Do, and L Saban. 2010. Sensitivity of lamprey ammocoetes to six chemicals. Archives of Environmental Contamination and Toxicology, 59:622–631. DOI 10.1007/s00244-010-9514-5