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Protectiveness of Aquatic Life Criteria for Copper Against Olfactory and Behavioral Effects in Freshwater and Saltwater Fish

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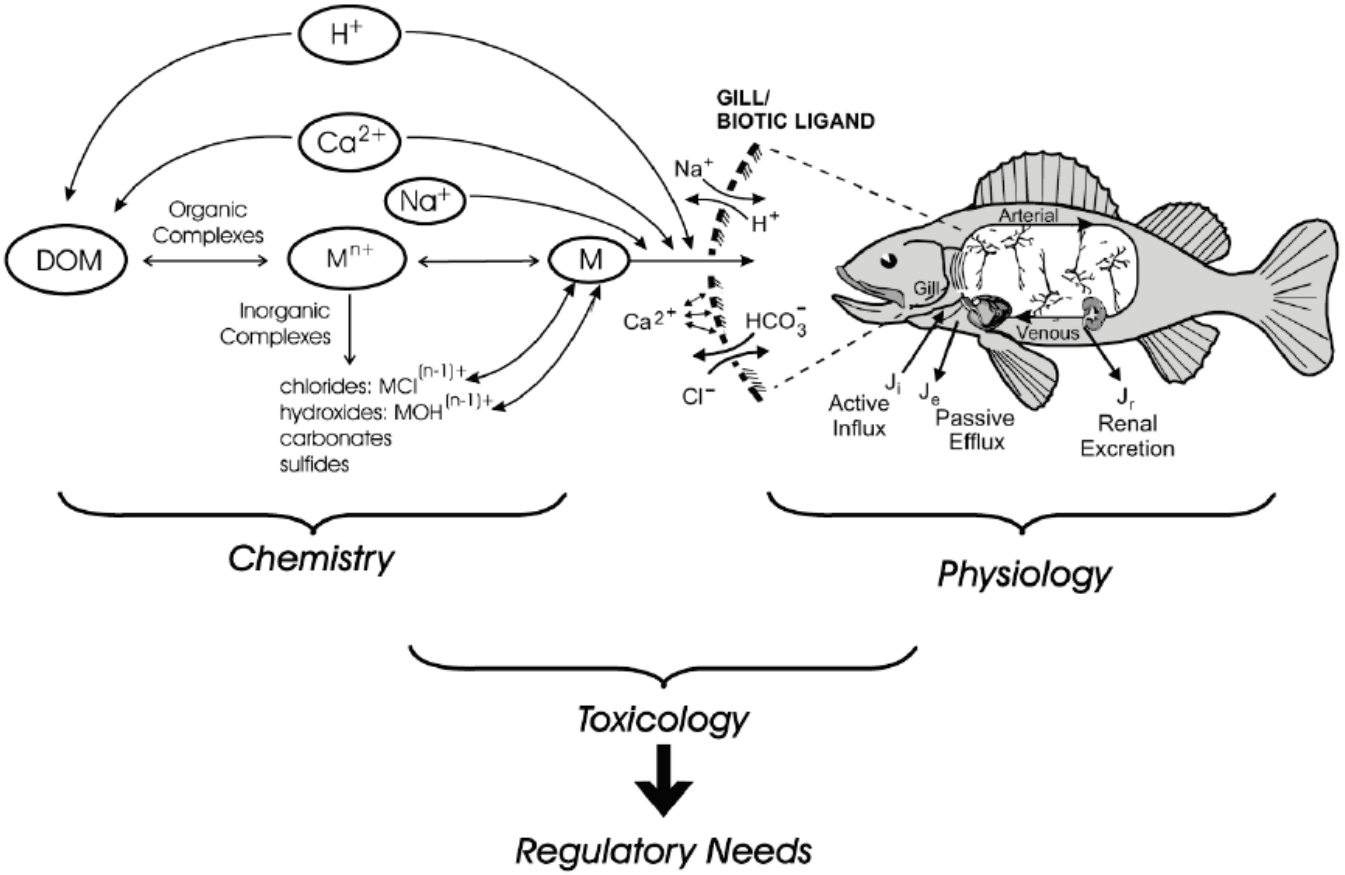
Copper Sources

- Surface runoff
  - Brake pad abrasion
  - Leaching from roofing materials and residential plumbing components
  - Pesticides; lawn and agricultural fertilizers
- Anti-fouling paints (direct release or runoff)
- *Puget Sound Toxics Report* (Ecology 2011)
  - Copper a Priority 1 level of concern in fresh water and nearshore marine areas
  - Recommended as priority for near-term actions (along with PAHs, DEHP, and petroleum)

Copper Bioavailability



From: Paquin et al. 2002. *Comp Biochem Physiol Part C* 133:3-35.

Copper and Olfactory Impairment/ Behavioral Effects

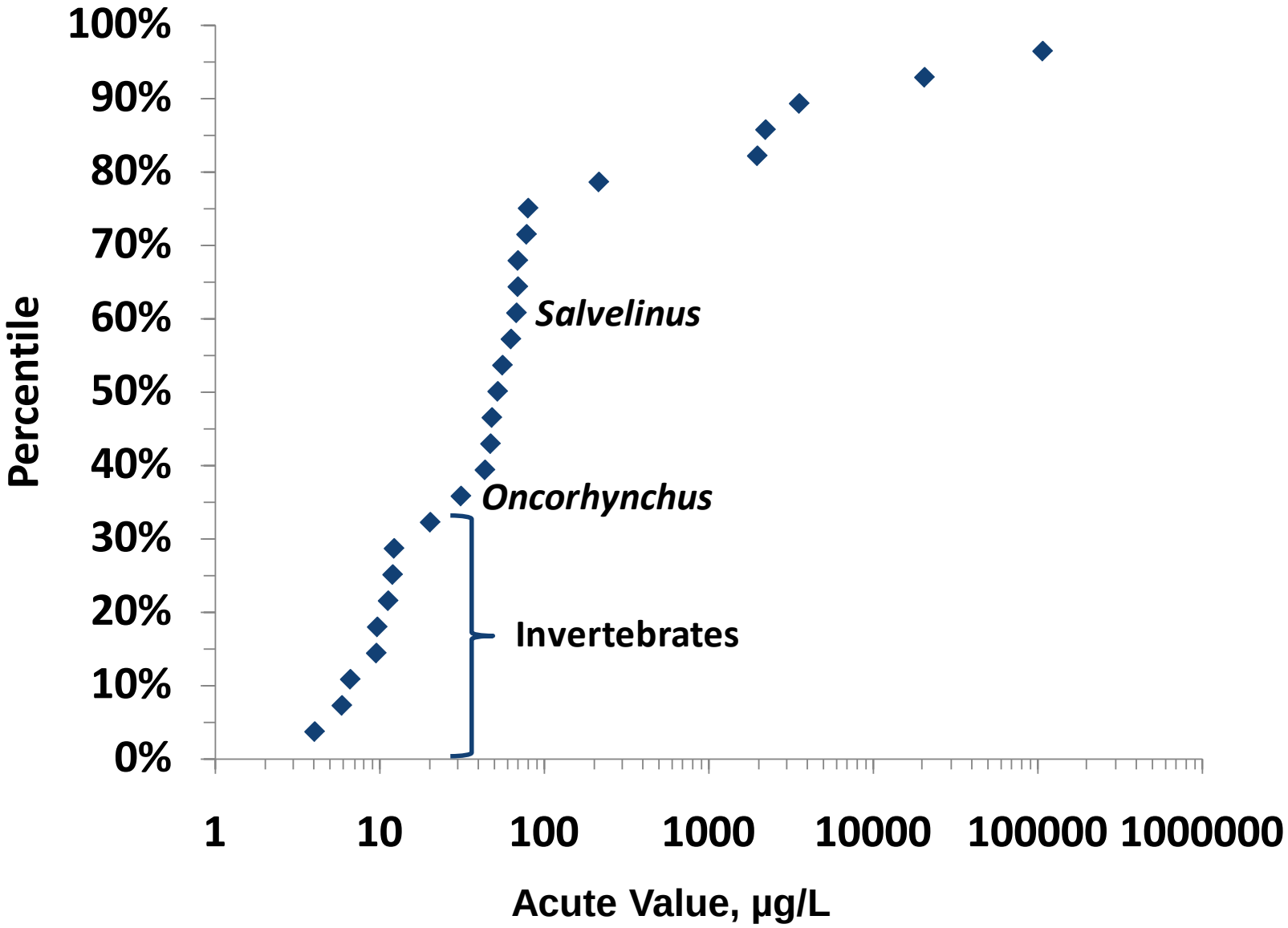
- Copper can impair olfactory function (sense of smell) in fish, including salmon
- DOC shown to mitigate against copper-induced olfactory impairment in juvenile coho, but hardness has negligible influence (McIntyre et al., 2008, *ES&T*, 42:1352-1358)
- DOC also shown to mitigate against behavioral responses to copper in juvenile Chinook (Kennedy et al., 2012, *ET&C*, 31:2281-2288)

Copper Water Quality Criteria (WQC)

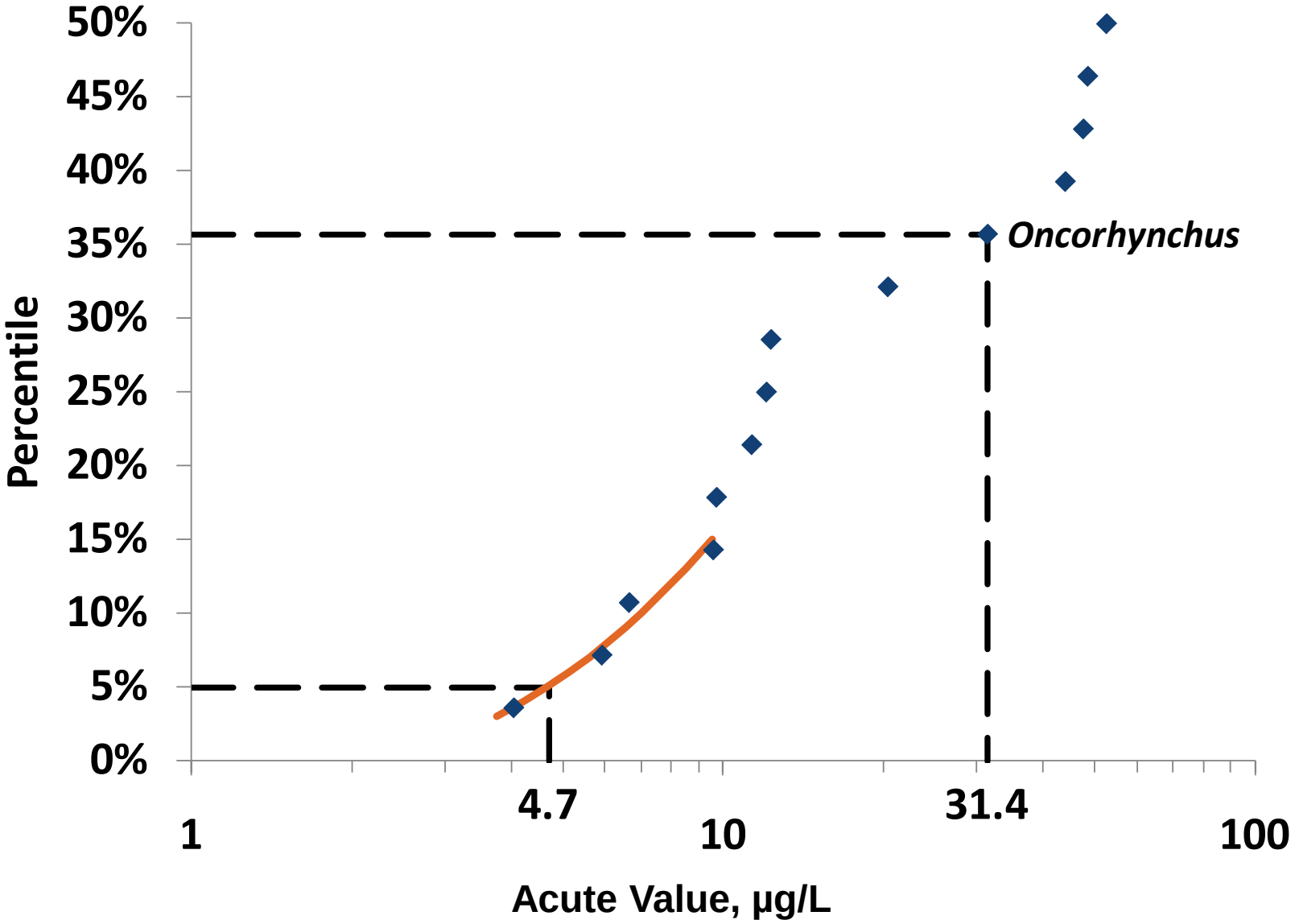
- Existing Washington State WQC:
  - Freshwater: hardness-based
  - Saltwater: fixed (not adjusted for water chemistry)
- USEPA-recommended WQC:
  - Freshwater: biotic ligand model (BLM)-based
  - Saltwater: currently fixed *(draft BLM-based saltwater criteria pending)*

Freshwater

Freshwater Copper WQC



Freshwater Copper WQC



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RELATIONSHIP BETWEEN BIOTIC LIGAND MODEL-BASED WATER QUALITY CRITERIA AND AVOIDANCE AND OLFACTORY RESPONSES TO COPPER BY FISH

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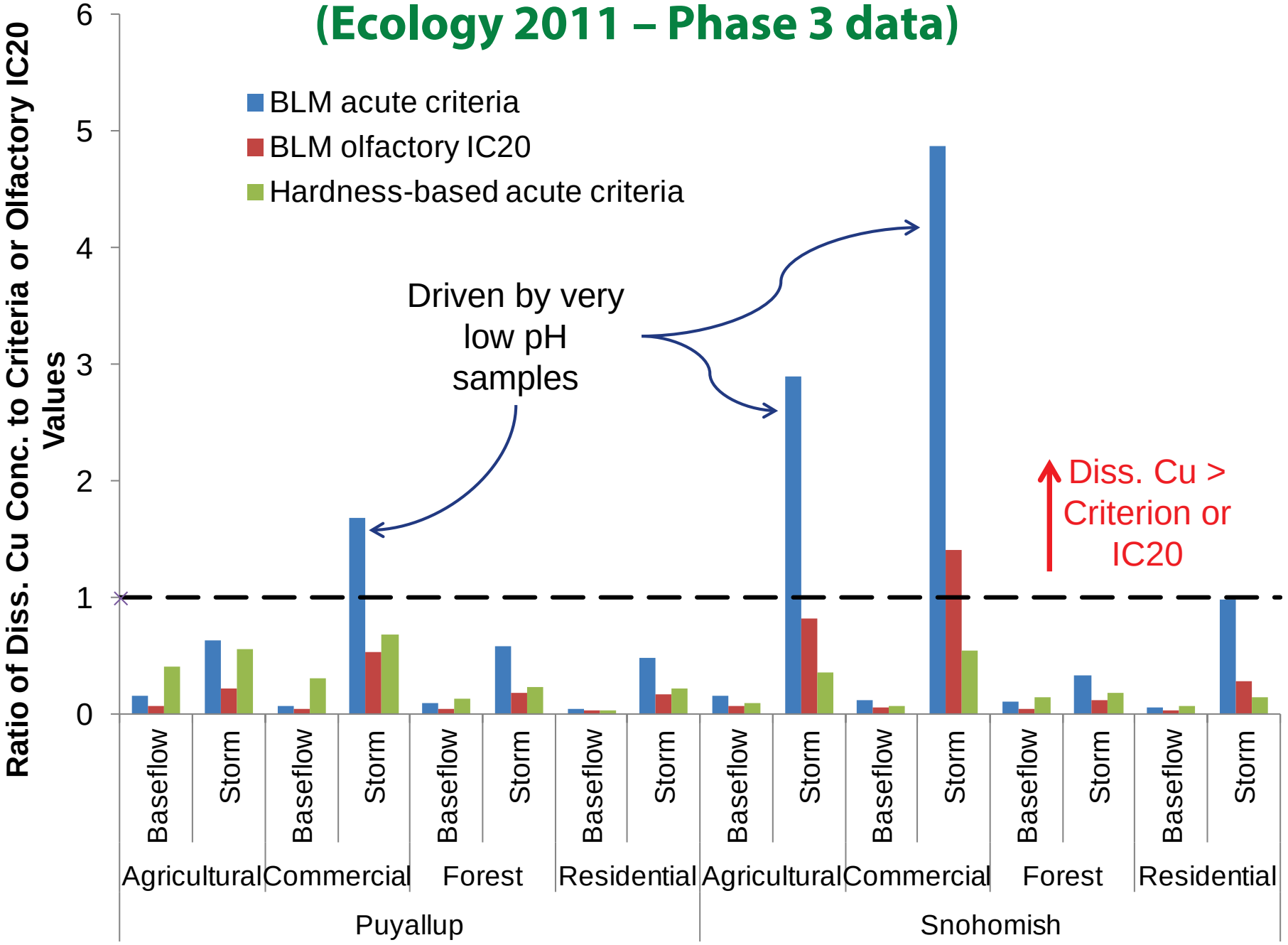
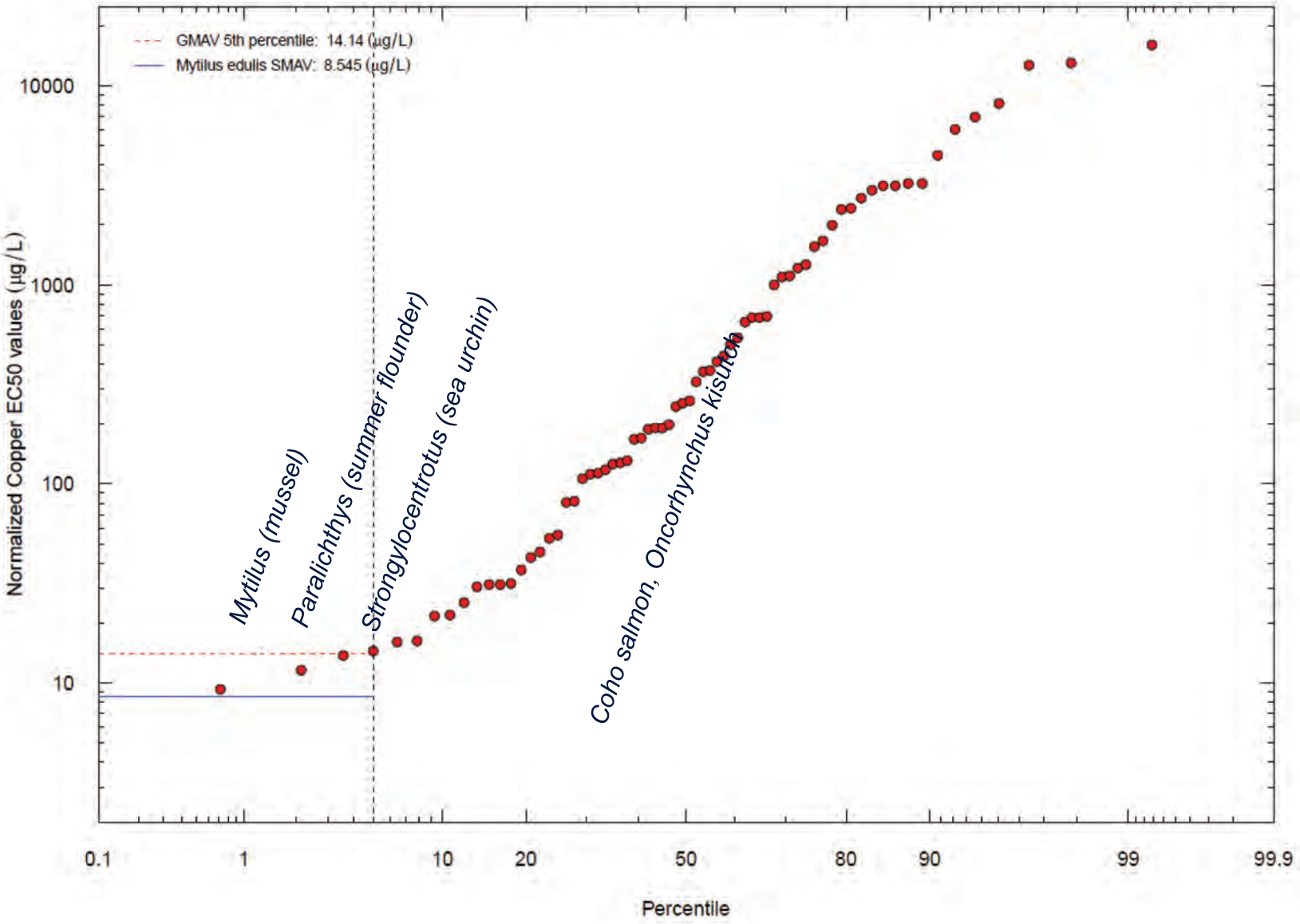
- BLM-based copper criteria protective against olfactory impairment and olfactory-mediated behaviors
  - Hardness-based copper criteria not always protective
- Parameterized existing BLM to predict IC20 values for olfactory impairment

Ratios of Diss. Cu Conc.'s to Criteria & Olfactory IC20s (Ecology 2011 – Phase 3 data)

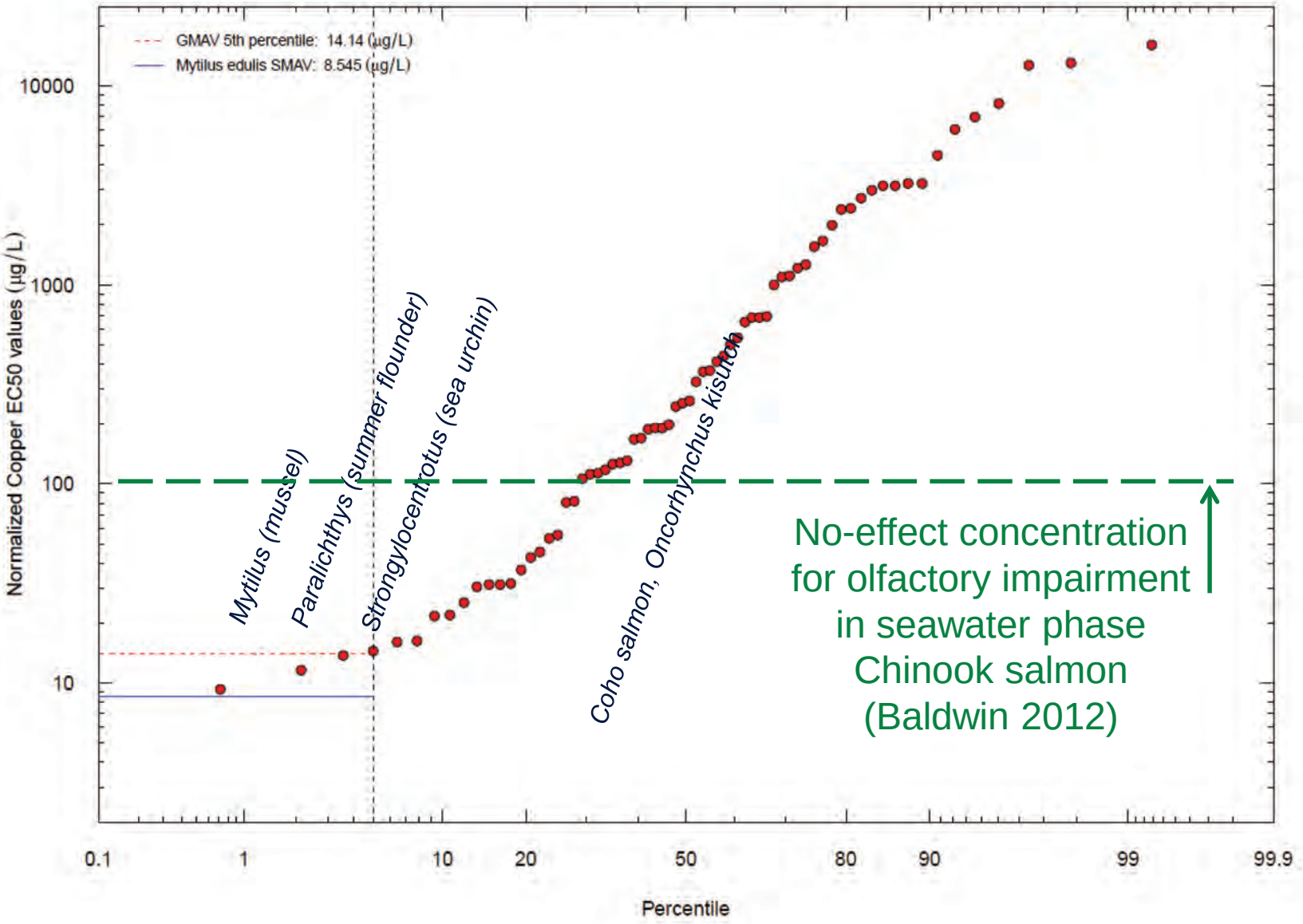


Saltwater

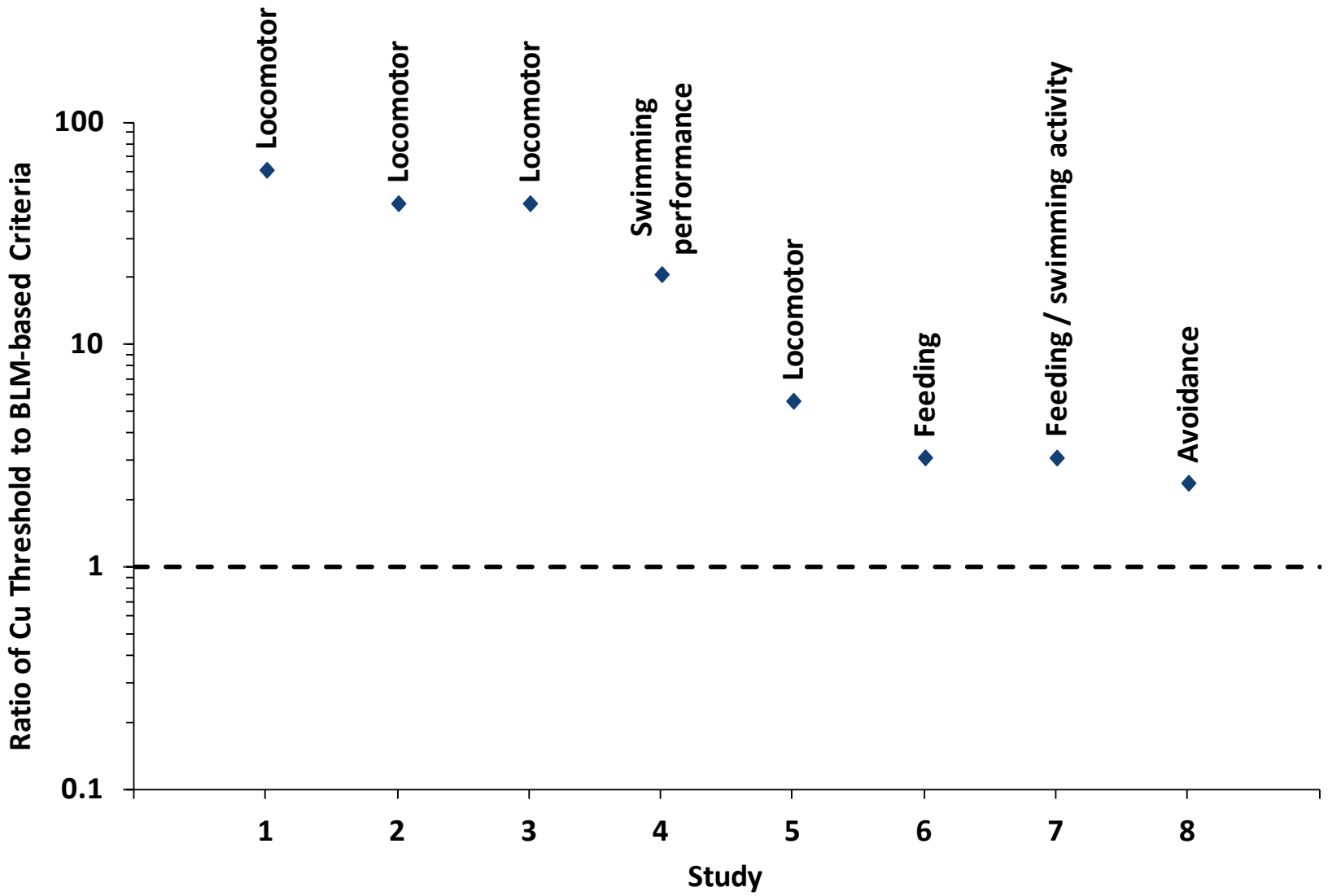
Saltwater Copper WQC



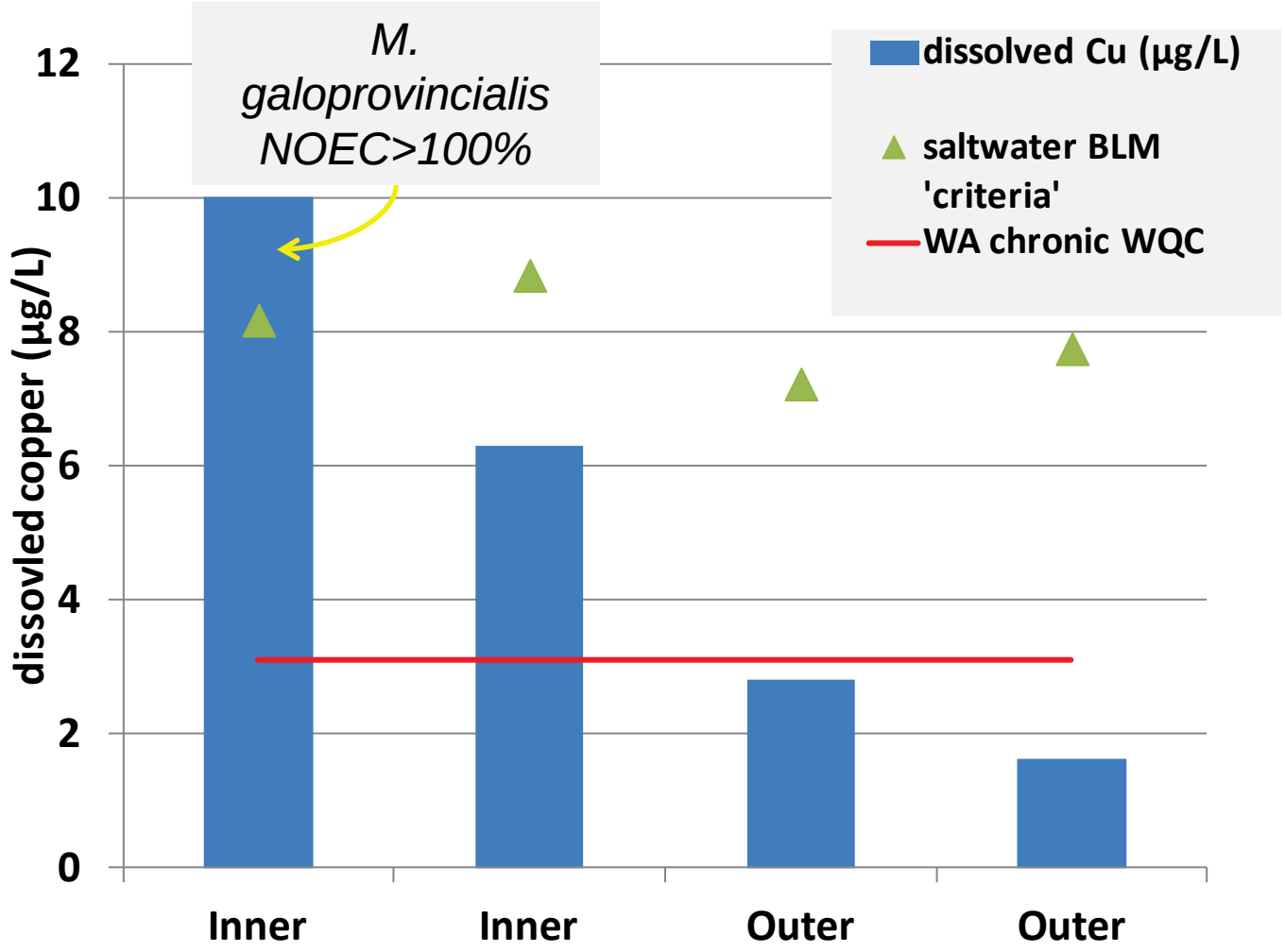
Saltwater Copper WQC



Ratios of Various Sub-lethal Effects Thresholds to Draft BLM-based Saltwater Cu Criteria



Saltwater Example - Marinas



Summary and Conclusions

- Water chemistry matters
  - Bioavailability-adjusted copper criteria appear to be protective against olfactory impairment and olfactory-mediated behaviors
  - Bioavailability should be considered in site-specific and regional assessments
  - Measurement of key parameters that influence metal bioavailability should become routine
- Many stressors in Salish Sea ecosystem
  - Use of BLM-based criteria helps identify locations and exposure scenarios where Cu is truly a concern