



Site-specific Water Quality Criteria for Cyanide in Puget Sound, Washington

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Site-Specific Criteria

- Defined: a tool to tailor standards to local conditions / key species
 - Used when you have scientific information that can better reflect protection of a designated use
- EPA describes three procedures used to derive a site-specific aquatic life criterion:
 - **Resident species recalculation**
 - Reference water body approach
 - Site water chemistry approach or water-effect ratio

Resident Species Recalculation

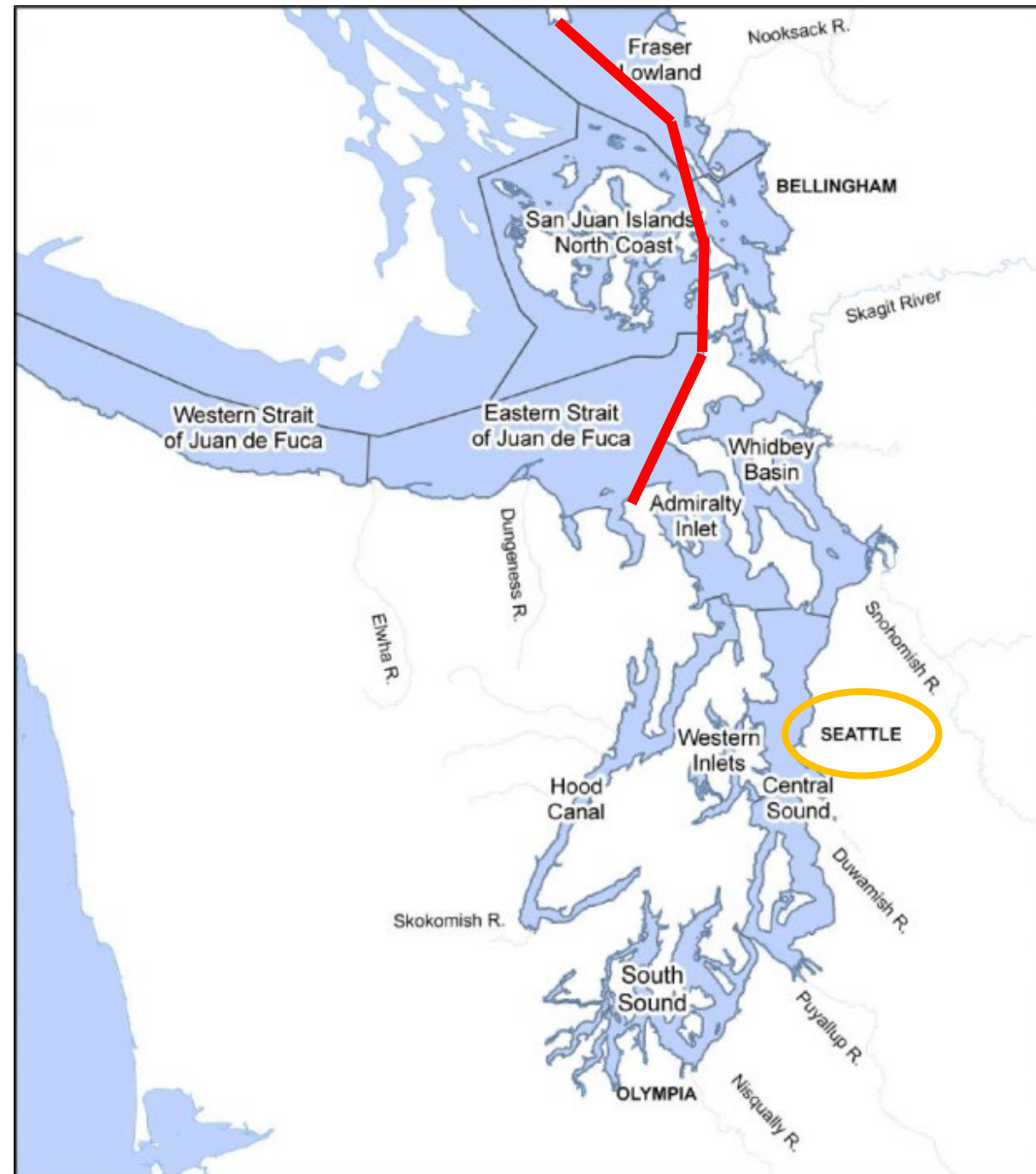
- Considers differences between species used to calculate national recommended criteria and the waterbody in question
 - Adjusts criteria for a water that lacks a sensitive species included in national criteria calculations

Does this crab represent.....these crab species?



Case Study: Puget Sound, Washington

- Water body type:
 - Marine
- Pollutant of concern:
 - Cyanide
- Effect level:
 - Acute and Chronic
- Boundary:
 - East of a line from Point Roberts to Lawrence Point, to Green Point to Deception Pass; and south from Deception Pass and of a line from Partridge Point to Point Wilson



Marine Acute Cyanide Criteria Dataset

Table 1. U.S. Environmental Protection Agency national marine water-quality criterion acute toxicity database for cyanide

Rank	Species	Genus mean acute value ($\mu\text{g/L}$)
8	Common Atlantic slippershell, <i>Crepidula fornicata</i>	>10,000
7	Amphipod, <i>Ampelisca abdita</i>	995.9
6	Winter flounder, <i>Pseudopleuronectes americanus</i>	372
5	Sheepshead minnow, <i>Cyprinodon variegatus</i>	300
4	Mysid, <i>Mysidopsis bahia</i> <i>bigelowi</i> ^a	118.4
3	Atlantic silverside, <i>Menidia menidia</i>	59
2	Copepod, <i>Acartia clausi</i>	30
1	Rock crab, <i>Cancer irroratus</i>	4.893

- The rock crab is approximately six times more sensitive than next most sensitive species
- Limited dataset (8 GMAVs)



Marine Chronic Cyanide Criteria

- Because the acute toxicity data for the eastern rock crab, *Cancer irroratus*, were based on tests with larvae, US EPA judged that they predicted more reliably cyanide's chronic toxicity than would be obtained using the standard US EPA practice of dividing the FAV by the acute-chronic ratio. Therefore, the acute and chronic criteria for cyanide are the same.

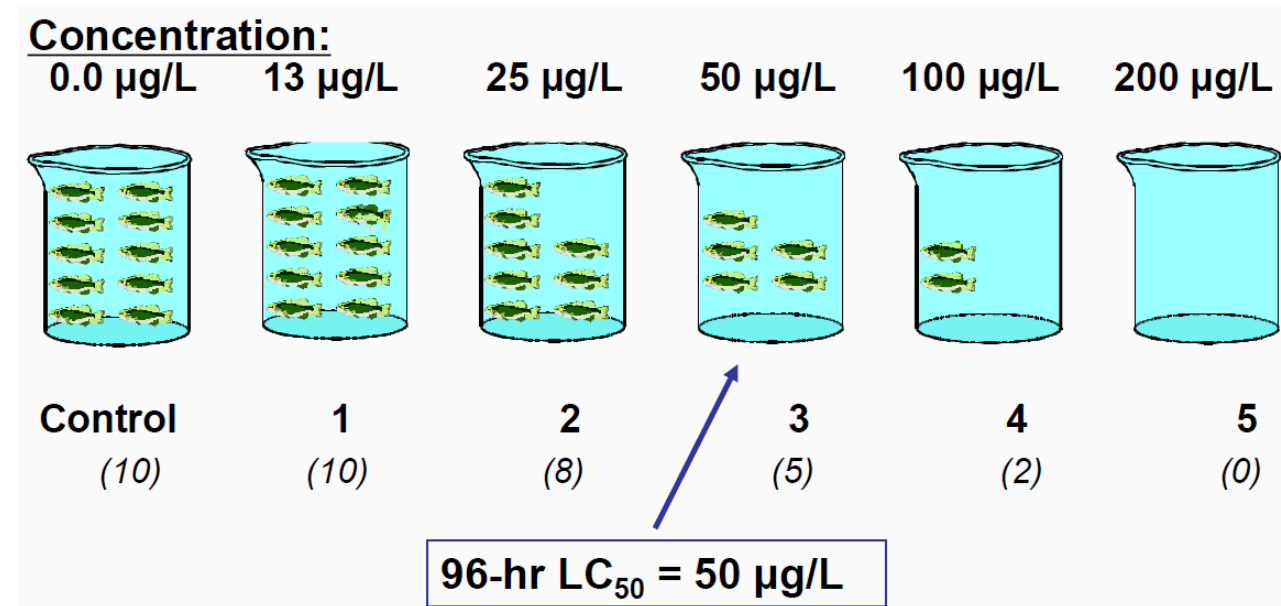
Pollutant (P = Priority Pollutant) ↑	CAS Number ↓	Freshwater CMC ¹ (acute) (µg/L) ↓	Freshwater CCC ² (chronic) (µg/L) ↓	Saltwater CMC ¹ (acute) (µg/L) ↓	Saltwater CCC ² (chronic) (µg/L) ↓
Cyanide (P)	57125	22	5.2	1	1

Study Objective

- Compare cyanide sensitivity of four resident *Cancer spp.* in Puget Sound to *Cancer irroratus* used in the national dataset
 - If resident species were comparable to *Cancer irroratus*, conduct a water effects ratio to learn whether cyanide's toxicity differs in Puget Sound waters compared with laboratory waters
 - If resident species were less sensitive, then the Puget Sound data would be substituted for *Cancer irroratus* data to derive a site-specific cyanide criterion

Method Summary

- Each Puget Sound crab species was field collected and held in recirculating systems until spawning
- Less than 24-hour organisms were tested in fresh filtered seawater
- 96-hour static renewal toxicity tests
- Cyanide concentrations were analytically measured



Cancer spp. Toxicity Tests

Species	LC50 (ug/L)	Mean LC50 (ug/L)	Difference from Cancer irroratus
<i>Cancer gracilis</i>	153	144	~29x less sensitive
<i>Cancer gracilis</i>	135		
<i>Cancer magister</i>	51	68	~14x less sensitive
<i>Cancer magister</i>	92		
<i>Cancer oregonensis</i>	111	131	~27x less sensitive
<i>Cancer oregonensis</i>	154		
<i>Cancer productus</i>	219	153	~31x less sensitive
<i>Cancer productus</i>	107		

Cancer irroratus
 LC50: 4.9 ug/L

Revised Marine Acute Cyanide Dataset

Rank	Species	Genus mean acute value ($\mu\text{g/L}$)
8	Common Atlantic slippershell, <i>Crepidula fornicata</i>	>10,000
7	Amphipod, <i>Ampelisca abdita</i>	995.9
6	Winter flounder, <i>Pseudopleuronectes americanus</i>	372
5	Sheepshead minnow, <i>Cyprinodon variegatus</i>	300
4	Cancroid crabs, <i>Cancer magister</i> , <i>orgegonensis</i> , <i>productus</i> and <i>gracilis</i>	118.5
3	Mysid Shrimp, <i>Mysidopsis bahia</i> / <i>bigelowi</i>	118.4
2	Atlantic silverside, <i>Menidia menidia</i>	59
1	Copepod, <i>Acartia clausi</i>	30

Puget Sound
 cyanide acute
 criterion: **9.4 $\mu\text{g/L}$**

Revised Chronic Criteria and New Approach

- Geometric mean for two marine cyanide acute-chronic ratios (ACRs) and four freshwater ACRs was 6.45
- Final acute value (FAV) = 18.8
- Acute to chronic ratio (ACR) = 6.45
- Puget Sound chronic cyanide criterion = **2.9 ug/L**

Marine Cyanide Criteria for Puget Sound

- EPA national marine cyanide criteria:
 - Acute criterion: 1 ug/L
 - Chronic criterion: 1 ug/L
- Puget Sound marine cyanide criteria:
 - Acute criterion: 9.4 ug/L
 - Chronic criterion: 2.9 ug/L



Conclusion

- On average the four species of West Coast cancid crabs were 24 times less sensitive than the only East Coast cancid crab tested
 - This led to a higher marine cyanide criteria in Puget Sound
- **Update:** this site-specific criteria is under EPA litigation regarding Endangered Species Act consultation approval
 - EPA conditionally approved the marine cyanide site-specific criteria pending ESA Section 7 consultation, however ESA consultation was never completed



Challenges

- Demonstrating differential toxicity between resident species and national datasets includes:
 - Identifying local resident species
 - Determining the most sensitive life stage to test
 - Culturing or collecting resident species
 - Evaluating background levels of pollutants from field-collected organisms
 - Conducting the field and laboratory work
 - Study funding

Questions

- How representative are national datasets to your region? Are surrogates over or underestimating protection for your state?
- Should states consider modification to national datasets during rule updates that account for more state-specific aquatic life?
- Is the recalculation method applicable to aquatic invasive species used in national datasets? (this question becomes more important when invasive species represent one of the four lowest GMAVs – see pentachlorophenol)



Questions?

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