

# Copper concentrations in five Puget Sound marinas



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Marinas have been shown to contribute elevated levels of metals to marine waters, copper (Cu) in particular (Schiff et al., 2004). The Cu comes primarily from antifouling paints which are designed to discourage biofouling (barnacles, mussels, and other organisms) of boat hulls. In 2011 the Washington State Legislature passed the Recreational Water Vessels – Antifouling Paints Law (RCW Chapter 70.300) to phase out Cu in marine antifouling paints. However, following a review of recent data and possible substitutions, Ecology made the recommendation that the phase out of Cu be delayed until 2021 to complete further study (Penttila, 2017), which led to passage of House Bill 2634.

In 2016 and 2017, the Washington State Department of Ecology (Ecology) completed a baseline study of copper in five Puget Sound marinas of different configuration and size and assessed potential impacts to marine biota (Hobbs et al., 2018). Four sampling events were conducted between September 2016 and June 2017. Sample media included: water (dissolved and total fractions of metals),

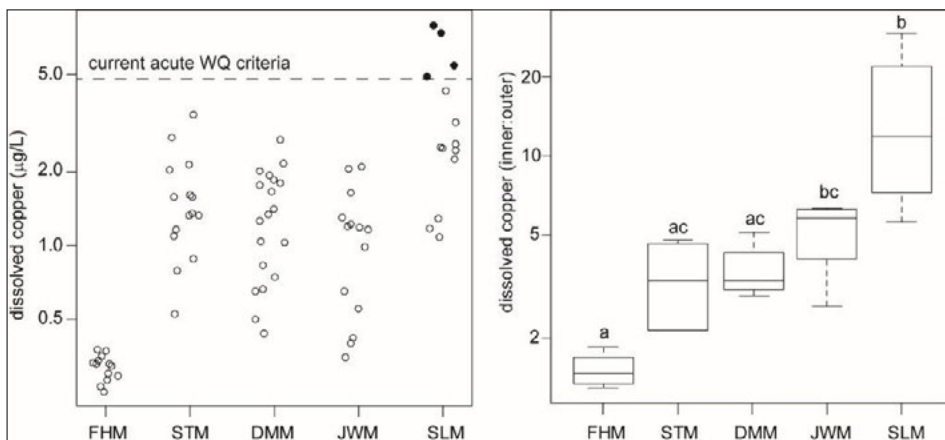
- **Copper from antifouling paint is taken up and bound to suspended matter and algae and then deposited on the bottom sediments in marinas.**
- **Dissolved Cu concentrations in water were above current state water quality criteria for acute exposure in one semi-enclosed marina for isolated samples.**

sediments (suspended and bottom), and biota (transplanted mussels and biofilms). All marinas were assessed within the breakwaters among the moorage slips and at local reference locations outside the marina. Water sampling occurred at times when upland stormwater discharges were not an issue.

Concentrations of dissolved Cu were occasionally high enough inside one marina to be above the state water quality criterion for acute impacts to aquatic life (Figure). Suspended sediments that were settling to the bottom of the marinas were collected over three to five month periods during the study. Suspended sediments and bottom sediments reliably showed higher Cu concentrations inside the marinas compared to outside the marinas. In addition, marinas with higher Cu concentrations in water also had higher concentrations in the suspended sediments.

None of the measured Cu concentrations in bottom sediments collected in this study suggested a possible impact to benthic (sediment-dwelling) invertebrates. Biofilms (algae) grown on artificial substrates inside the marinas had higher Cu concentrations in the marinas with higher dissolved Cu concentrations in the water; similar to suspended particulate matter. Lastly, transplanted mussels deployed inside and outside the marinas had good survival and increased growth characteristics following the deployment period. However, mussel tissue concentrations of Cu did not conclusively show differences between inside and outside locations, nor were the concentrations different from clean reference samples.

Overall, Ecology found strong evidence that Cu accumulates inside the study marinas to higher levels than outside marinas, regardless of marina configuration. Marinas that are more enclosed, where water is slower to flush in and out, accumulated higher levels of Cu than more open marinas (Figure). This study provides an adequate baseline dataset to measure progress as a result of recent legislation, towards the reduction of Cu to Puget Sound from marinas.



(Left) Dissolved copper in marina waters, where black dots are above the current state water quality criterion. (Right) The relative (inside:outside) dissolved copper concentrations in marinas over the year; letters above the box that differ are significantly different. (x-axis) Marinas are more enclosed (slower flushing) from left (open) to right (enclosed). FHM=Friday Harbor Marina; STM=Swantown Marina; DMM=Des Moines Marina; JWM=John Wayne Marina; SLM=Skyline Marina.



John Wayne Marina in Sequim Bay.  
Photo: Melissa McCall

## RECOMMENDED CITATION

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