

## Integration of Chlorpyrifos Acetylcholinesterase Inhibition, Water Temperature, and Dissolved Oxygen Concentration into a Regional Scale Multiple Stressor Risk Assessment Estimating Risk to Chinook Salmon

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First published: 05 August 2019

<https://doi.org/10.1002/ieam.4199>

Citations: 6

### ABSTRACT

We estimated the risk to populations of Chinook salmon (*Oncorhynchus tshawytscha*) due to chlorpyrifos (CH), water temperature (WT), and dissolved oxygen concentration (DO) in 4 watersheds in Washington State, USA. The watersheds included the Nooksack and Skagit Rivers in the Northern Puget Sound, the Cedar River in the Seattle–Tacoma corridor, and the Yakima River, a tributary of the Columbia River. The Bayesian network relative risk model (BN-RRM) was used to conduct this ecological risk assessment and was modified to contain an acetylcholinesterase (AChE) inhibition pathway parameterized using data from CH toxicity data sets. The completed BN-RRM estimated risk at a population scale to Chinook salmon employing classical matrix modeling runs up to 50-y timeframes. There were 3 primary conclusions drawn from the model-building process and the risk calculations. First, the incorporation of an AChE inhibition pathway and the output from a population model can be combined with environmental factors in a quantitative fashion. Second, the probability of not meeting the management goal of no loss to the population ranges from 65% to 85%. Environmental conditions contributed to a larger proportion of the risk compared to CH. Third, the sensitivity analysis describing the influence of the variables on the predicted risk varied depending on seasonal conditions. In the summer, WT and DO were more influential than CH. In the winter, when the seasonal conditions are more

benign, CH was the driver. Fourth, in order to reach the management goal, we calculated the conditions that would increase juvenile survival, adult survival, and a reduction in toxicological effects. The same process in this example should be applicable to the inclusion of multiple pesticides and to more descriptive population models such as those describing metapopulations. *Integr Environ Assess Manag* 2019;00:1–15. © 2019 SETAC

## Open Research

### Data Availability Statement

The Netica model is available as a download in Supplemental Data, as are the tables describing the nodes. The data sets we used to establish exposure–response curves, chemical concentrations, temperature, and dissolved oxygen are in the public domain. Our collection of this information can be found at the collection of Western Washington University Library at [https://cedar.wvu.edu/esci\\_facpubs/60/](https://cedar.wvu.edu/esci_facpubs/60/).

## Citing Literature

## Supporting Information

Filename	Description
<a href="#">ieam4199-sup-0001-AOP_paper_Supplemental_07222019.docx</a> 11.9 MB	This article contains online-only Supplemental Data.
<a href="#">ieam4199-sup-0002-Chlorpyrifos_DO_WT_Chinook.neta</a> 10.8 KB	

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**PUBLICATION INFO** ▾

Integrated Environmental Assessment and Management (IEAM)

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