Linking Adverse Outcome Pathways and Population Models: Current State of the Science and Future Directions

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Analysis of population impacts of chemical stressors through the use of modeling provides a linkage between endpoints observed in the individual and ecological risk to the population as a whole. In this presentation, we describe the evolution of an approach developed in our laboratory to link chemically-induced alterations in molecular and biochemical endpoints to adverse outcomes in whole organisms and populations. Our approach employs a simple density dependent logistic matrix model linked to adverse outcome pathways (AOPs) for reproductive effects in fish of contaminants that impact different points within the hypothalamic-pituitary-gonadal axis. We provide two examples that illustrate the implementation of AOPs in conjunction with the population models to forecast chemical impacts. In the first example, quantitative relationships between estradiol, testosterone, and vitellogenin concentrations and fecundity established in fathead minnow *(Pimephales promelas)* 21-d reproduction studies with different HPG-active chemicals are used to forecast the effects on populations exposed to stressors that reduce vitellogenesis. The second example utilizes linked AOP and population models parameterized with long-term monitoring data for white sucker (*Catostomus commersoni*) collected from a study site at Jackfish Bay, Lake Superior to predict population trends over time, including after removal of chemical stressors. Together, these case studies demonstrate the practical utility of linking population models to AOPs to support ecological risk assessment of chemicals. In progressing beyond these studies, further exploratory research efforts include linking other types of AOPs to population models (e.g. AOPs for early developmental effects), examining cross-species applicability of linked AOP and population models, and incorporating multiple stressors (both chemical and non-chemical) and community interactions within a framework for ecological risk.

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