Bayesian Multilevel Discrete Time Hazard Analysis for Pulsed Dose Experiments

Primary Investigator: Craig Stow - NOAA GLERL

Co-Investigators: Pete Landrum - NOAA GLERL (Emeritus)

Overview

This research will use a relatively new model format – multilevel discrete time hazard analysis – to synthesize experimental pulsed dose responses. This model will be programmed into a Bayesian format so that a rigorous estimate of parameter uncertainty will be obtained for the coefficients of primary interest.

Objectives

Increase number of regional coastal and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood.

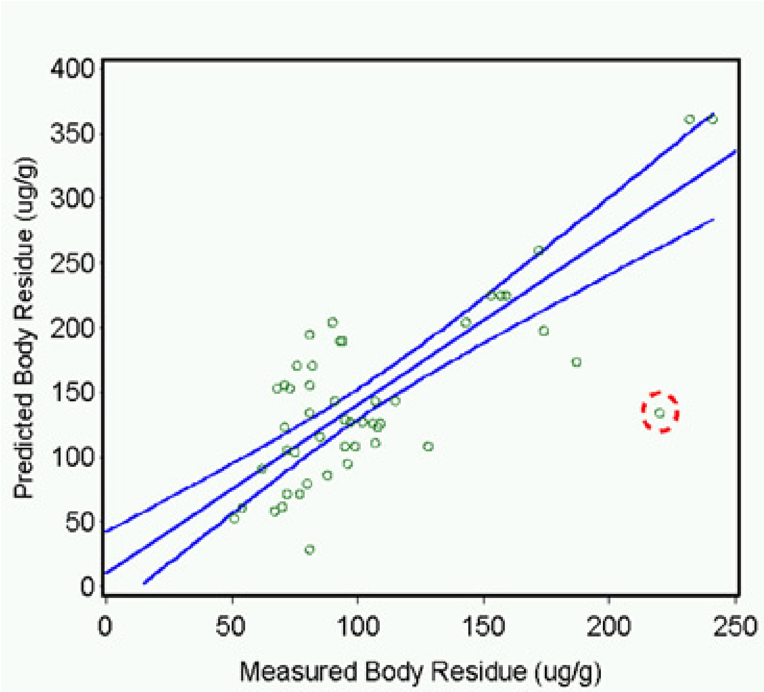
Meet annual targets for the number of coastal, marine, and Great Lakes ecological characterizations that meet management needs.

Proposed Work

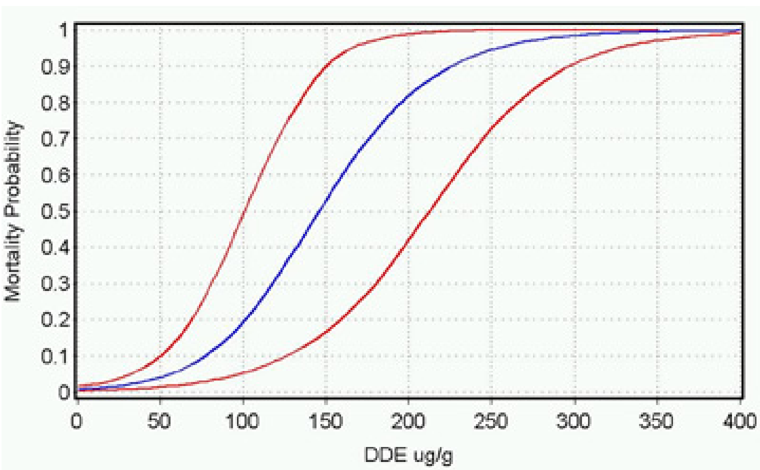
Obtain microcosm dose-response data for specific organisms and contaminants (completed) Convert data to individual-level response format (partially completed) Program data into Bayesian format using WinBUGs software (partially completed) Experiment with different model functional forms (logistic, cloglog, others) (partially completed) Estimate model parameters, uncertainty, and functions of interest Produce manuscript for submission

Scientific Rationale

The toxic effects of many contaminants have been well-studied using laboratory dose-response experiments. However, the literature examining the effect of contaminant exposure in short-duration doses is sparse. This research will use a relatively new model format – multilevel discrete time hazard analysis – to synthesize experimental pulsed dose responses. Hazard analysis of a form of survival analysis where the probability of death of an individual in time interval t given survival until interval t is estimated as a function of contaminant body burden. The multilevel approach facilitates estimation by subgroups, which allows examination of possible experimental artifacts that may introduce variability onto the results. This model will be programmed into a Bayesian format so that a rigorous estimate of parameter uncertainty will be obtained for the coefficients of primary interest.



The predicted body residues and 95% confidence intervals compared to the measured body residues in dead organisms for both the uptake and elimination data. The equation is Predicted Body Residue = 10.4 (s.e. = 15.8) Measured Body Residue + 1.3 (s.e. = 0.14), r2 = 0.64 , n=50. One data point (circled in red) was eliminated as an outlier with an externally studentized residual of -3.62.



Predicted mortality probability and the associated uncertainty using upper tier model parameters that partially pool information from all 53 experimental beakers. Blue indicates mean mortality probability, red depicts upper and lower bounds of the 95 predictive interval.

Governmental/Societal Relevance

Quantifying the toxic/lethal effects of common contaminants is essential for assessment and mitigation of ecological damage.

Relevance to Ecosystem Forecasting

This project will develop rate and uncertainty estimates useful for predicting toxicological damage in ecosystem where toxic exposures are in pulsed doses.