Coastal Response Research Center
at the University of New Hampshire

Coastal Response Research Center: Project Highlights for Improving Oil Spill Response and Restoration Science

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Introduction

The Coastal Response Research Center, a partnership between NOAA's Office of Response and Restoration and the University of New Hampshire, focuses on research to advance the knowledge, technology and practice of spill response and restoration. A key mission is to transform research results into standards of practice and demonstration projects. After completing four funding cycles, the Center has funded 19 projects, ten of which have examined toxicological endpoints. These studies have ranged from pulse exposures of single polycyclic aromatic hydrocarbons (PAHs), mixtures of PAHs from water-accommodated fractions and chemically-enhanced fractions of oils. Five of the ten studies conducted bioassays using chemically dispersed oil in their experimental designs. Species used have ranged in trophic levels and sensitivities, thus providing a range of effects. The studies highlighted have conducted detailed chemical analyses in characterizing exposures. Three of the studies present different methods for modeling PAH toxicity: total lipid model (equilibrium partitioning, individual based), time-dependent toxicity (toxico-kinetic, individual-based), and toxicity at different life stages (Leslie matrix, population-based). In evaluating these projects in relationship to each other, there is improved understanding of effects of spilled and dispersed oil on biological resources. The poster summarizes projects which may be of interest to the broader environmental policy and management community. These studies are currently being evaluated and for translating the existing research into field products, improved decision-making, and management.

Polycyclic Aromatic Hydrocarbon (PAH) Toxicity Workshop, August 15 – 16, 2006, Seattle, WA. The Coastal Response Research Center (CRRC) hosted a workshop focused on PAH toxicity issues. PAHs are a complex class of organic chemicals that are ubiquitously distributed in the environment point (e.g., oil spills) and non-point (e.g., storm-water run-off and atmospheric deposition), and present short and long term risks to human health and NOAA trust resources. The overall goal of the workshop was to bring together CRRC-funded researchers highlighted here and NOAA scientists to discuss current research and to develop methods to translate research into applications that improve NOAA operations. Participants represented the Office of Response and Restoration (OR&R), and NOAA's Fisheries Northwest and Alaska Science Centers. CRRC researchers represented University of Maryland's Chesapeake Biological Laboratory, Virginia Institute of Marine Sciences, University of South Carolina, University of California at Davis, and HydroQual, Inc. There was strong agreement that improved information management of data sets is a critical component to better predictions of short and long term effects of oil spills. Participants also argued that a more holistic approach to assessing, monitoring, and studying PAH effects would improve decision-making and better inform research strategies for NOAA and CRRC (Figure 1).

Translating Research into Practice

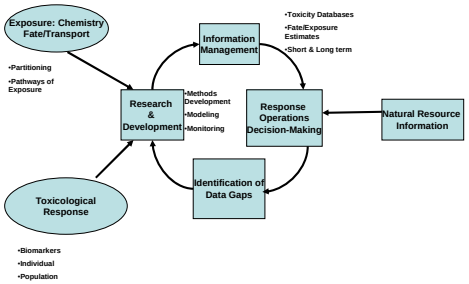

Figure 1. Conceptual Diagram Linking Research and Operations for Oil Spills

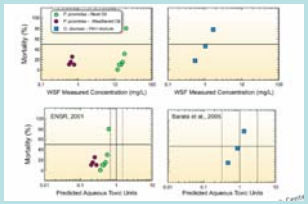

Figure 2. Observed mortality as a function of total measured concentration in water soluble fraction (WSF) (mg/L) (top panels) and predicted aqueous toxic units (bottom panels).

McGrath and DiToro. HydroQual, Inc. and University of Delaware

Objectives:
•Use the target-lipid model (TLM) to develop a universal endpoint (toxic unit) to normalize PAHs from disparate studies to compare toxicities.
•Use the target-lipid model to predict chronic toxicity endpoints.
Results:
•Developed a database of studies where individual PAHs and mixtures of PAHs exposed aquatic organisms met criteria:
  •Constant exposures
  •Measured exposure concentrations
  •Measured body residues associated with effects
•Validated the TLM for acute toxicity for aqueous and sediment exposures
•Provided a screening method for systematically defining "how clean is clean?"

Figure 3. Time to death (hours) vs. Measured 1-ethylnaphthalene (ENAP) (ug/L).

Unger and Newman. Virginia Institute of Marine Science

Objectives:
• To develop time-dependent model for predicting mortality from individual PAHs and mixtures of 6 representative PAHs
  •Accounting for exposure duration and concentrations
  •Receptor: grass shrimp
  •Examining latent mortality
Results:
•Generating dissolved PAH exposure using generator column
•Quantifying PAH exposures over time
•Demonstrating a method for addressing the problems of changing concentrations and exposure durations (i.e., spill conditions) by applying survival analysis.

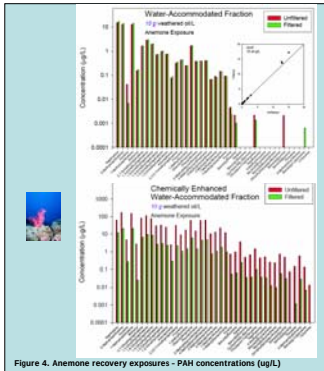

Figure 4. Anemone recovery exposures - PAH concentrations (ug/L)

Mitchelmore and Baker. Chesapeake Biological Laboratory, University of Maryland

•Objectives – evaluate acute and chronic impacts of dispersant, Arabian Light Crude water-accommodated fraction (WAF), and chemically-enhanced WAF (CE-WAF) on anemones (1st year) and corals (2nd year)
•Exposures – Gradient of exposures for 8 hours, recovery for 1 month. Measured 53 PAH in water for each treatment across time (0, 4, 8, 24, 48, 72, 96 hours, and 28 days)
•Endpoints:
  •Mortality
  •Behavioral (tentacle extrusion, mucous production)
  •Bioaccumulation of PAHs
  •Biomarkers (protein levels, algal cell counts, chl a, DNA damage, mRNA levels)
•Results:
  •demonstrated differences in exposures between unfiltered and filtered media
  •Utility of using integrated endpoints
  •Experimental design connects measured exposure to effects

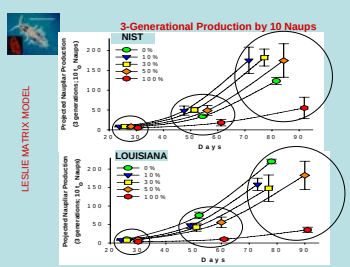

Figure 5. Projected naupliar production vs. time for treatments exposed to NIST (top panel) and South Louisiana Crude (bottom) WAF concentrations.

Chandler and Coull. University of South Carolina

Objective: Develop lifecycle assay for water soluble fractions of crude oil (South Louisiana Crude)
  Benchmarked against National Institute of Standards crude oil standard
  Used Chandler's ASTM-standard harpacticoid copepod bioassay

Endpoints measured for discrete life stages of benthic copepods:
  Mortality, development b/n stages, sex ratios, fertility success, viable offspring production/female, egg quality and population growth trajectories

Results: demonstrated utility of lifecycle analysis and potential population-level effects

PAH Toxicity Workshop Results

1. Identification of the need for an organizing framework for understanding short and long term effects of spills. This is needed for articulating management and research needs.
2. Identification of database characteristics and data needs to incorporate chemistry and biological effects predictions into model forecasts.
3. Identification of potential data-rich spill case studies to inform database needs and seed oil (PAH) library.
4. Identification of strategies for improving collaboration across NOAA including integrating messages and research needs, leveraging funding, and developing non-traditional methods for integrating research results into spill response practices.
5. Identification of new ideas for better preparing to apply broader suite of NOAA scientific capabilities to spill response, assessment and restoration.
6. Summary of CRRC-funded research with potential for moving into operations and decision-making.

Summary of CRRC-funded research with potential for moving into operations and decision-making

1. Collection of research with measured exposure concentrations for PAHs linked to defined endpoints across levels of biological organization
2. Collection of research with a range of trophic levels and sensitivities represented
3. Development of new tools for modeling PAH toxicity associated with spills
4. Robust database that feeds into database needs (Figure 1) and a method for normalizing disparate data using the toxic unit approach.
5. Demonstration of varying exposure regimes whether test media is filtered or unfiltered.

Literature cited

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For more information on the projects and the workshop, please visit www.crrc.unh.edu.