

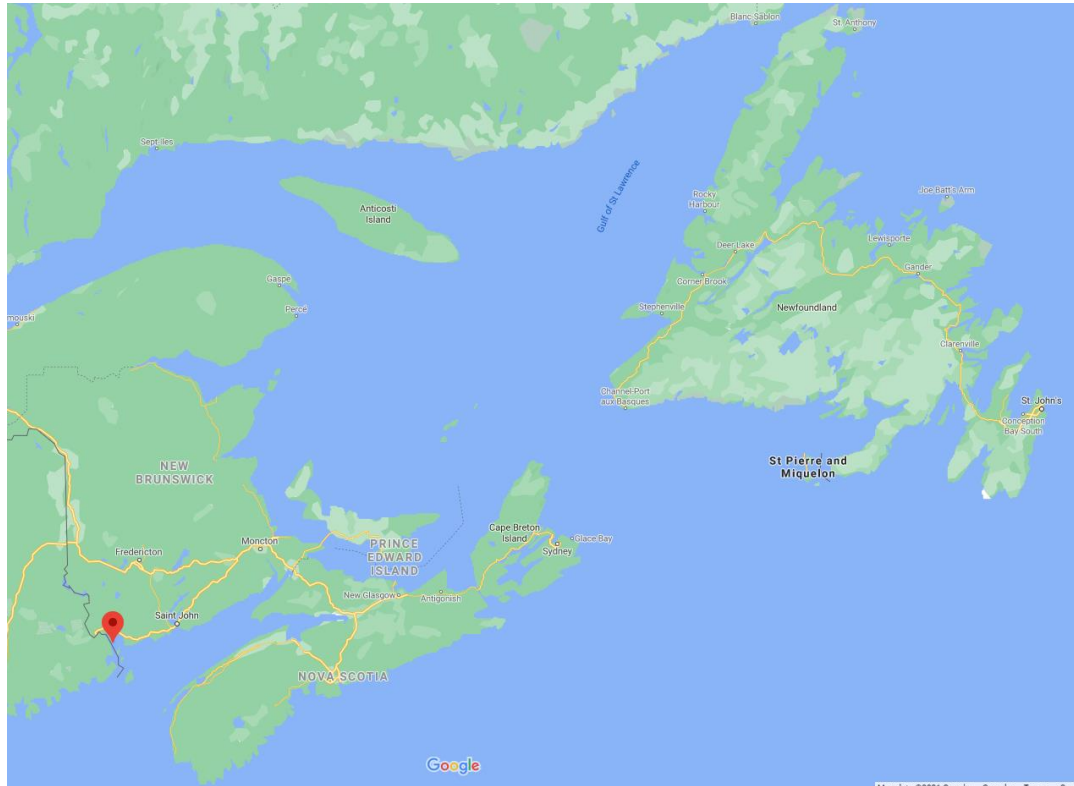
Huntsman ESRF Research

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Huntsman Marine Science Centre



NGO, Federally registered non-profit, research and education institution



ESRF Project Objective

*Investigate the effects of east coast Canada **WAF** and **CEWAF** on early life stages of **commercially harvested marine species***

- **Provide realistic exposure scenarios**
- **Provide relevant and reliable ecotoxicity data**
 - Inform regulatory decisions



Toxicity Trials

Expose organisms to a range of concentrations, for a specific duration

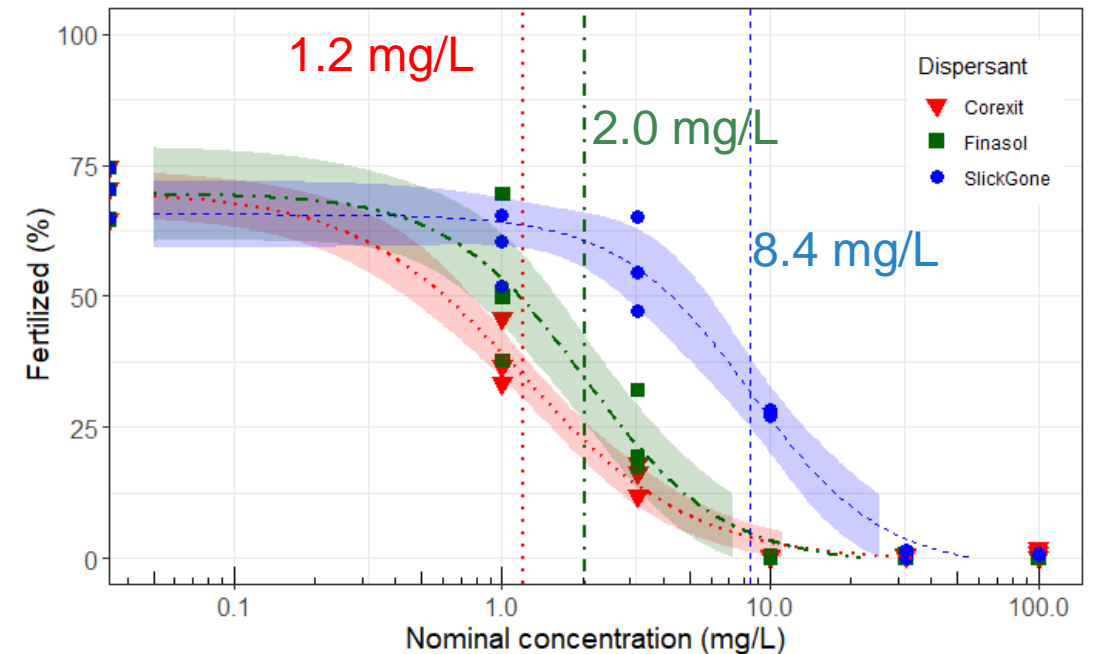
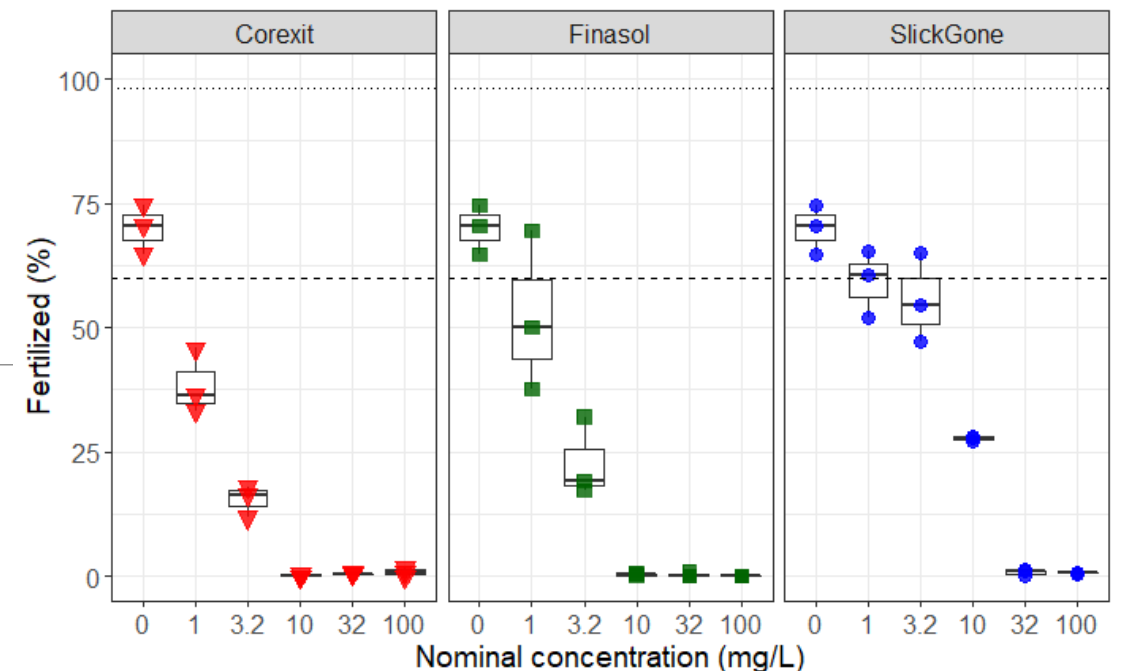
- Minimum 3 concentrations + control
- Minimum 3 replicates per concentration
- Durations 1 – 48 hrs

Measure the response at each concentration

- Lethal and sublethal
- Meet validity criteria

Determine the concentration at which a 50% change from control (unexposed) organisms is observed

- LC50, EC50
- Lower values are more toxic

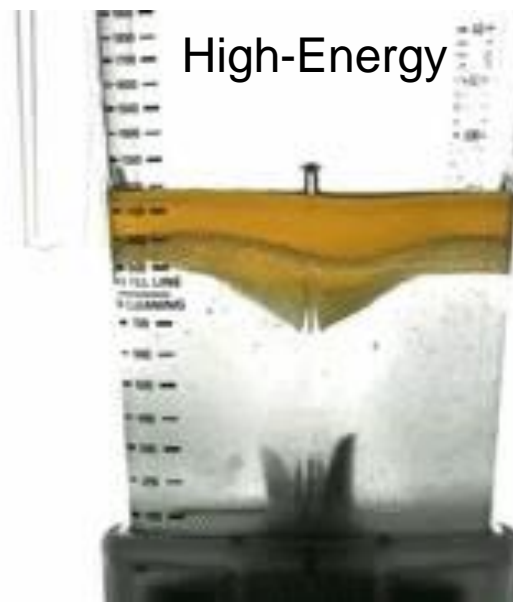




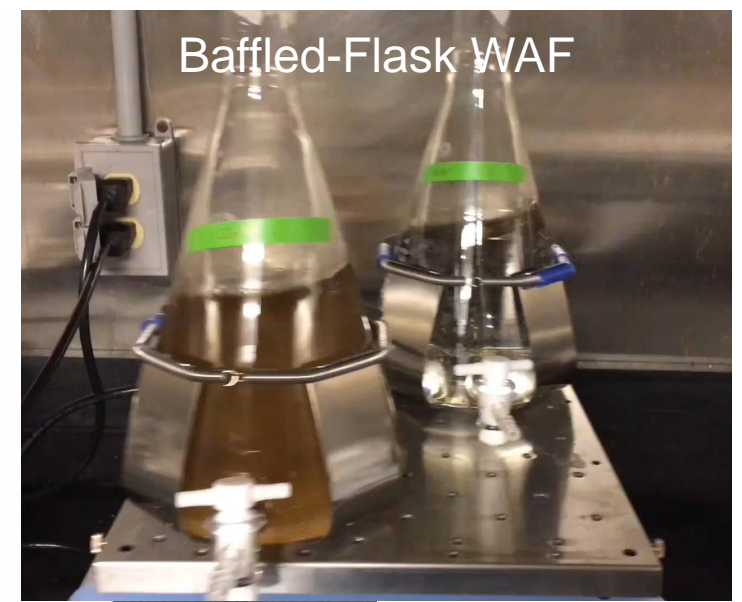
No-Energy



Low-Energy



High-Energy



Baffled-Flask WAF

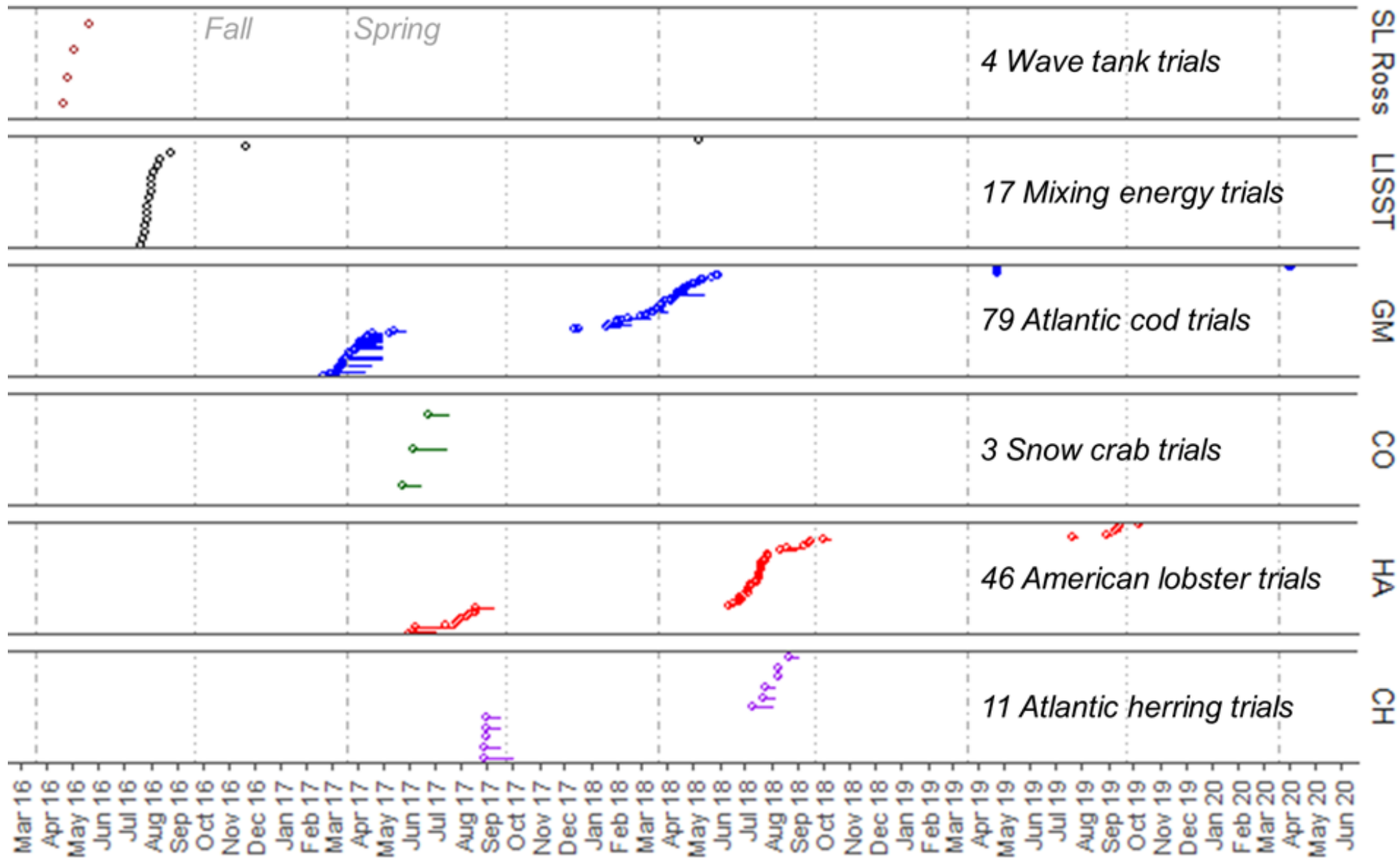


Real World Environment

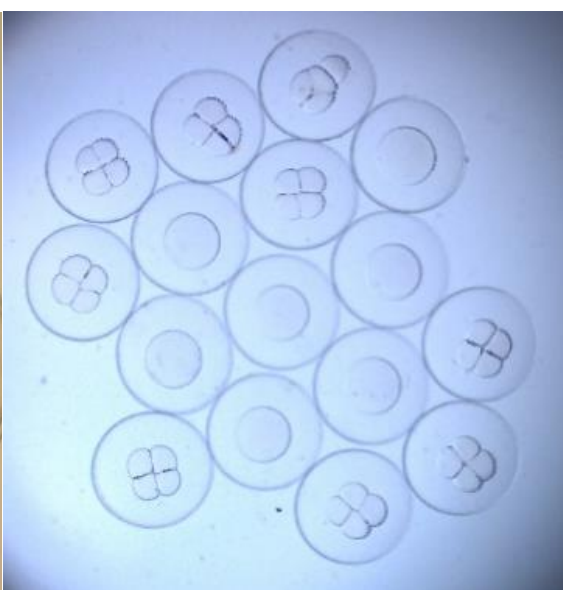
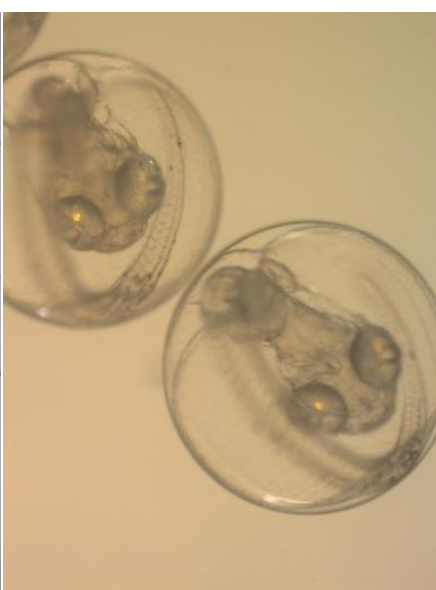
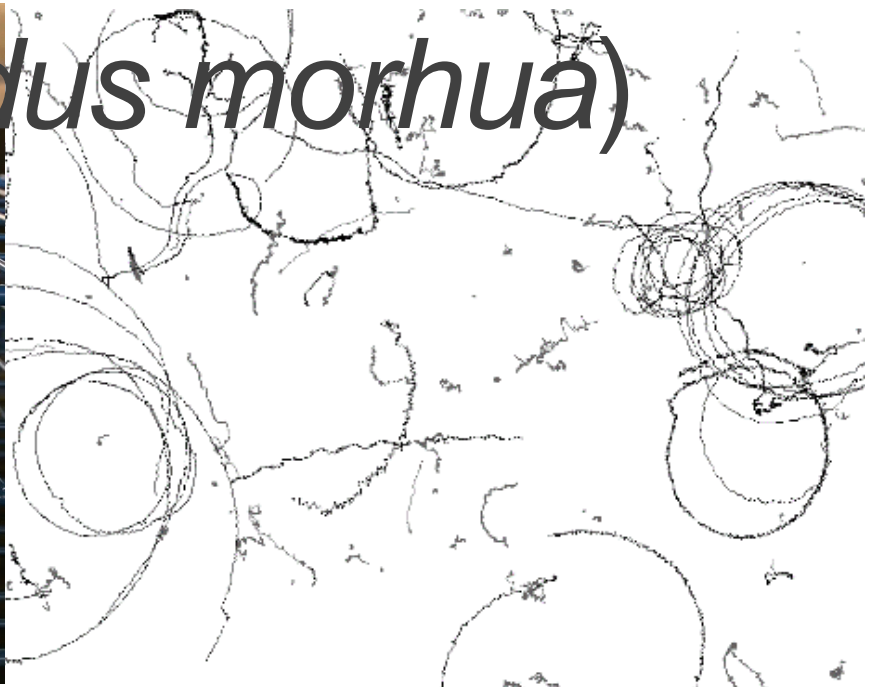
<https://www.cnlop.ca/incidents/ibjul182019/>



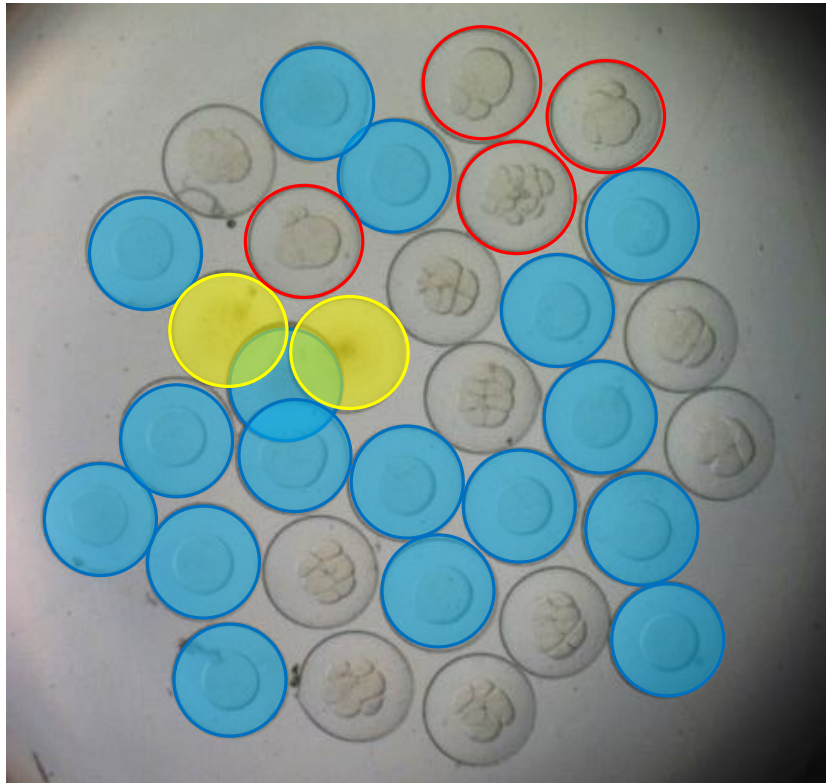
Wave Tank: Breaking Wave



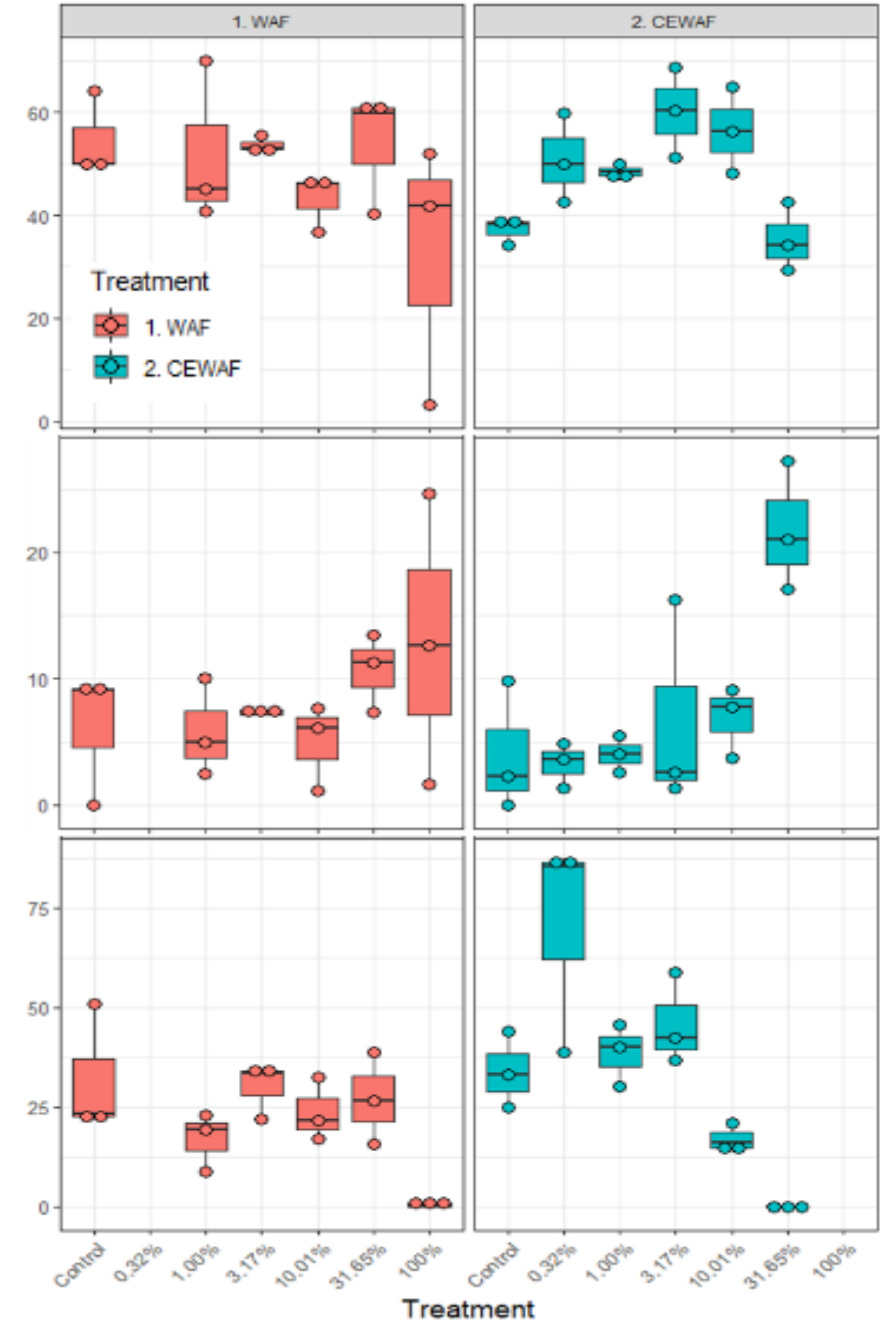
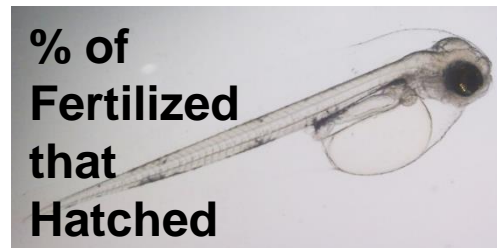
Atlantic cod (*Gadus morhua*)



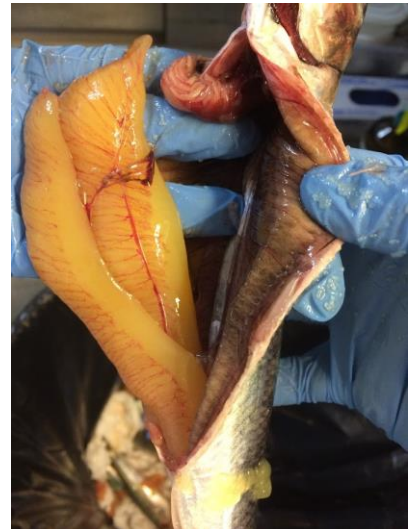
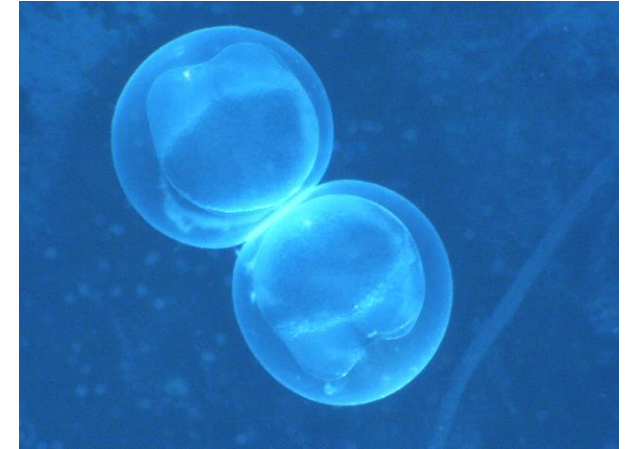
Cod Fertilization in WAF/CEWAF



● Non viable
● Non fertilized
● Abnormal fertilization



Atlantic herring (*Clupea harengus*)



Toxicity to Atlantic herring embryos

Objective: assess the toxicity of physically and chemically dispersed oil on Atlantic herring

Methods: Fertilization (1-hr) and Embryo (2, 7, 10 dpf) exposures (1, 6, 18, 24-hrs); monitor until hatch

- Results:**
- Increasing strength of solution saw decreasing hatching success.
 - Embryos exposed at 10 dpf were less sensitive than the 2 and 7 dpf exposures

- Outcome:**
- Effects are not likely to be equally distributed across the embryonic life stage
 - We observed significant variability in responses based on the specific pairing or cross that was made.



American lobster (*Homarus americanus*)

Special permit to collect “berried” female lobsters

Freshly hatched (<24 hrs) larvae are collected and used for exposure trials

Immobilization, mortality, moulting, and growth



Toxicity to Larval lobster

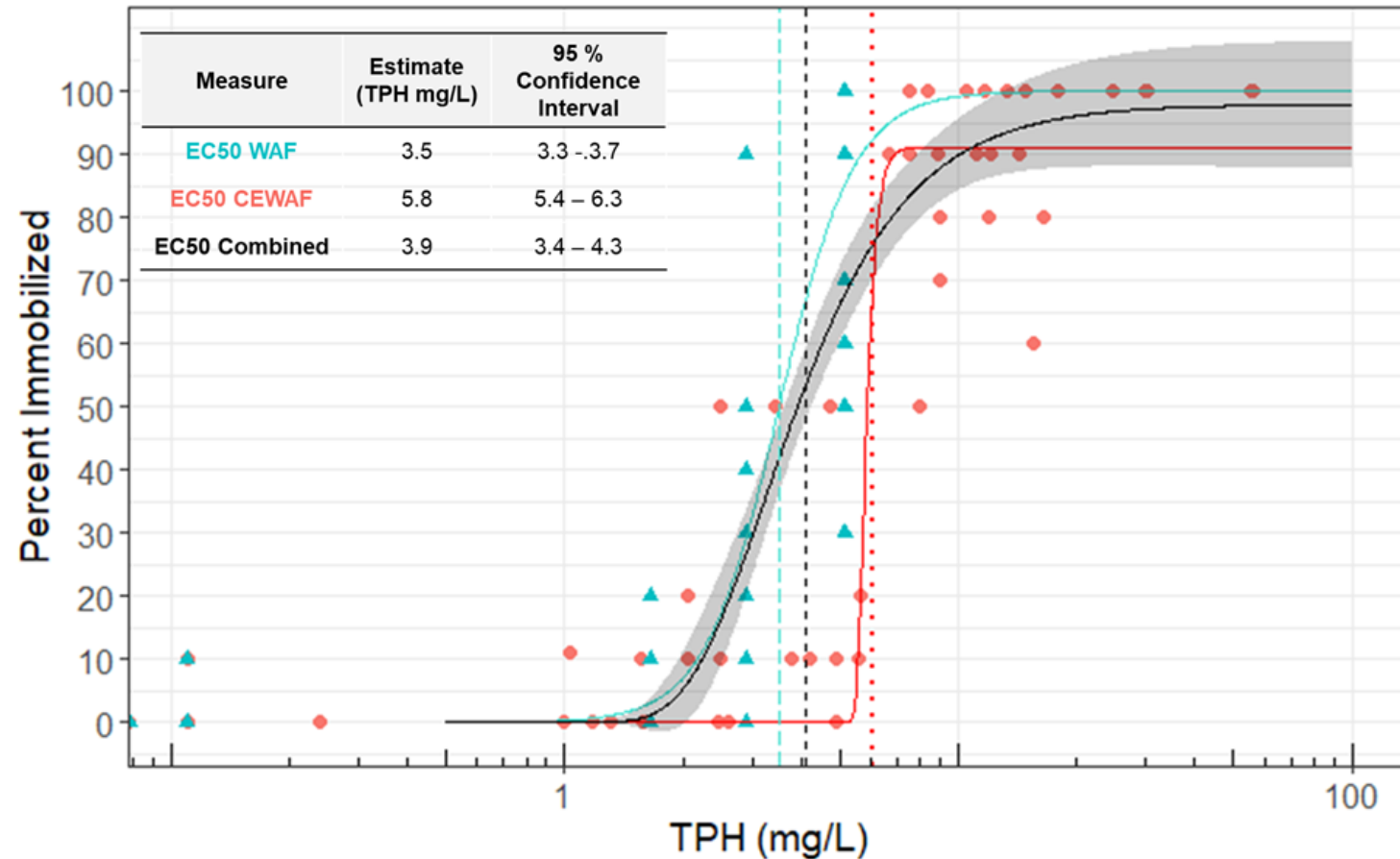


Objective: Sensitivity of American lobster larvae between different batches released from the same lobster and amongst different lobsters

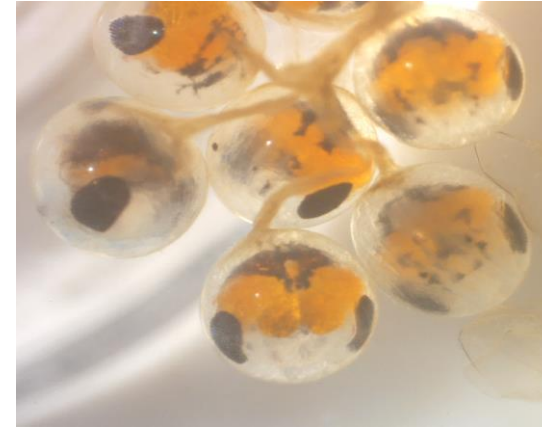
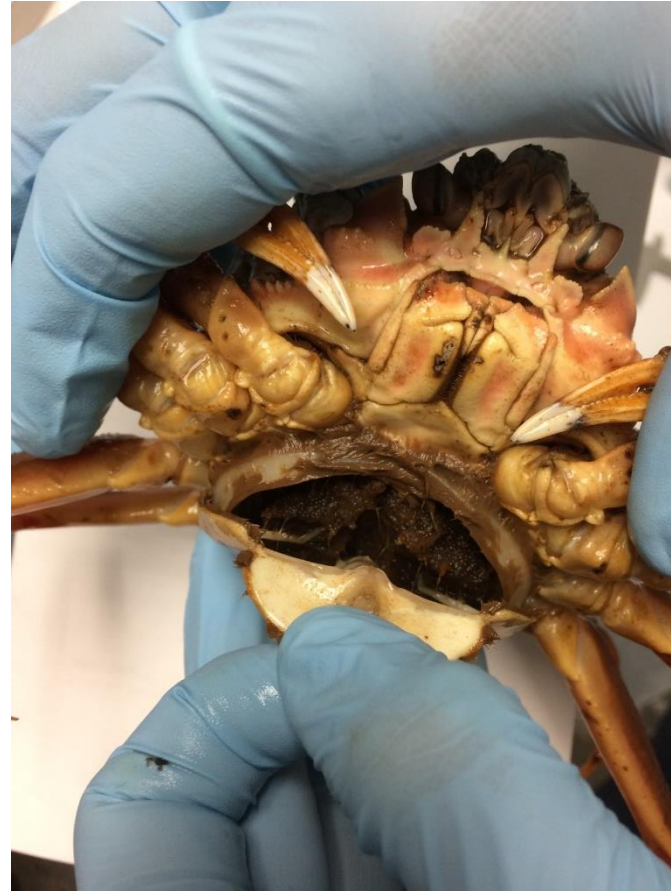
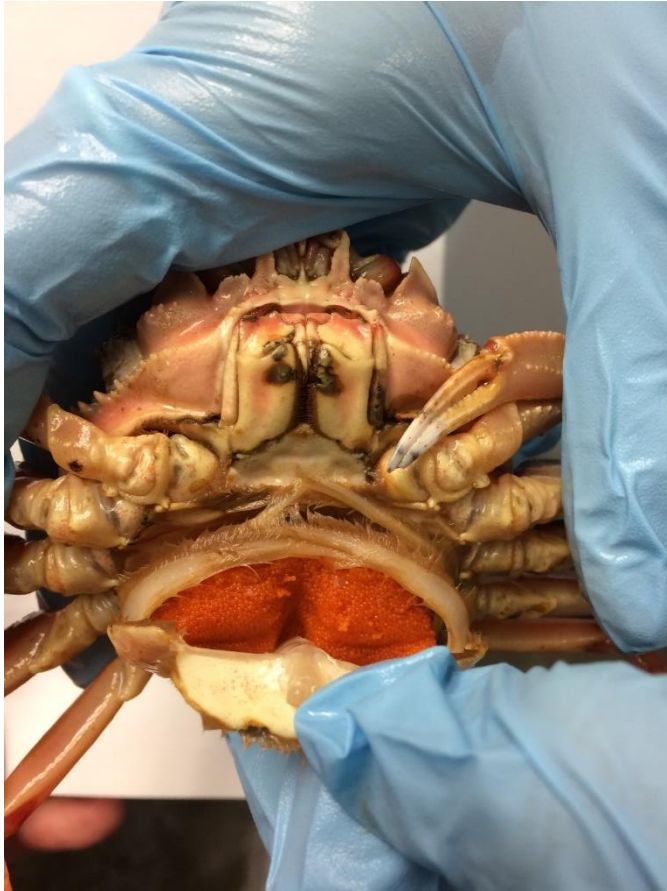
Methods: 24-hr exposure; 19 bioassays with 13 different females

Results: The individual TPH-based 24h EC50 values ranged from 2.54 - 9.73 mg/L when the exposures were considered together, pooled EC50 = 3.9 mg/L (3.4 - 4.3)

Outcome: Limited variability within and between larval lobsters for acute response to petroleum hydrocarbons



Snow crab (*Chionoecetes opilio*)



Vulnerable, early life stages

- Embryo
- Zoea
- Megalop

Vulnerable time periods

- Moulting

Toxicity to Larval Snow crab

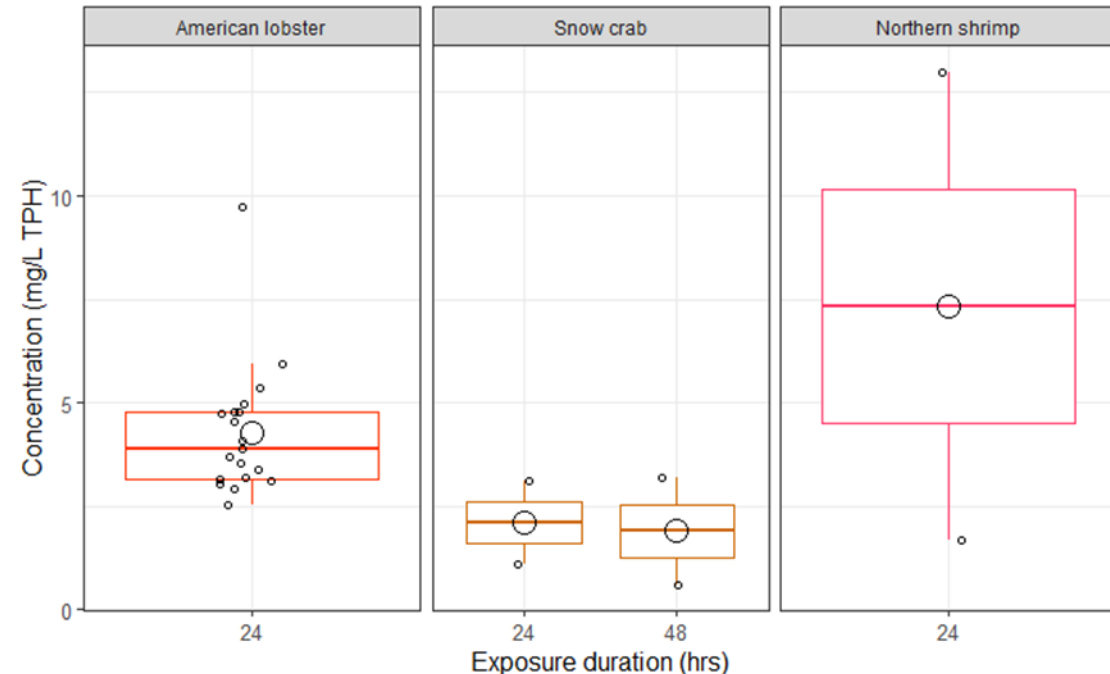
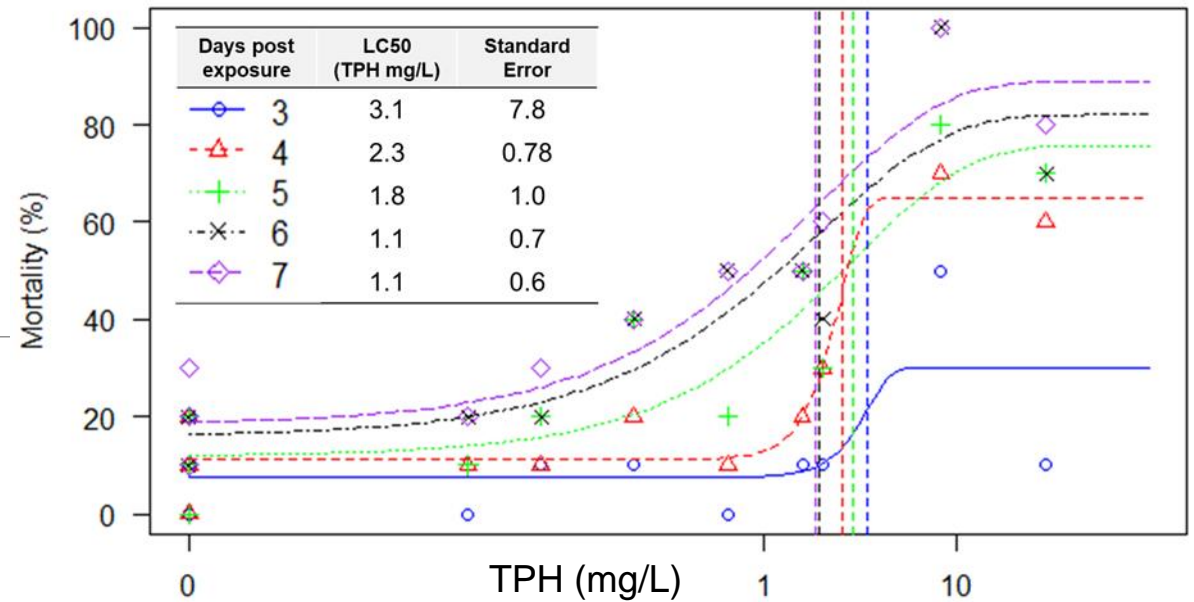
Objective: Assess toxicity to larval snow crab in place of Northern shrimp

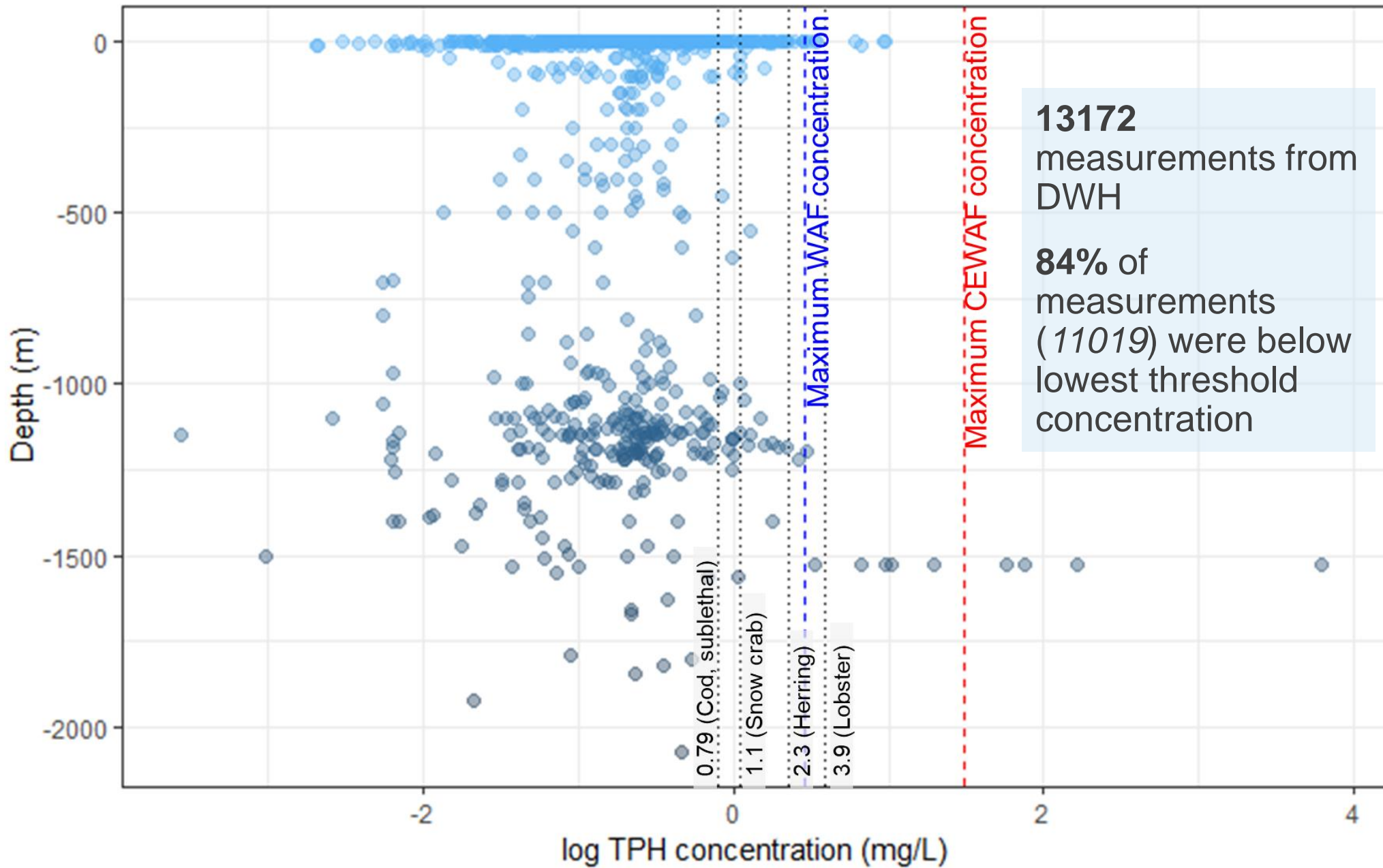
Methods: 24 and 48-hr exposure; transferred to clean seawater after the exposure period

Results: TPH between 1 to 3 mg/L are sufficient to cause latent mortality effects that were not observed within the first 48-hours post exposure

Outcome:

- Support the limited variability observed in crustacean responses to crude oil
- Suggests that effect concentrations derived from American lobster and/or snow crab larvae would be reflective of the expected response from Northern shrimp



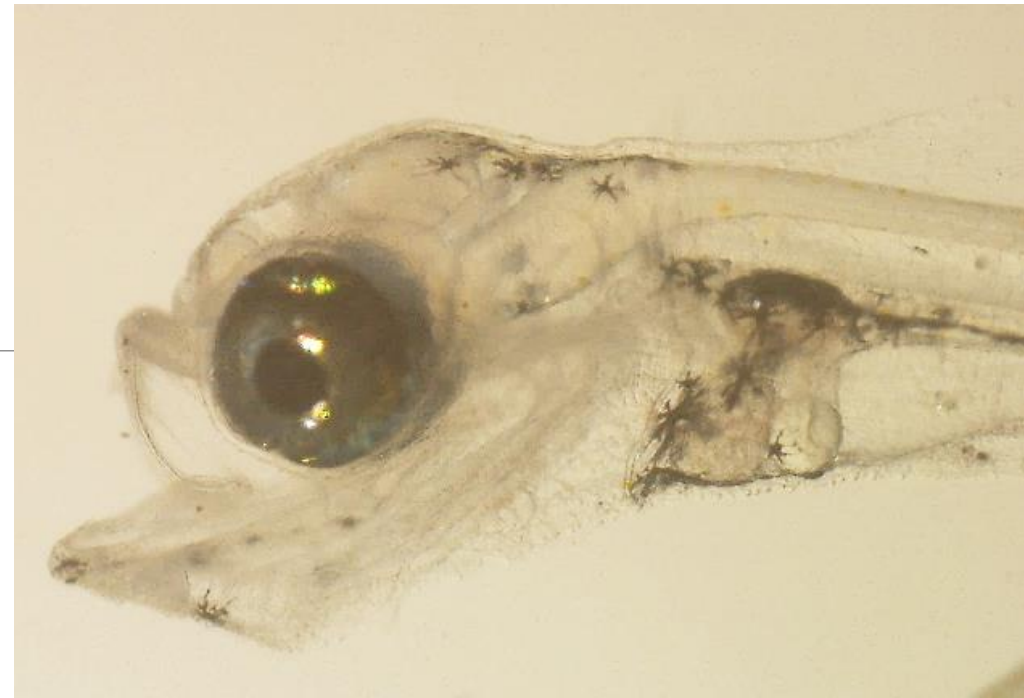


Main Findings

The observation of effects is dependent on the **life stage**, **exposure concentration** and **duration**

- Our results show significant variability within the life history of a species, with specific developmental points (e.g., hatching) and early life stages being more vulnerable
- When the effects are reported on a constituent concentration basis, thereby normalizing the responses to TPH, there is little difference between response from exposure to WAF or CEWAF

The toxicity of the **dispersant alone** occurs at concentrations **3 - 40 times greater** than the highest concentrations expected to occur in the field following application



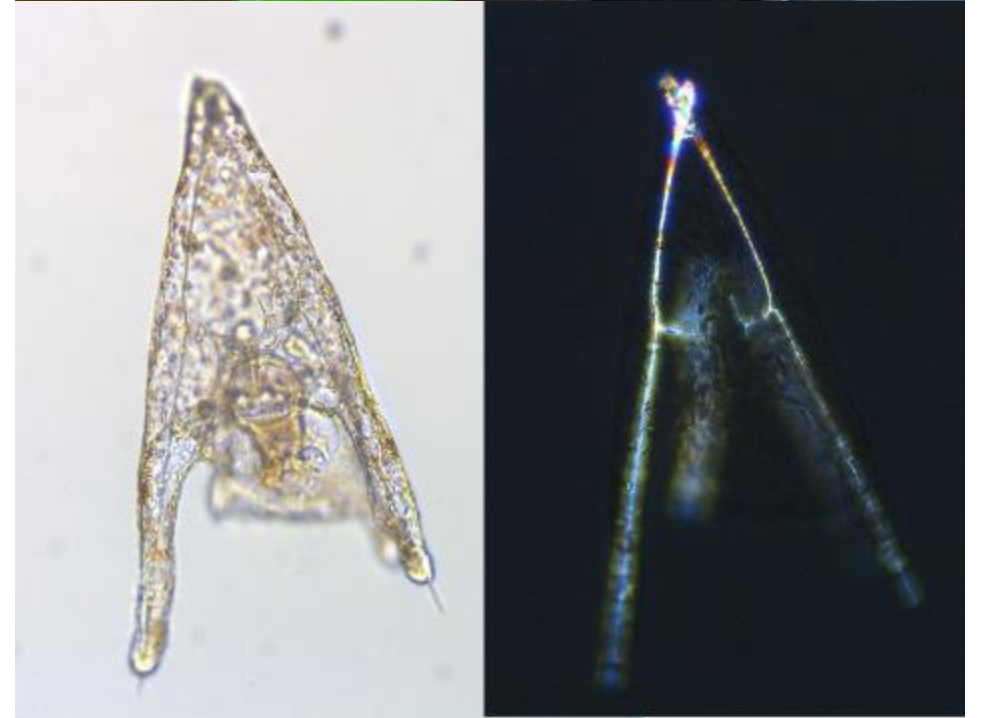
Ongoing Research

Multi-Partner Research Initiative

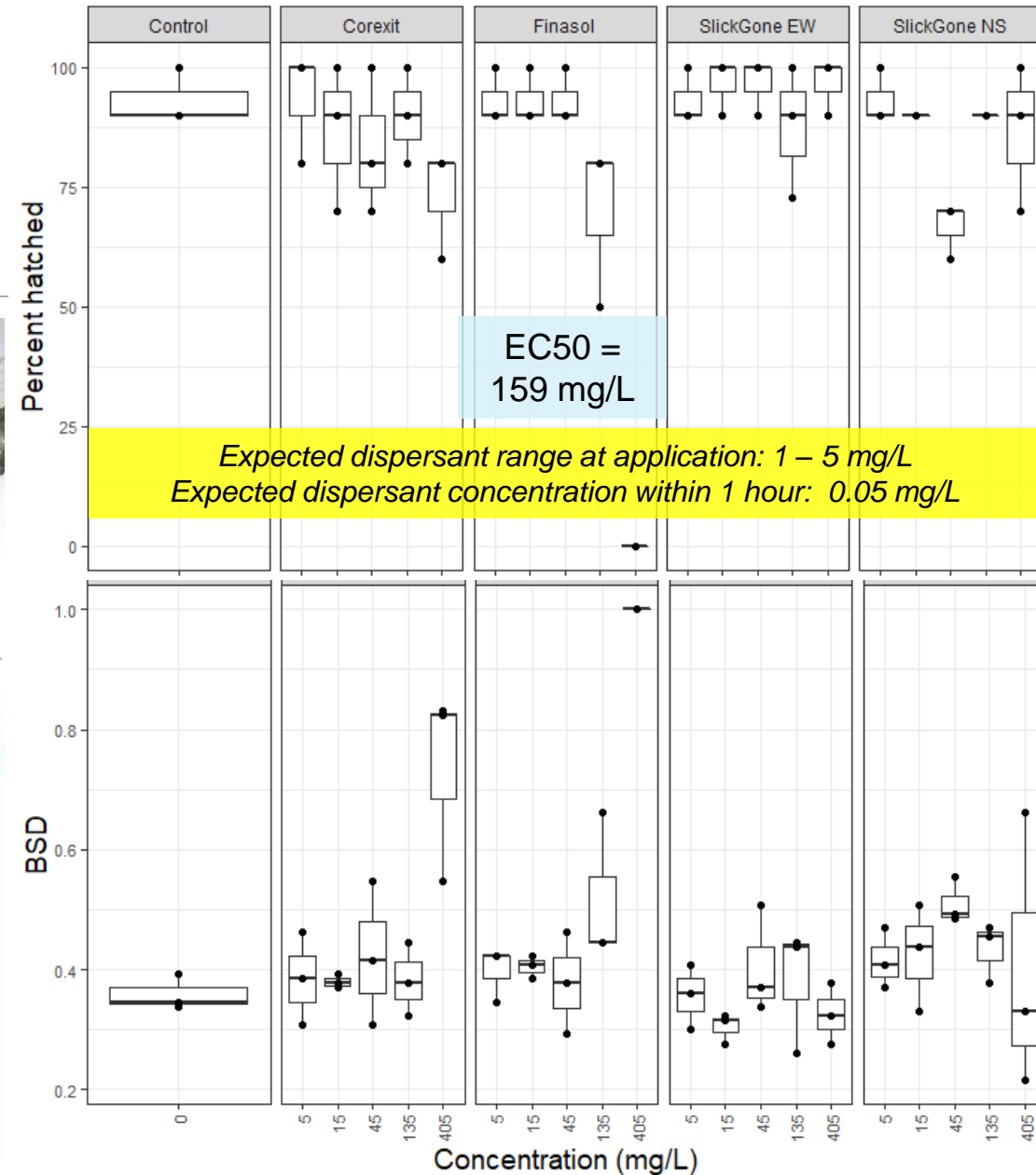
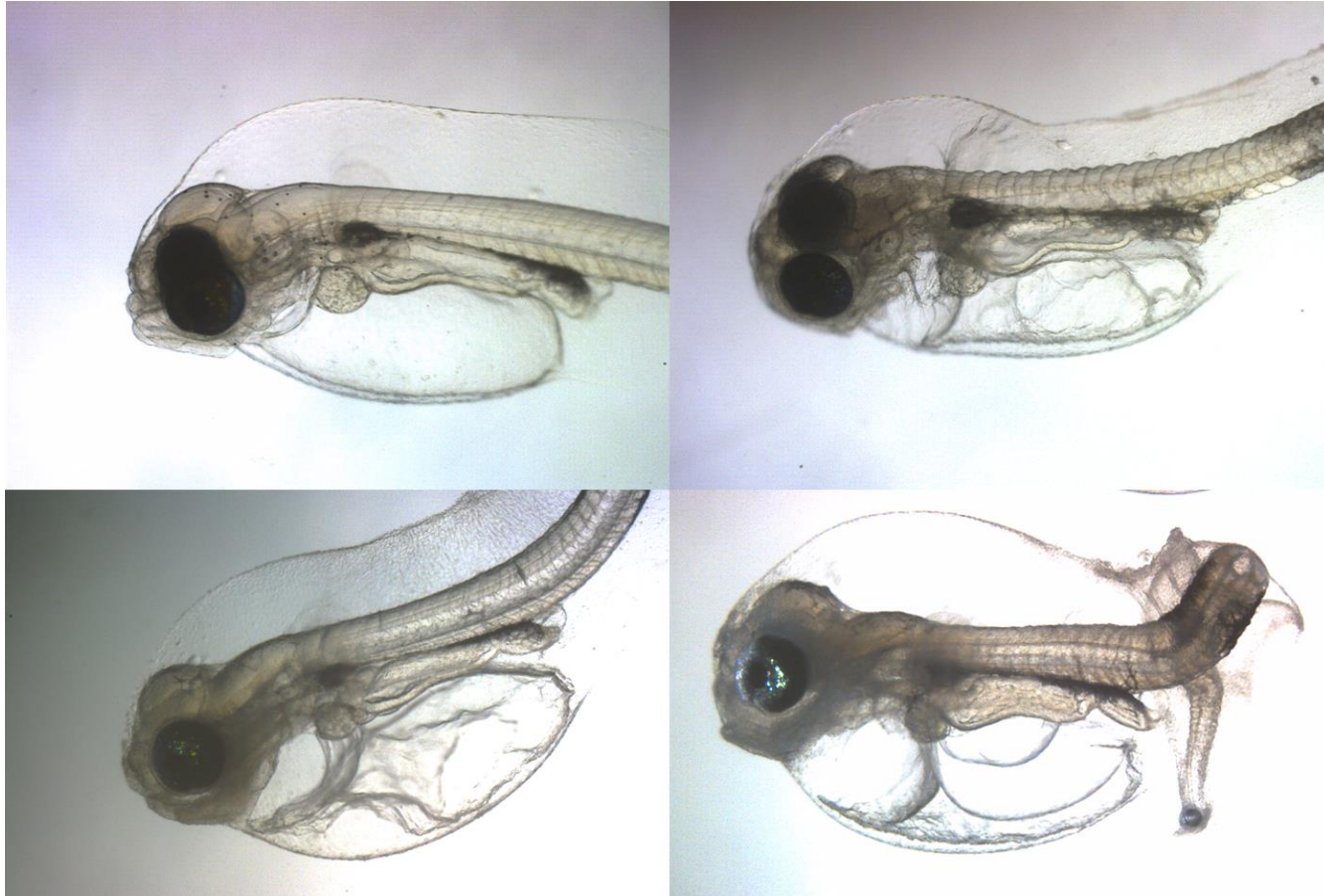
- Multiple products, multiple ARMs
 - In situ burn residues, herding agents, dispersants
- Modernization of CROSERF Protocol

National Contaminant Advisory Group

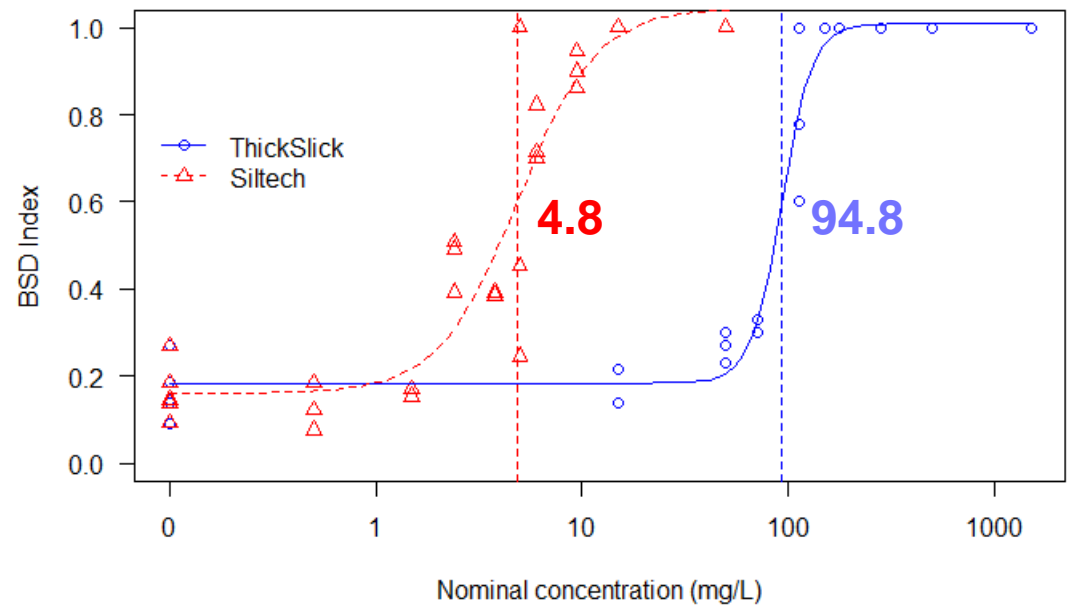
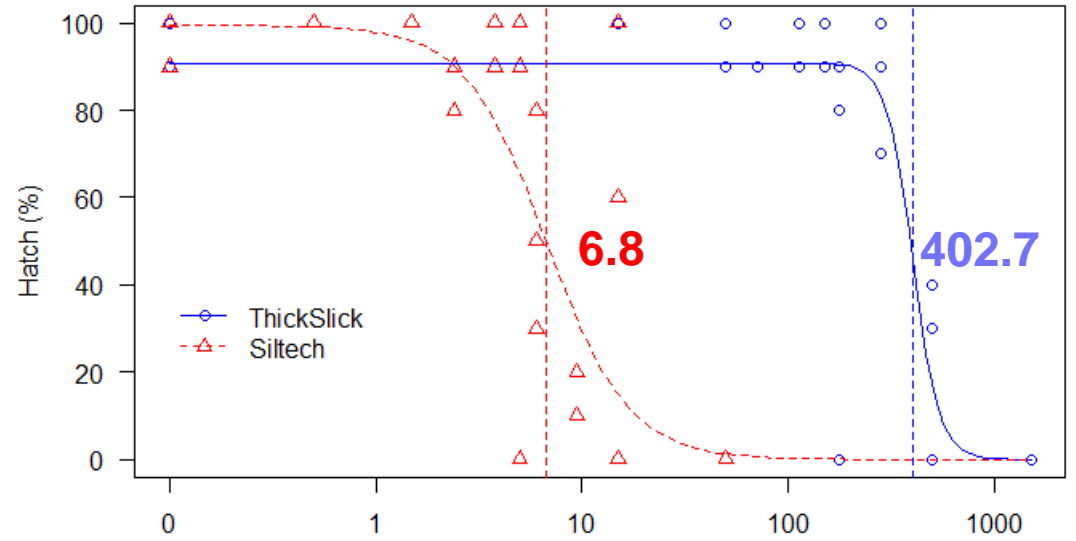
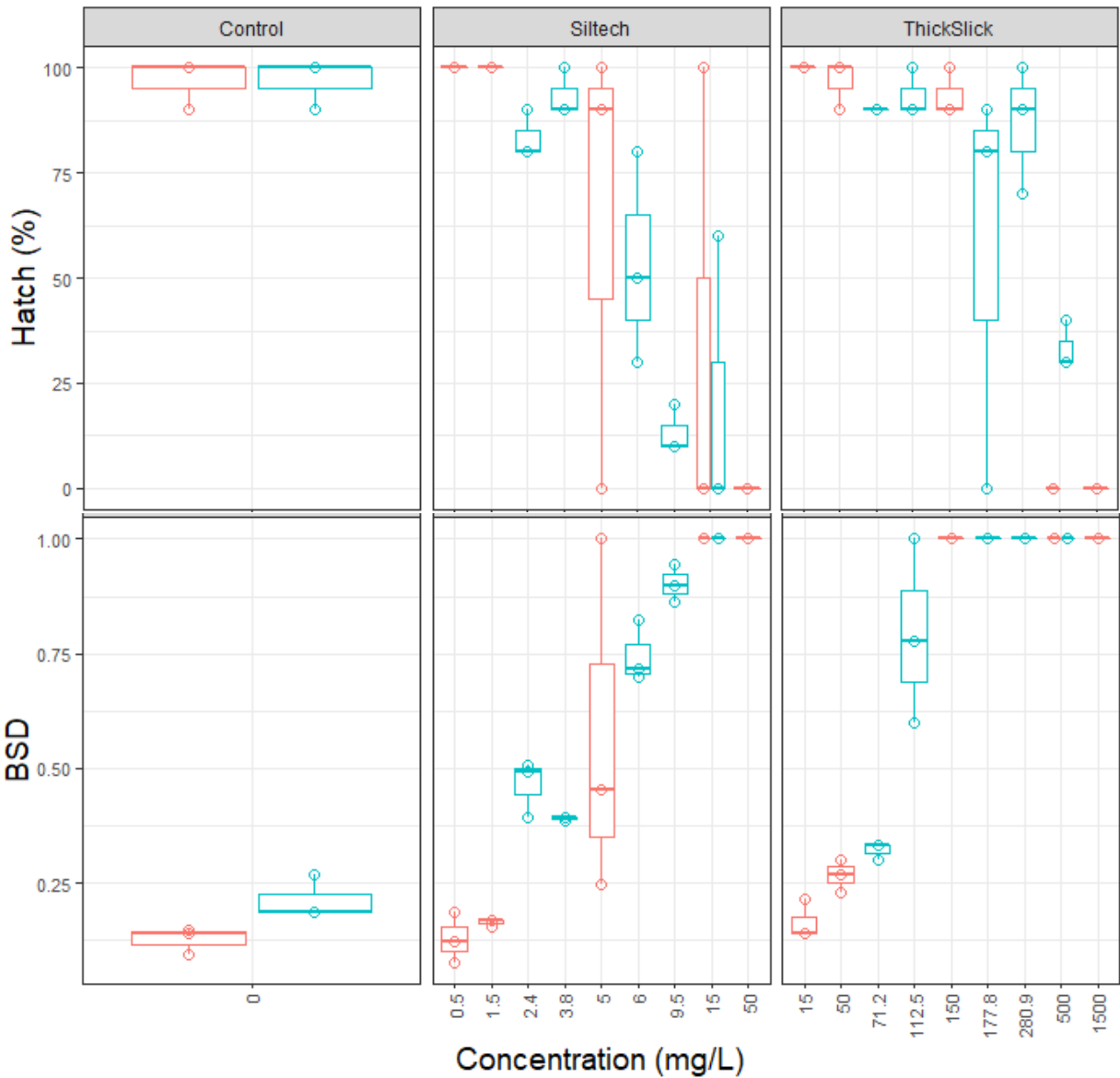
- Single PACs, mixtures, modifying factors



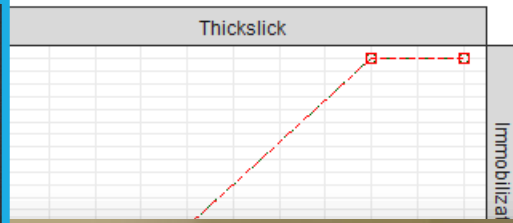
Acute Toxicity of Dispersants to Atlantic cod (MPRI)



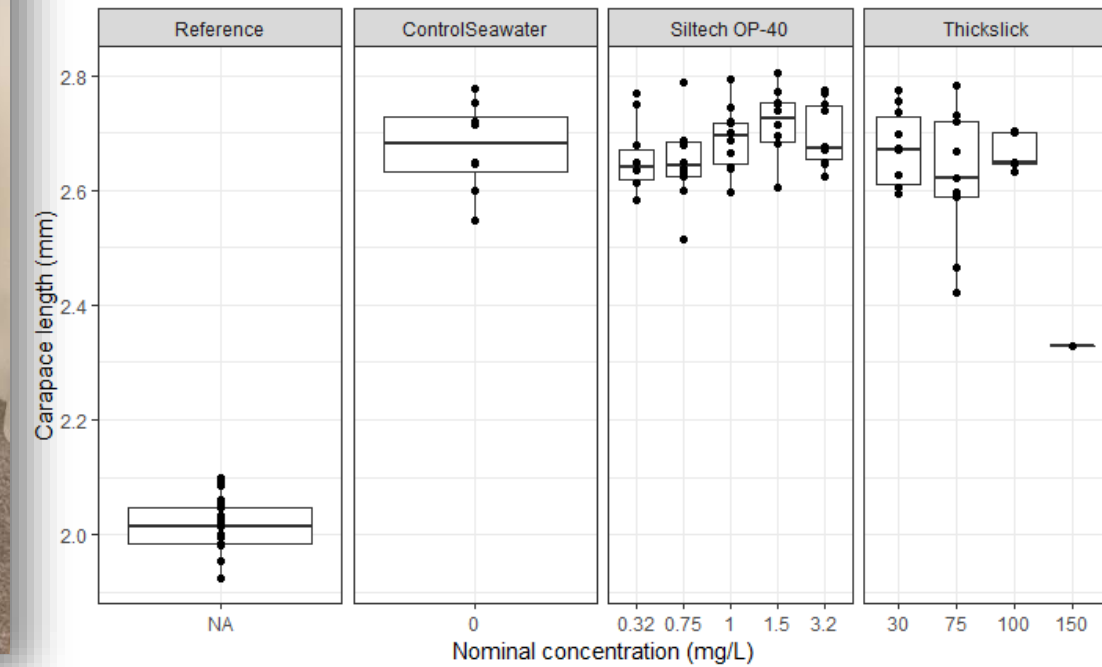
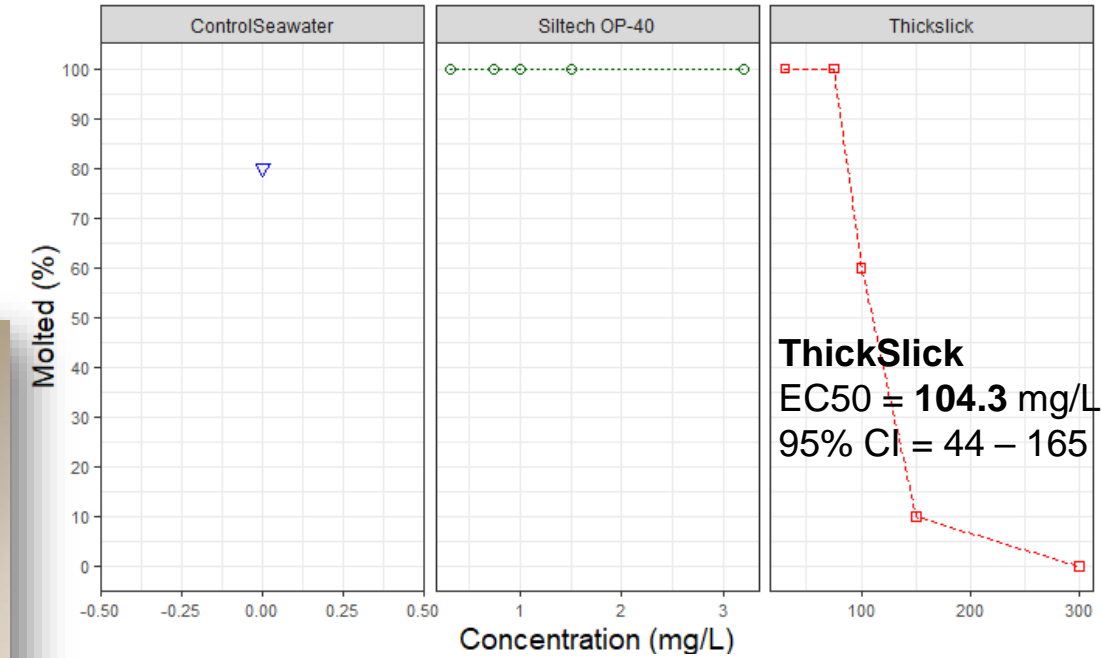
Atlantic cod: pre-hatch embryos, 24-hr exposure to herders

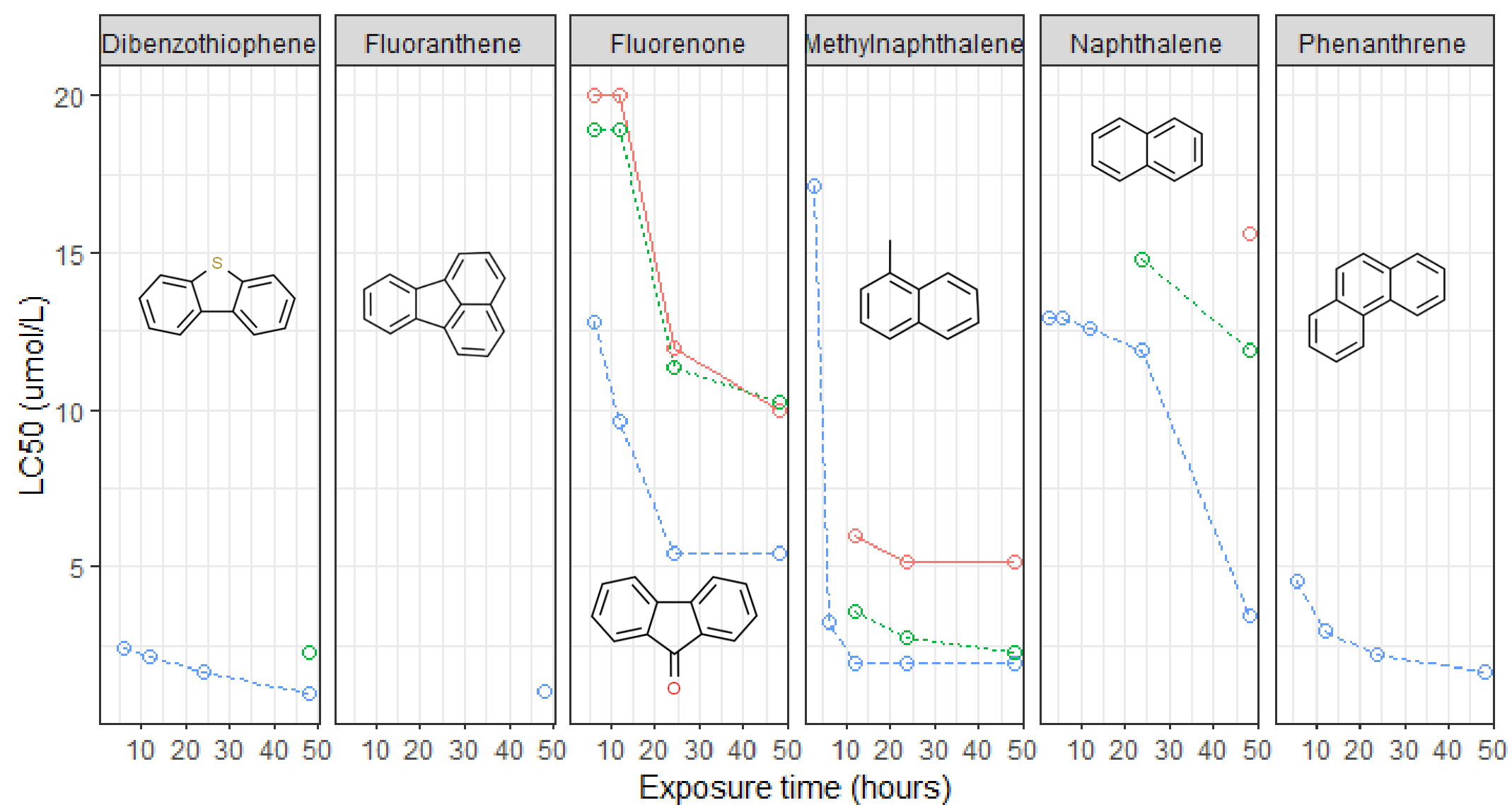


American lobster: 24-hr exposure



Concentration (mg/L)





NCAG

- Single compound toxicity results
- Response over time, short durations
- Modifying factors temperature, salinity, UV, mixtures
- Validate and improve predictive models

Temperature (°C) —○— 10 —●— 15 —○— 20

Considerations

Oil spill response decisions **are not based on lab-based toxicity tests**

- **Numerous** factors need to be considered
- Lab-based data may be **used as inputs** into population level impact models to predict responses based on different scenarios (e.g., with and without dispersant)

Windows of opportunity for dispersant usage

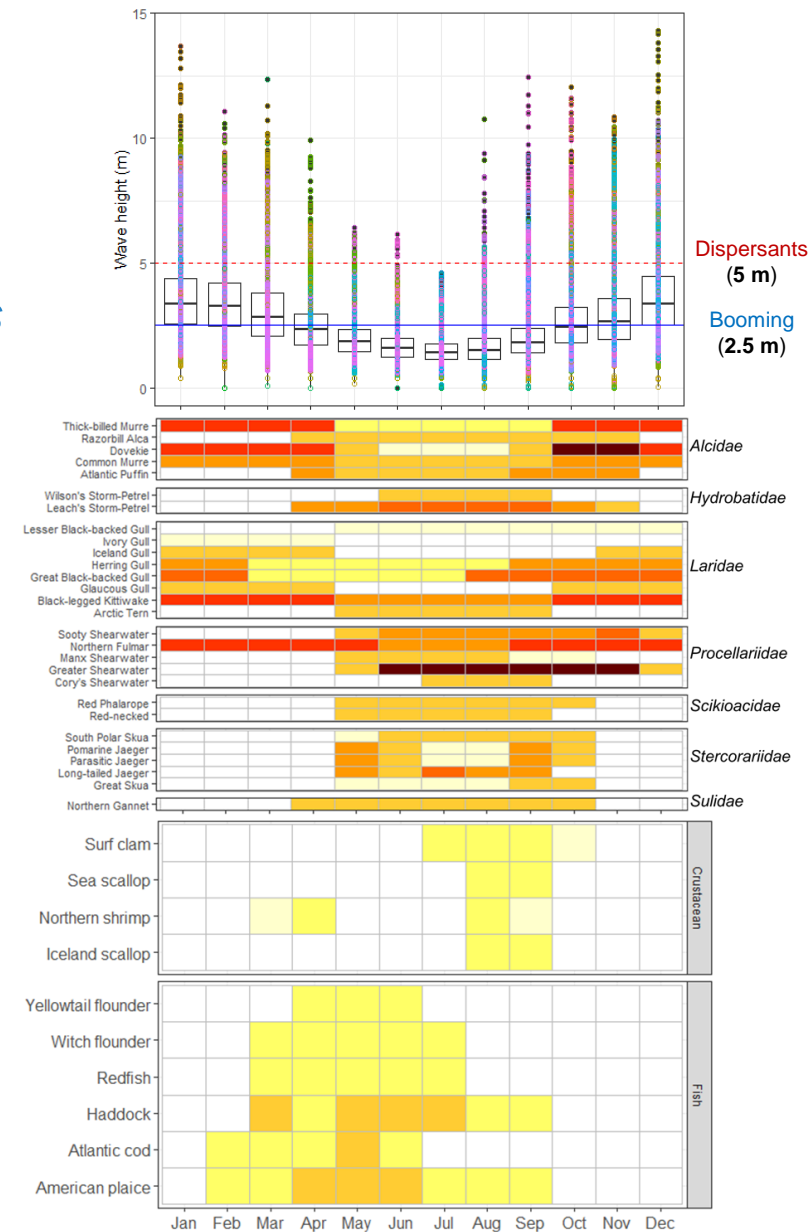
- Operational conditions, Type and extent of spill, Time elapsed

Exposure

- Seasonality, Life history traits, Migratory animals

Spill Impact Mitigation Assessment (SIMA)

- Process by which **relevant data** are evaluated, outcomes are predicted, and an attempt at weighing and **balancing the trade-offs** of response measures
- Models: SIMAP, Fecundity-Hindcast
- The decision to apply dispersants to break up a surface slick and **minimize effects to seabirds and mammals** is balanced against the **potential impacts to pelagic organisms**, including commercially important fish and crustacean species



Data Gaps and Additional Research Needs

- Deep-sea, sediment, and benthic exposures
- Wildlife
- Multiple stressors
- Variable exposure scenarios
- Always seeking input based on concerns





Questions

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