Dispersant Effectiveness & Toxicity Effects of Chemically Dispersed Crude Oil on Fish

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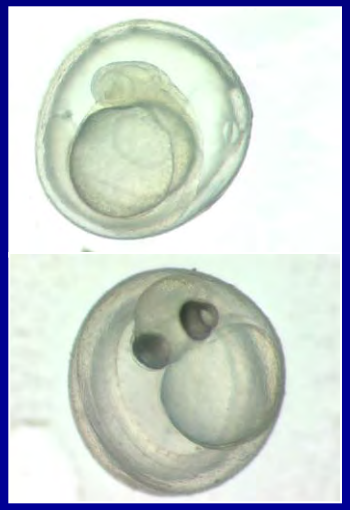
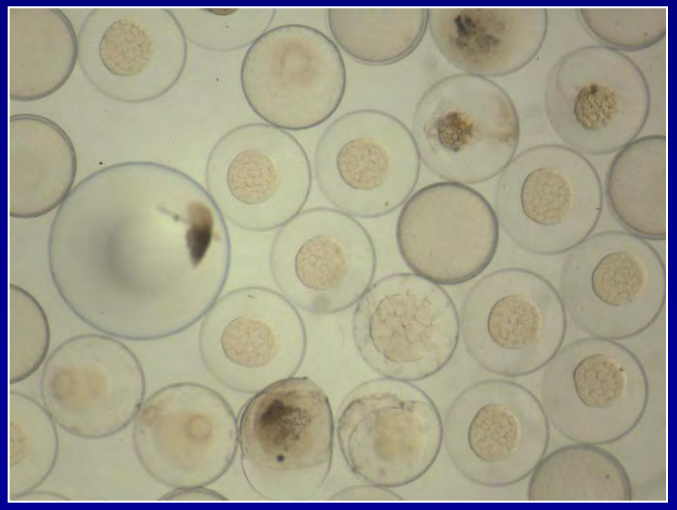
Rationale and Background

- Alaska North Slope (ANS) oil may be introduced to the Prince William Sound marine system by various means including oil spill
- Chemical dispersant is one of the most frequently used oil spill response strategies, as evidenced in last year's Gulf of Mexico Deepwater Horizon oil spill
- Knowledge gaps, however, exist in terms of both the effectiveness and the toxicity effects of chemical dispersant on crude oil in PWS environmental conditions

State of Knowledge for Oil Effects

- Lab tests have shown the toxicity of crude oil to Pacific herring embryos (Paine *et al.* 1996; Carls *et al.* 1999)
- Embryos are vulnerable to oil because freshly laid eggs stick to stationary surfaces (Smith and Cameron 1979)
- There is a positive correlation between oiled areas in Prince William Sound following the *Exxon Valdez* spill and physical deformities in herring embryos (Hose *et al.* 1996)



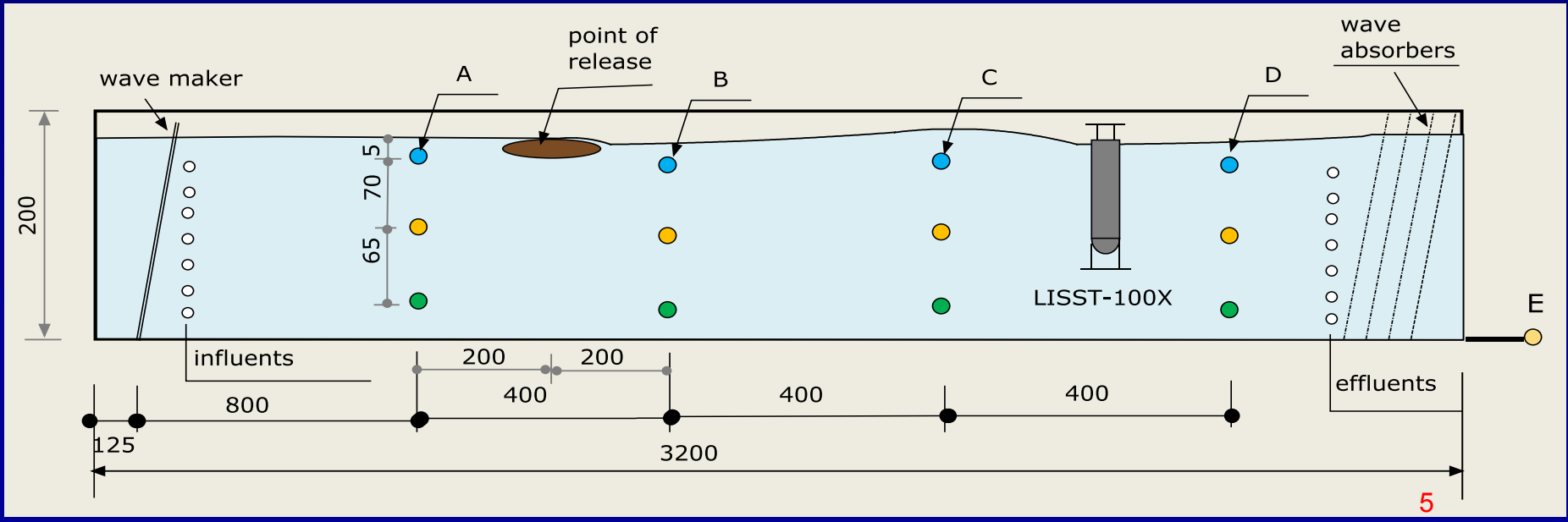


Objectives

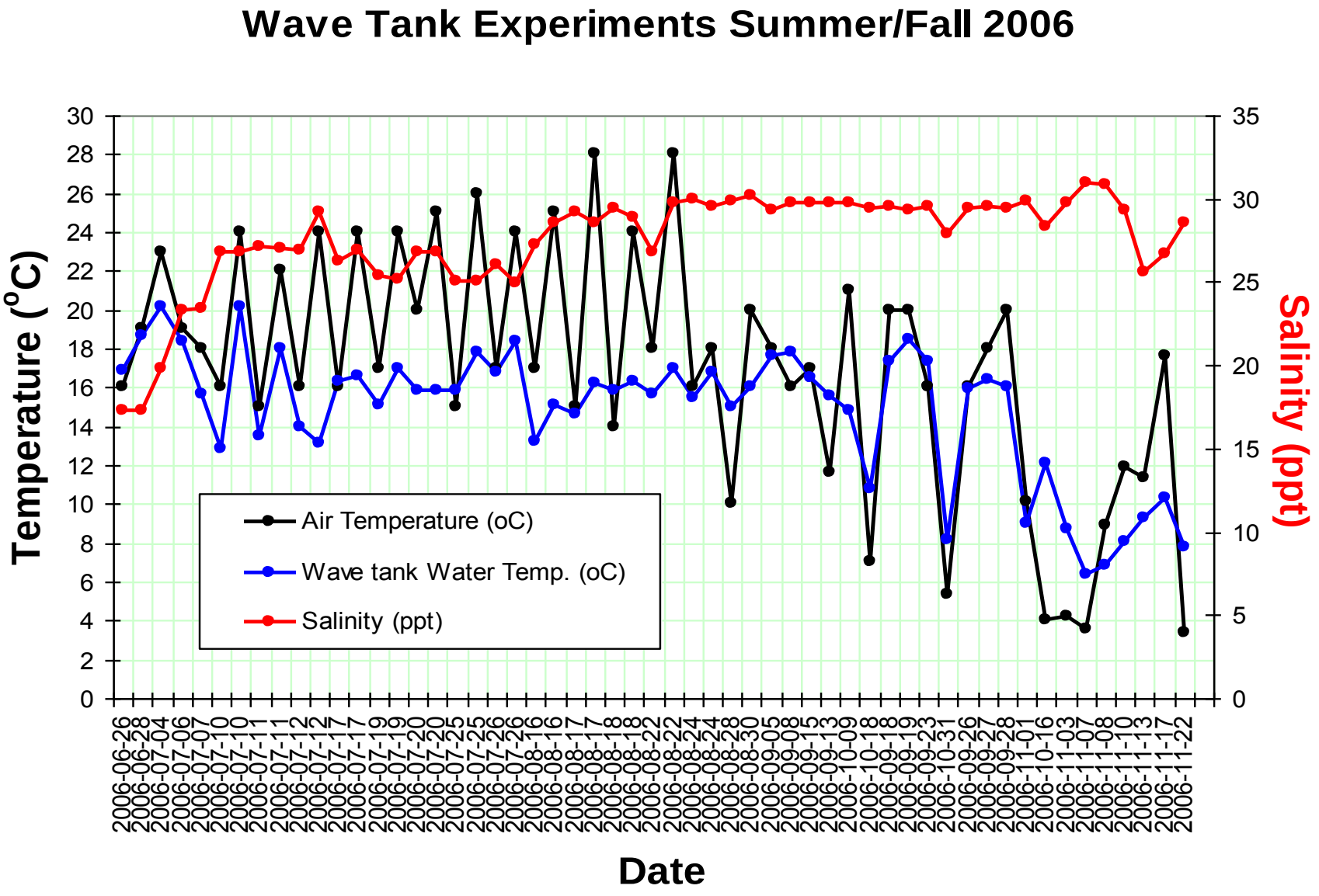
- Enhancing understanding for the impacts of crude oil spills and potential application of dispersants in PWS-relevant environmental conditions
- Evaluating the factors controlling the toxicity of dispersed and non-dispersed oil on early life stages of fish species of commercially importance to PWS
- Elucidating factors, including environmentally relevant time periods of exposure, oil concentration, temperature, salinity, and sensitivity of different species and life stages

Dispersant Efficacy Tests in Wave Tank

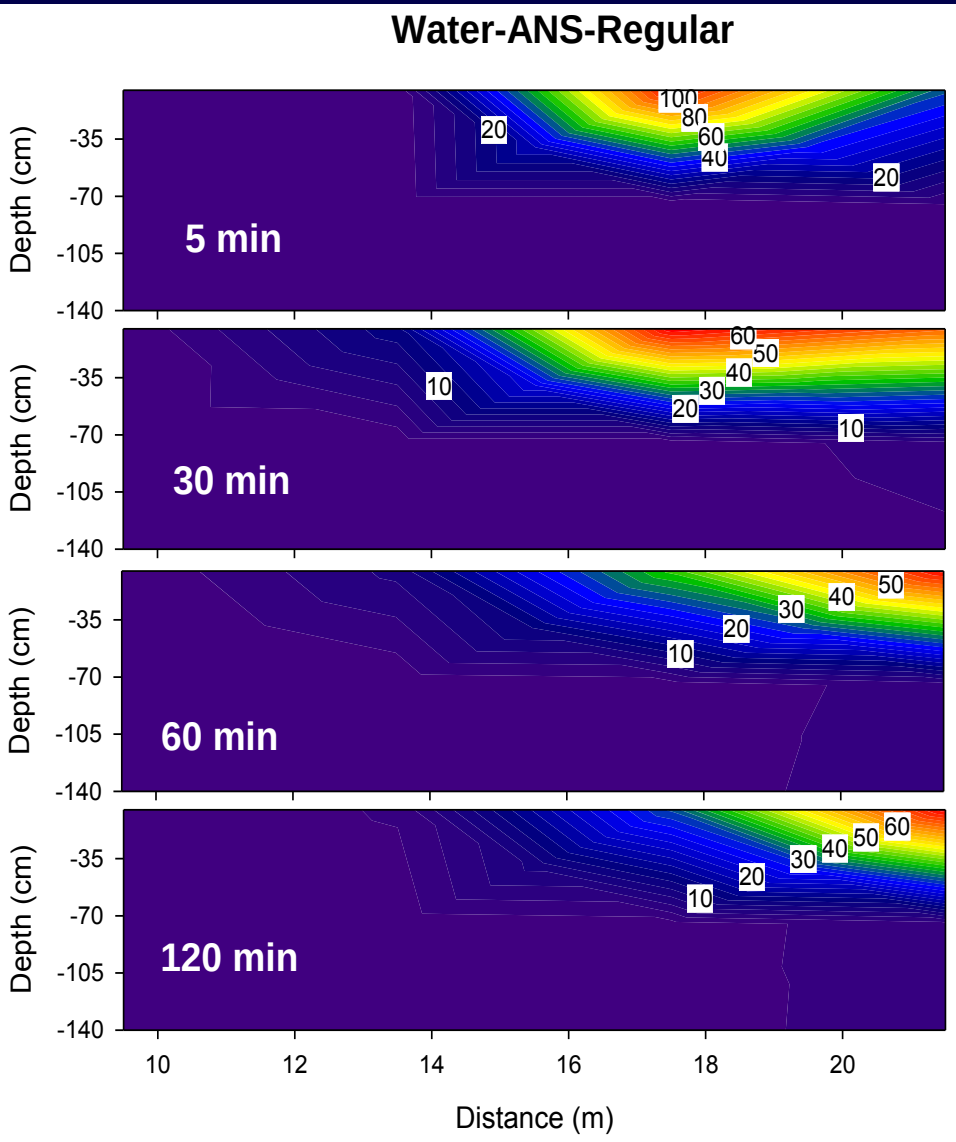
- Mixing energy is provided by wave and currents with hydrodynamics similar to the ocean environment
- Oil and dispersant loadings close to the field conditions
- Dispersion of oil monitored with both hydrocarbon concentration and oil droplet size distribution analysis
- ***The system is suitable for WAF and CEWAF generation in mesocosm scale for testing sub-lethal response***

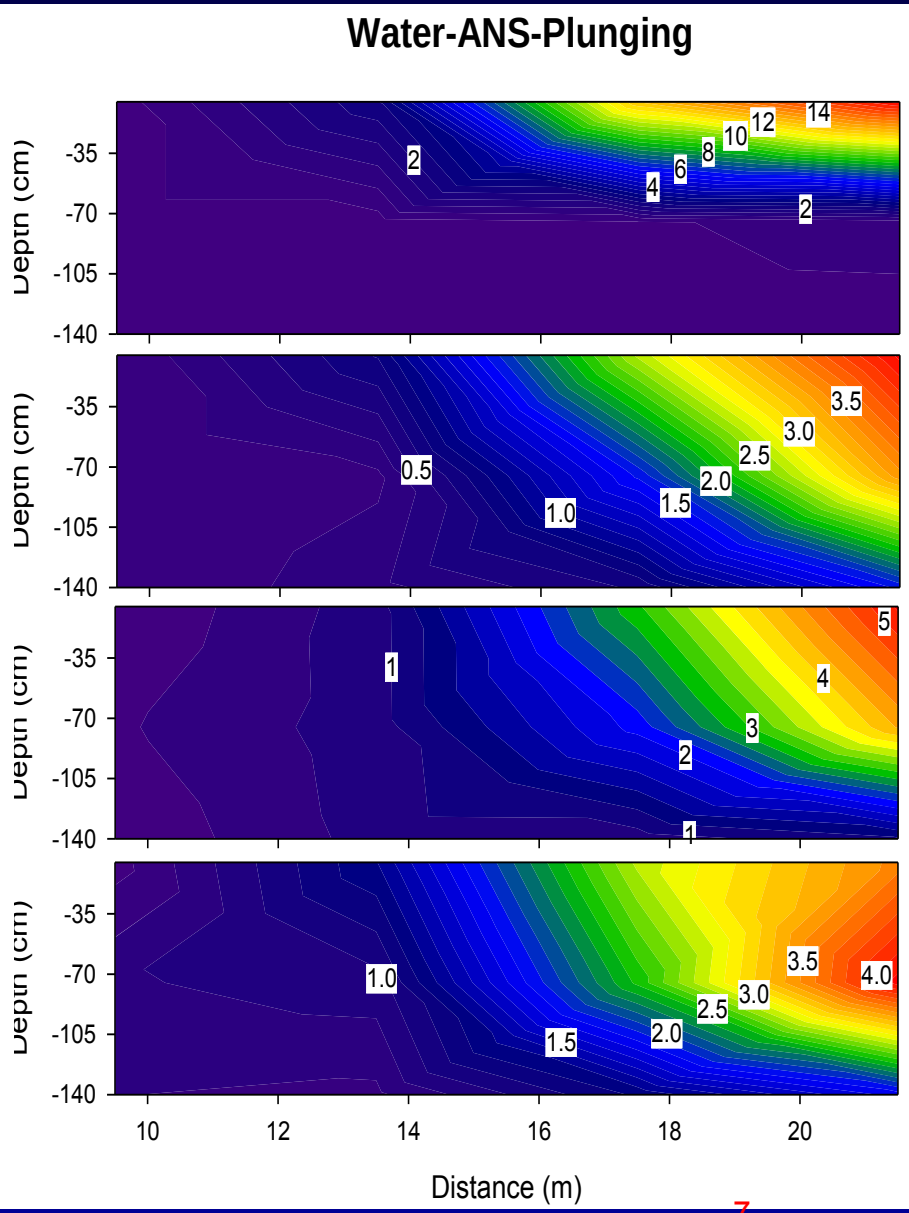


DE Testing in Summer and Fall Conditions

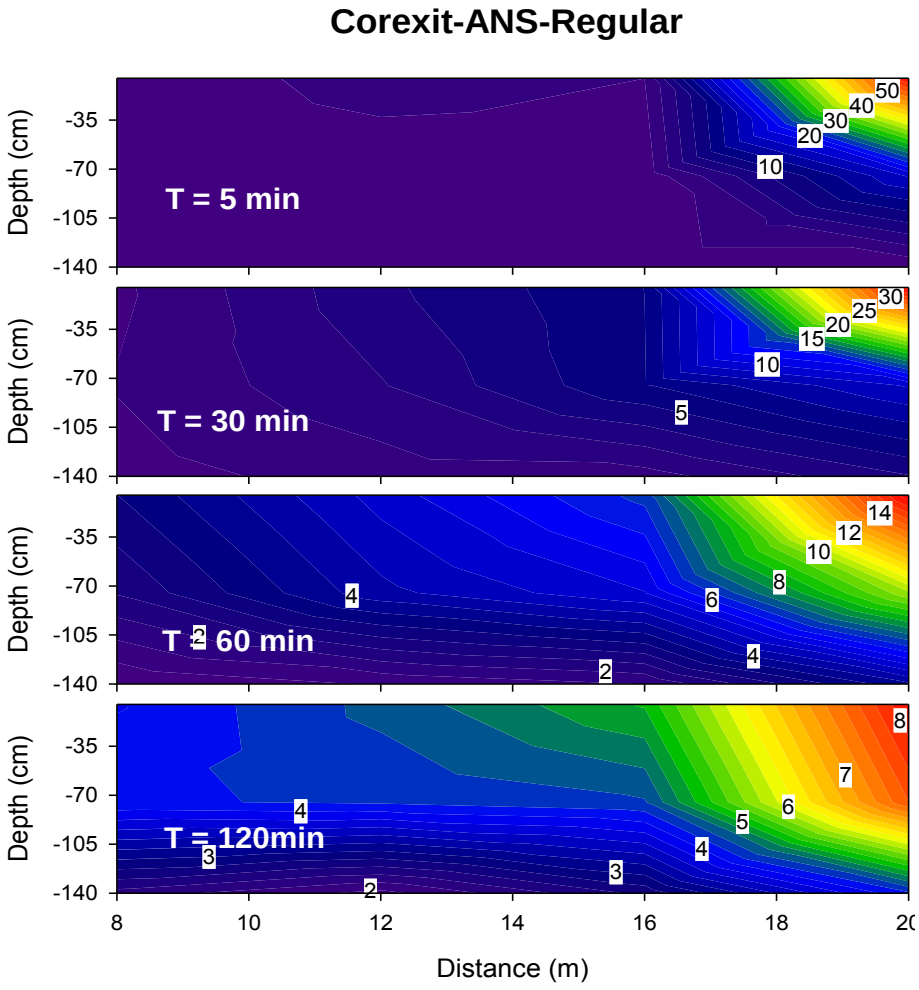


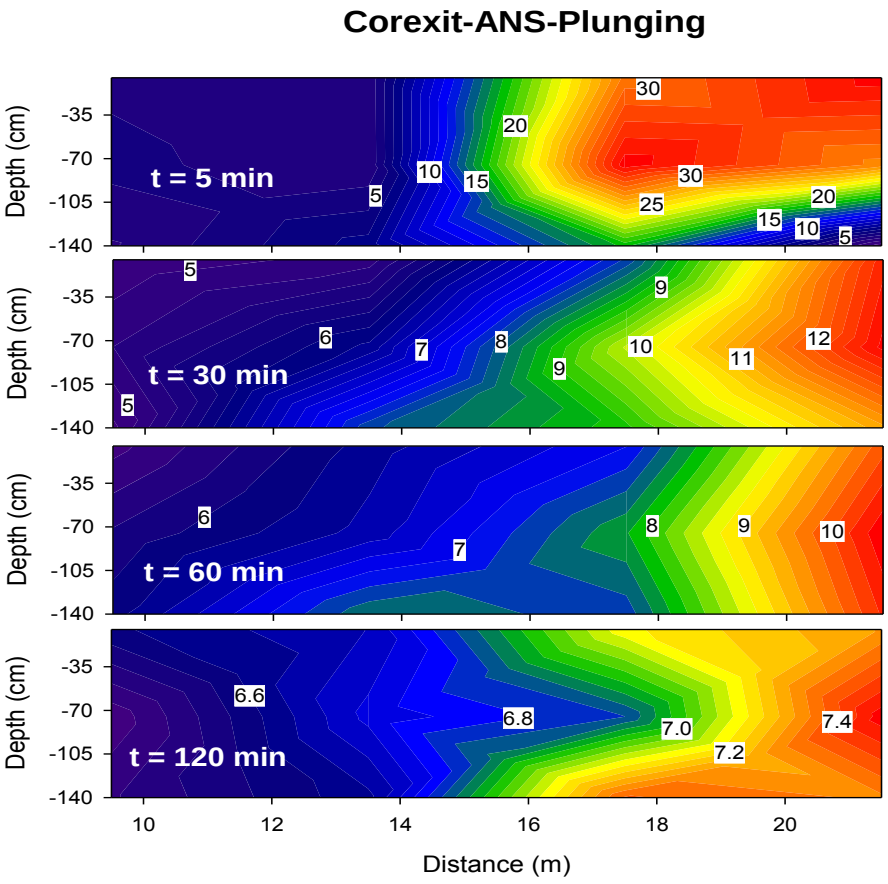
Physical Dispersion



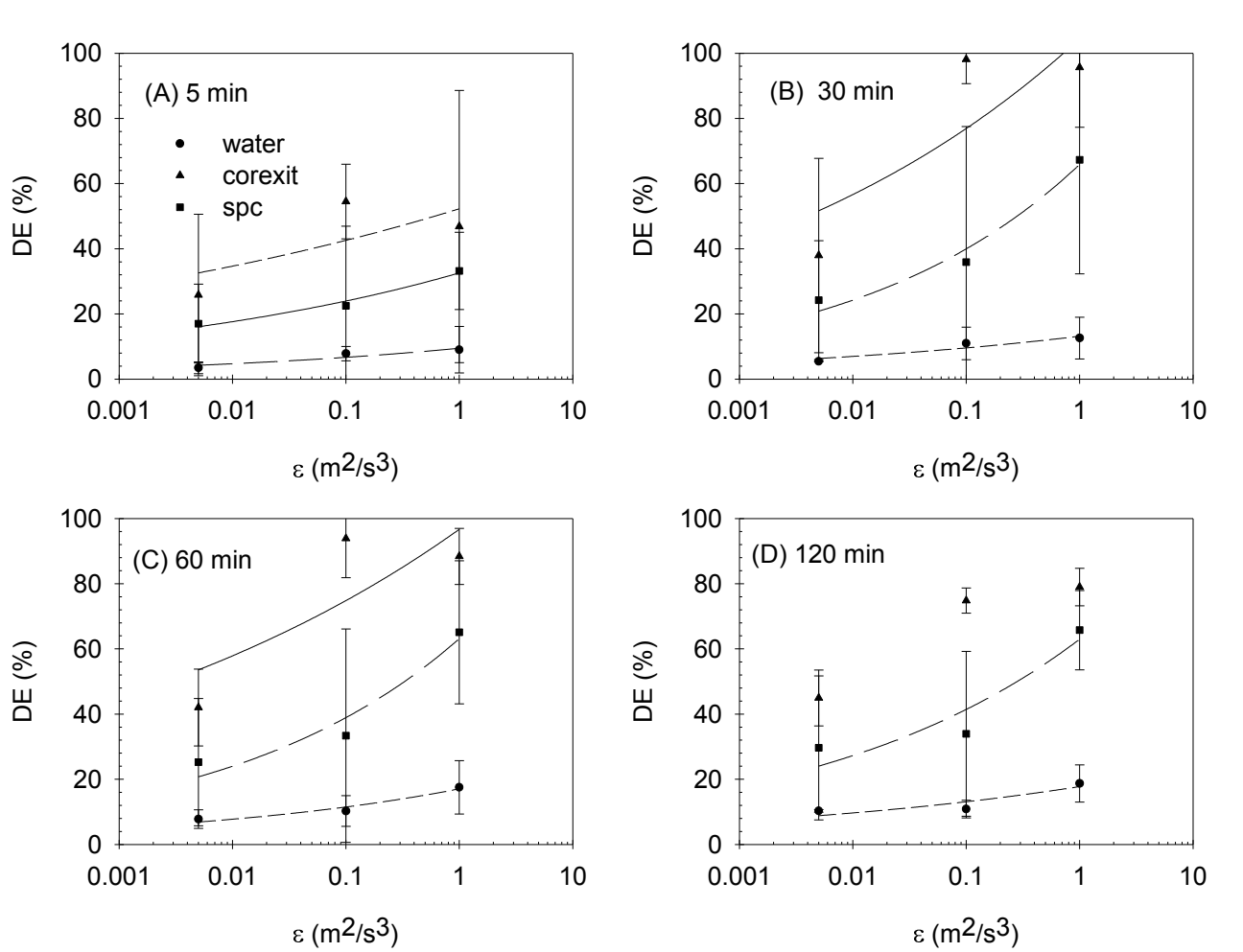


Chemical Dispersion



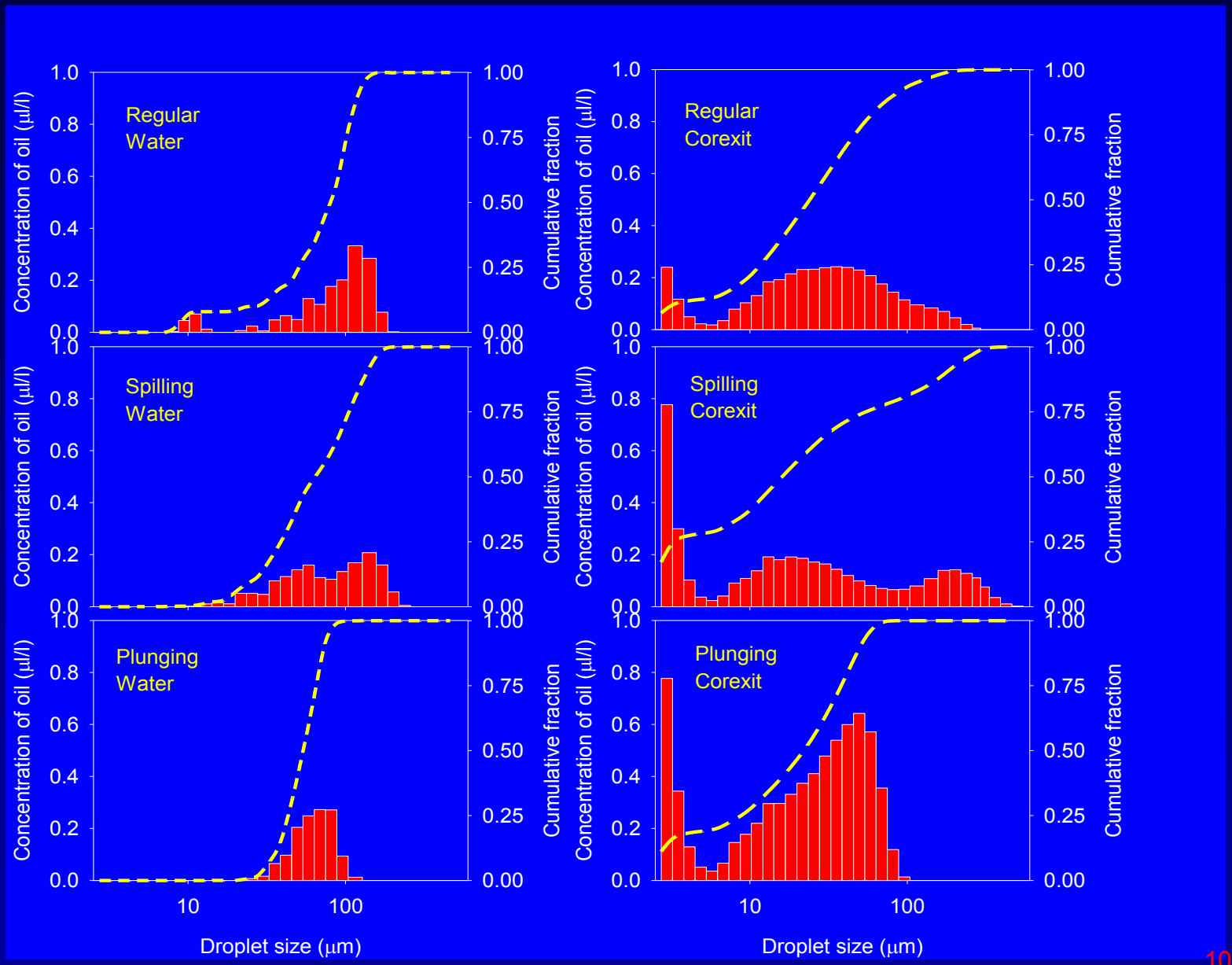


Dispersant Efficacy of ANS Crude Oil

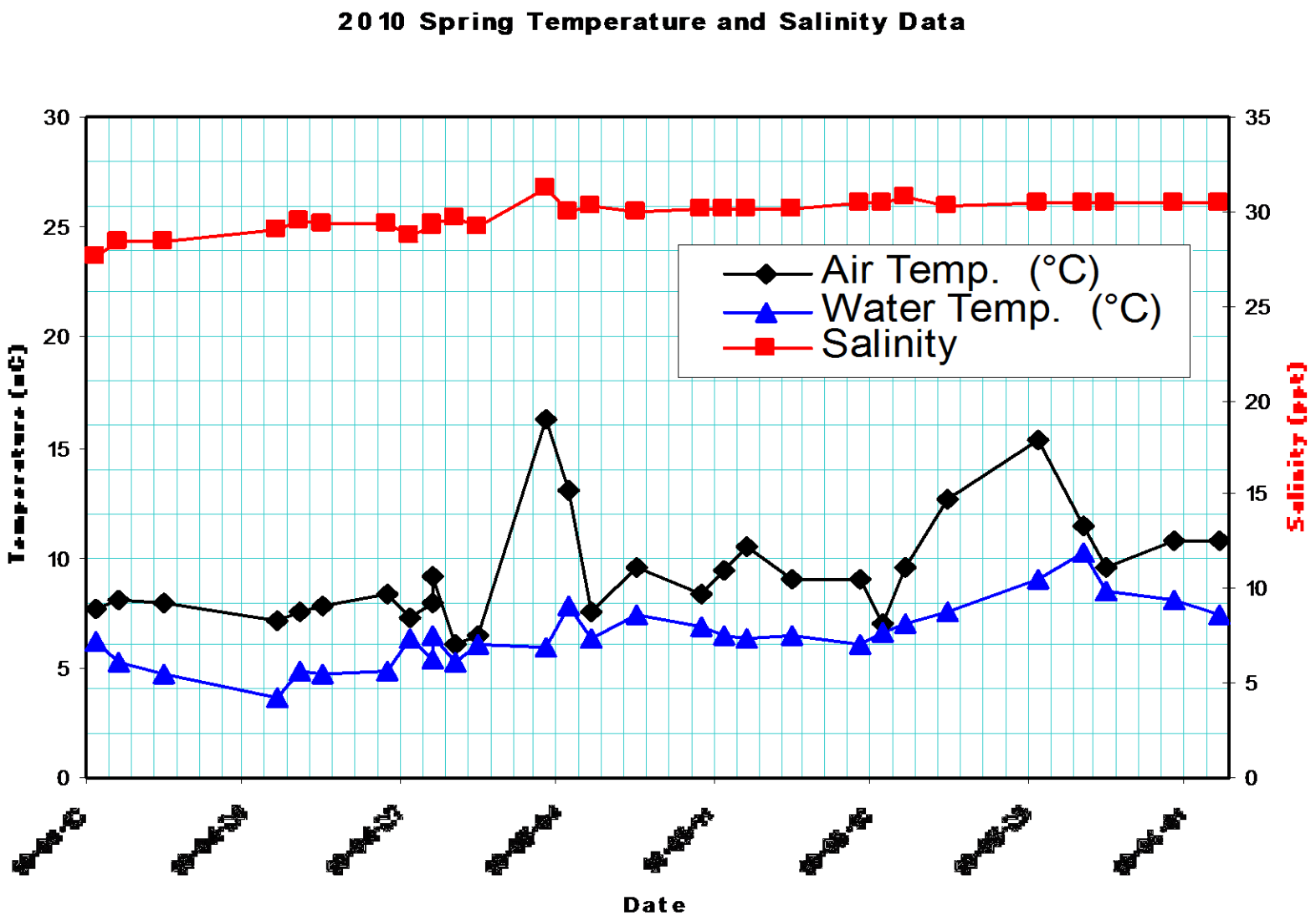


- DE of physical dispersion (control) was < 15%; DE increase at higher mixing energy level
- DE of Corexit9500 was > 50% under regular waves, and > 80% under breaking waves
- DE of SPC1000 was 2-fold lower than Corexit9500

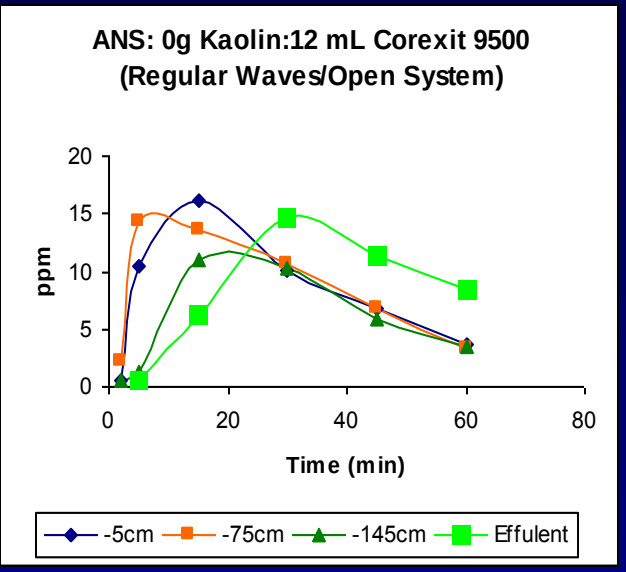
Oil Droplet Size Distribution

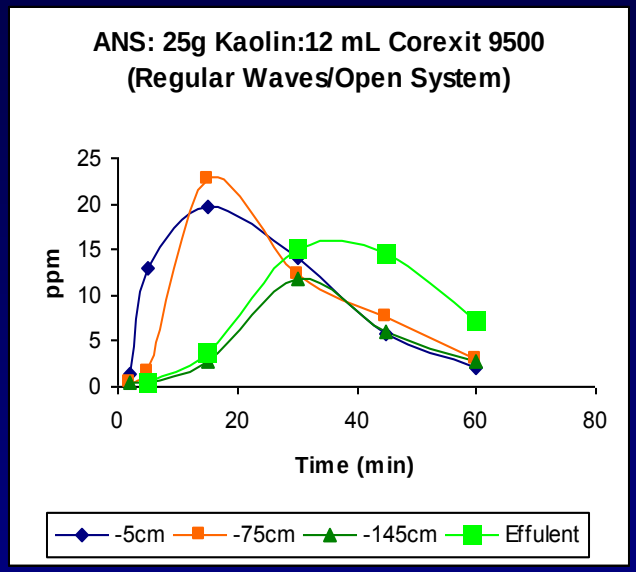


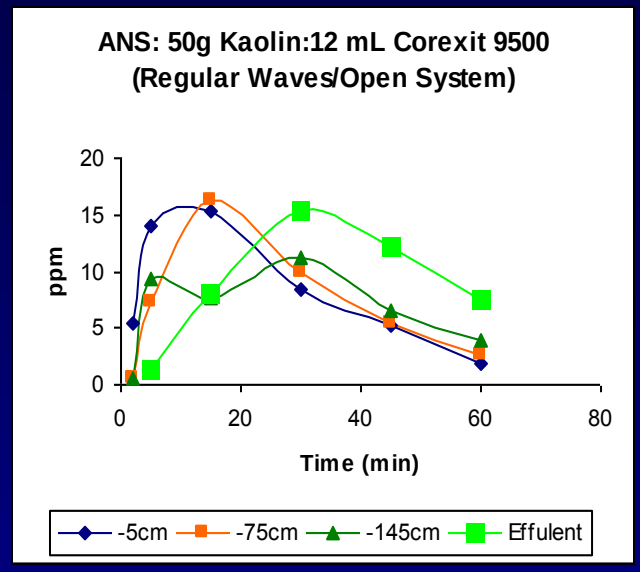
DE Testing in Winter and Spring Conditions

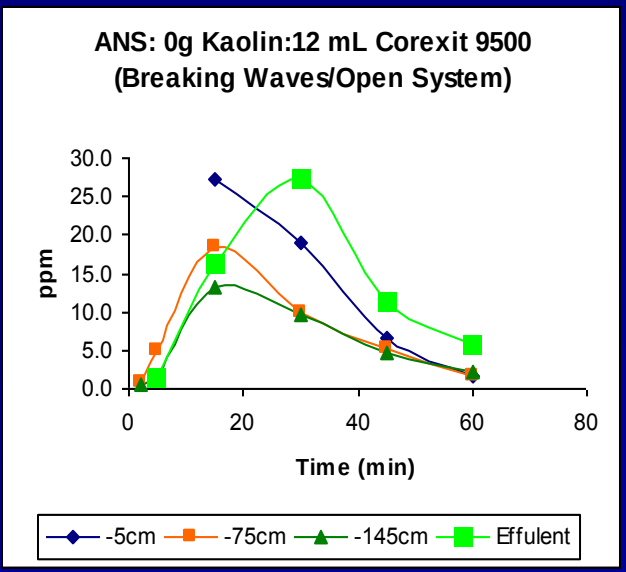


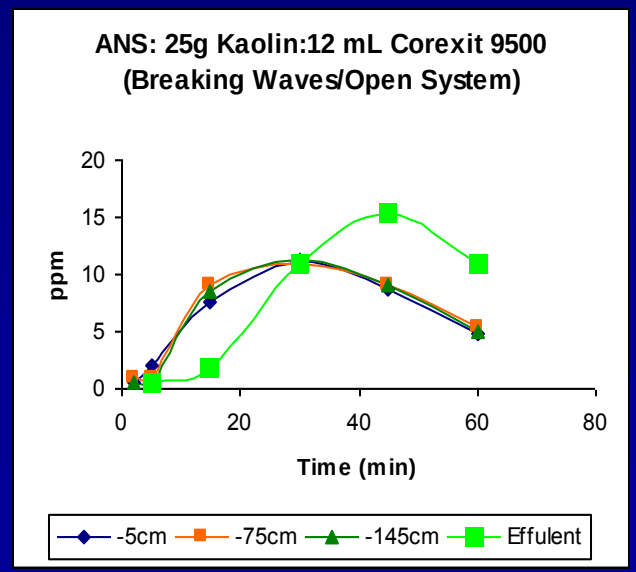
ANS Dispersion in the Flow-through WT

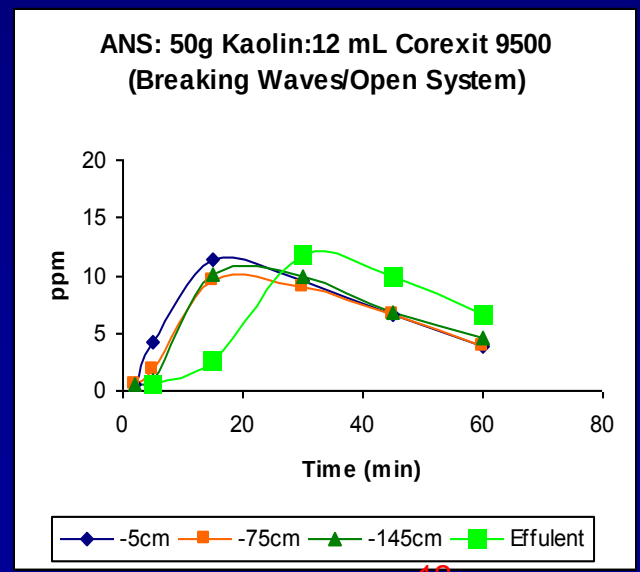




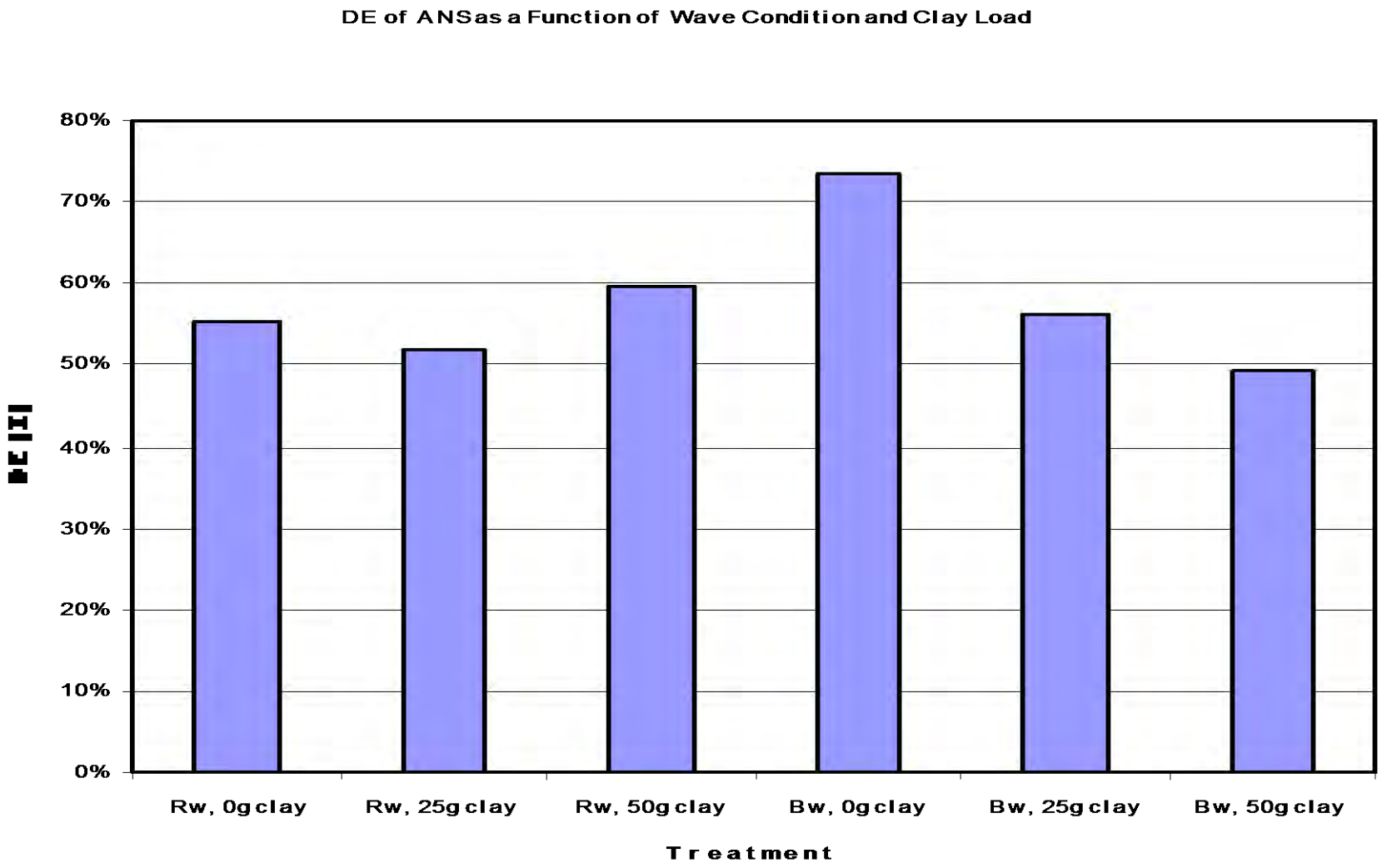








DE of ANS Oil in the Flow-Through WT



Summary of Wave Tank DE Tests

- **Evaluating the dispersant effectiveness under dynamic flow-through conditions provides a more realistic setting that may be encountered in the field**
- **Chemical dispersants under moderately high wave energy conditions significantly increased oil concentration in the water column, reduced dispersed oil droplet size distribution, and accelerated dilution rate of the dispersed oil by current**
- **The flow-through wave tank system can also be used to conduct environmentally relevant exposure studies on the toxicity of dispersed oil on sensitive marine species**