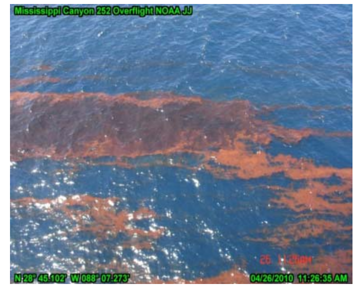


Deepwater Horizon Dispersant Use Meeting Report
May 26-27, 2010

Report Issued by: Coastal Response Research Center
University of New Hampshire
June 4, 2010
Revision 3

University *of* New Hampshire

Coastal Response Research Center

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

FOREWORD

The Coastal Response Research Center, a partnership between the National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration (ORR) and the University of New Hampshire (UNH), develops new approaches to spill response and restoration through research and synthesis of information. The Center's mission requires it to serve as a hub for research, development, and technology transfer to the oil spill community. The CRRC has a long history of overseeing research and development on the efficacy and effects of dispersed oil and convening dispersant related workshops with stakeholders from the oil spill community. At the request of NOAA, the center held a meeting on May 26 and 27 at the Lod Cook Alumni Center on the Louisiana State University (LSU) campus in Baton Rouge focusing on the use of dispersants in the Deepwater Horizon (DWH) incident in the Gulf of Mexico.

The meeting, titled "Deepwater Horizon Dispersant Use Meeting", was attended by over 50 scientists, engineers and spill response practitioners from numerous organizations, including: U.S. Coast Guard (USCG), Mineral Management Service (MMS), National Oceanic and Atmosphere Administration (NOAA), industry, state government, and academia. The ultimate goals of this meeting were to: (1) Provide input to the affected Regional Response Teams (RRTs) on the use of dispersants going forward in the DWH incident; and (2) Identify possible new monitoring protocols in the event of continuing aerial and subsurface dispersant application.

This report contains considerations on future use of dispersants and possible monitoring protocols for the RRTs along with the notes from the breakout groups, a participant list, the meeting agenda and Powerpoint presentations. I hope you find the input helpful and the discussion illuminating. If you have any comments, please contact me. The Center hopes that this report will be of use to the RRTs as they move forward with the Deepwater Horizon response and to the greater oil spill community and the nation.

Sincerely,

Nancy E. Kinner, Ph.D.
UNH Co-Director
Professor of Civil/Environmental Engineering

Acknowledgements

The Coastal Response Research Center gratefully acknowledges the CRRC authors of this report: Nancy E. Kinner, Joseph J. Cunningham III, Zachary E. Magdol, Heather R. Ballestero, and Tyler M. Crowe. The Center acknowledges the time and effort provided by the participants in the workshop, whose contributions have been synthesized into this report. In addition, the Center acknowledges the thoughtful input and comments received from the reviewers of the draft report: Craig Carroll (USEPA, RRT6); Richard Coffin (US-NRL); William Conner (NOAA, ORR); Charlie Henry (NOAA, ORR); Bruce Hollebone (Environment Canada); Robert Pond (USCG); Jeep Rice (NOAA, NMFS); Terry Wade (Texas A&M University). The Center also gratefully acknowledges the help of Professor Donald W. Davis (LSU – Emeritus), David Nieland (LSU, Sea Grant) and the staff of the Lod Cook Hotel and Alumni Center at LSU for their help in making this meeting happen in less than 96 hours.

The following individuals helped plan this meeting: Carl Childs (NOAA OR&R); Tom Coolbaugh (Exxon Mobil); Dave Fritz (BP); Kurt Hansen (USCG, R&D Center); Charlie Henry (NOAA ORR); Bruce Hollebone (Environment Canada); Ken Lee (Fisheries and Oceans, Canada); Joe Mullin (MMS), Bob Pond (USCG); Alan Mearns (NOAA); and Al Venosa (USEPA). The Center staff for this meeting consisted of: Heather Ballestero; Joseph Corsello; Tyler Crowe; Joseph Cunningham; Michael Curry; Eric Doe; Nancy Kinner; Zachary Magdol; and Kathy Mandsager. The Center also gratefully acknowledges Bruce Hollebone and Nichole Rutherford (NOAA OR&R) for serving as group leaders.

Citation:
Coastal Response Research Center. 2010. Deepwater Horizon Dispersant Use Meeting Report. University of New Hampshire, Durham, NH, 21 pp and appendices.

Table of Contents

I. EXECUTIVE SUMMARY

Meeting participants developed the following input to the RRTs:

Input Regarding Overall DWH Response Methods

1. Chemical dispersants, mechanical recovery and *in situ* burning are components of an effective response to surface oil pollution.

2. Mechanical recovery is the preferred method of on water oil spill response because it removes the oil from the environment, but is not always effective due to environmental conditions (e.g., weather, waves).

3. No combination of response actions can fully contain oil or mitigate impacts from a spill the size and complexity of the DWH incident.

4. Toxicity must be considered when a decision is made to apply chemical dispersants.

5. The effects of using 2.5 MG of dispersants during the Ixtoc spill in 1979 (Jernelov and Linden, 1981) should be considered as part of the evaluation of the DWH incident.

Input Regarding Dispersant Use for the DWH Incident

6. It is the consensus of this group that up to this point, use of dispersants and the effects of dispersing oil into the water column has generally been less environmentally harmful than allowing the oil to migrate on the surface into the sensitive wetlands and near shore coastal habitats.

7. For the DWH spill, the RRTs should provide for a continual re-evaluation of tradeoff options going forward. Because of the magnitude of the DWH spill and with the expectation of prolonged dispersant application, the RRTs should consider commissioning a Consensus Ecological Risk Assessment, or equivalent, including use of existing temporal and spatial data on the resources at risk and using the most current environmental data.

8. Dispersed oil should be tracked over time and space in combination with 3-D modeling in order to inform future decisions on the use of dispersants for the DWH incident

9. There are short term laboratory and modeling studies which can be done to aid operational decision making (e.g., effect of high oil temp, high ambient pressure, and the presence of methane on dispersion effectiveness).

Input Regarding Monitoring Protocols for Dispersant Use

10. Monitoring protocols have been used for the DWH incident, modified as needed, and should be further adapted as noted in the specific sections of this report in the event of continuing aerial and subsurface dispersant application.

II. INTRODUCTION

At approximately 2200 hours on Tuesday, April 20, 2010, the U.S. Coast Guard (USCG) received a report that the mobile offshore drilling unit (MODU) Deepwater Horizon (DWH) located in the Mississippi Canyon lease site 252 (approximately 42 miles southeast of Venice, LA), had experienced an explosion and was on fire. The MODU sunk on April 24, scattering debris from the riser pipe across the ocean floor in ~5,000 feet of water. It became clear with a few days that the blowout preventer was not functional and oil was leaking into the water from more than one location on the broken riser.

Within hours of the incident, the USCG responded and began Search and Rescue (SAR) and environmental response operations. The release is relatively close to sensitive nearshore coastal habitats and wetlands, and prevailing winds drive the surface oil towards land. To prevent landfall of the oil, mechanical recovery techniques were used, including skimming and booming, as well as *in situ* burning. However, when poor weather conditions limited the effectiveness and suitability of mechanical recovery and burning, dispersants were applied to disperse surface oil and prevent landfall. In early May, responders began injecting dispersants at the source of the release in order to prevent oil from reaching the surface. These techniques have largely been successful, and have reduced the amount of oil reaching the nearshore. Consequently, dispersant use, primarily aerial (surface) application and in the oil plume as it exits the riser (deep ocean application), has become a major response tool as the release has continued unabated. The response was declared a Spill of National Significance (SONS) on April 29, 2010, and recent reports from the National Incident Command estimate that between 12,000 and 19,000 barrels of oil are released into the water every day, making the DWH incident the largest oil spill in U.S. history. More than 990,000 gallons of dispersant have been used thus far in the response, and with completion of relief wells scheduled for August, 2010, there is potential for significant further release of oil and application of dispersants.

In the event continued dispersant use is necessary throughout the summer, the Regional Response Teams (RRTs) expressed interest in late May in convening a meeting of scientists and practitioners to discuss dispersant use and provide input to the affected RRTs. This meeting, titled "Deepwater Horizon Dispersant Use Meeting" brought together approximately 50 participants to: (1) Provide input to the affected RRTs on the use of dispersants going forward in the DWH Incident; and (2) Identify possible new monitoring protocols in the event of continuing aerial and subsurface dispersant application. Four breakout groups were established that discussed: (1) Efficacy and effectiveness of surface and deep ocean use of dispersants; (2) Physical transport and chemical behavior of dispersants and dispersed oil; (3) Exposure pathways and biological effects resulting from deep ocean application of dispersants; and (4) Exposure pathways and biological effects resulting from surface application of dispersants.

III. MEETING ORGANIZATION AND STRUCTURE

The meeting, held at Louisiana State University on May 26 and 27, 2010, consisted of plenary sessions where invited speakers gave an overview of dispersant use in past oil spills, as well as an overview of the DWH incident and the response to date. Four breakout groups discussed key aspects of dispersant use in the DWH response: (1) Efficacy and effectiveness of surface and deep ocean dispersants use; (2) Physical transport and chemical behavior of dispersants and dispersed oil; (3) Exposure pathways and biological effects resulting from deep ocean application of dispersants; and (4) Exposure pathways and biological effects resulting from surface application of dispersants. Meeting participants were selected by a planning committee comprised of government and international partners with expertise in dispersants and oil spill response and research; meeting participants (Appendix B) represented a wide range of issue-related expertise and background, and included representatives from federal, state and foreign government agencies, as well as industry and academia.

Breakout questions (Appendix C) were developed by the Center staff and the planning committee. The breakout groups (Appendix D) developed input on continued use of dispersants for the DWH response, the risks/benefits of such use, and possible monitoring protocols going forward. In addition, they determined what information was needed to give the input, whether it was available for the DWH incident, or could be gleaned using information from past experience or the literature.

As a starting point, the following guidance was given to the breakout groups: (1) Surface dispersant operations have only been conducted in pre-approved zones (> 3miles offshore, >10 m water depth). Most dispersants have been applied 20-50 miles offshore where the water is much greater than 100 ft deep; (3) The footprint of surface dispersant application is relatively small; (4) The body of water in which the dispersants are applied is constantly changing; and (5) This meeting focused on oil effects and dispersants in general (no discussions of specific dispersants, just general composition types).

IV. MEETING RESULTS

A. Dispersant Efficacy and Effectiveness for Surface and Deep Ocean Application

Group A initially considered the efficacy and efficiency of surface and subsurface dispersant usage, however, on the second day of the workshop, the group was divided into two subgroups: Group A1 examined the efficacy and efficiency of deep ocean dispersant application, while Group A2 considered the efficacy and efficiency of surface dispersant application.

Group members included:

Group Lead: Joseph Cunningham, Coastal Response Research Center
Recorders: Joe Corsello* & Eric Doe, University of New Hampshire
Tom Coolbaugh*, Exxon Mobil
Craig Carroll#, U.S. EPA
Per Daling, SINTEF
J.T Ewing*, Texas General Land Office
Ben Fieldhouse, Environment Canada
Chantal Guenette*, Canadian Coast Guard
Ann Hayward Walker*, SEA Consulting
Lek Kadeli#, U.S. EPA
Paul Kepkay, Bedford Institute of Oceanography - Fisheries & Oceans Canada
Ed Levine*, NOAA
Zhengkai Li, Bedford Institute of Oceanography - Fisheries & Oceans Canada
Joe Mullin*, Minerals Management Service
Duane Newell*, U.S. EPA Contractor
Bob Pond, USCG
Kelly Reynolds*, ITOPF
Al Venosa, U.S. EPA

*Group Members assigned to Group A2 on Day 2
Group Members who were present for Day 1, but absent during Day 2

Information Required to Make Assessment:

- Spatial location of high, low, and non- effectiveness of dispersant
- Results of continuous water column monitoring, rather than discrete sampling events
- Extent of weathering from surface and subsurface oil
- GPS track routes to see if sampling boats are operating within the vicinity of aerial dispersant application tracks
- Properties of oil on the surface, including thickness and extent of weathering
- Properties of dispersant applied and untreated oil
- 3D visualization of plume
- Location, volume, and trends of plume
- Complete weathering profile of oil
- Accurate volumetric oil flow rate and dispersant application range
- Effect of temperature and pressure on droplet formation and dispersion

- Estimates of contact time and mixing energy
- Dispersability of emulsion after multiple applications of dispersant

Current State of Knowledge:

- Oil emulsion (> 15 – 20% water) is non-dispersible
- Plume is between 1100 – 1300 m deep moving SW direction
- DWH oil high in alkanes, and has a PAH composition similar to South Louisiana reference crude
- Lighter PAHs (< C15) are likely volatilizing
- Viscosity of emulsified oil is between 5500-8500 centistoke
- Emulsion may be destabilizing (50-60%)
- Primary detection method, C3 (fluorometer), only gives relative trends – does not accurately measure concentration of total oil or degree of dispersion

Knowledge Gaps:

- Ability of emulsions to be dispersed with multiple applications of dispersant
- Appropriate endpoint for dispersant application (i.e., how clean is clean?)
- Effectiveness and appropriateness of other dispersant applications (i.e., boat, subsurface, airplane, helicopter)
- Actual range of oil flowrates and composition (i.e., percentage oil, methane)
- Size of plume (volumetric)
- Diffusion of oil components from dispersed droplets into the water column (e.g., aliphatics, PAHs)
- Chemical composition of the plume (i.e., presence of oil, dispersant)
- Extent of surface and resurfacing of dispersed oil

Suggestions to Address Knowledge Gaps:

- Short and long term collection of chemical data (oil and dispersant concentration) at the surface and subsurface
- Measurement of methane concentrations and flowrate throughout the water column
- Analysis of natural vs chemically enhanced dispersion in the subsurface and surface

On day two, Group A was divided into two subgroups; Group A1 examined the efficacy and effects of surface water application, while A2 examined the efficacy and effects of deep ocean application.

Input for RRTs: Group A1 – Surface Application:

1. Surface application of dispersants has been demonstrated to be effective for the DWH incident and should continue to be used.
2. The use of chemical dispersants is needed to augment other response options because of a combination of factors for the DWH incident (i.e., continuous, large volume release).
3. Winds and currents may move any oil on the surface toward sensitive wetlands
4. Limitations of mechanical containment and recovery, as well as *in situ* burning.

5. Weathered DWH oil may be dispersible. Further lab and field studies are needed to assess the efficacy and efficiency and optimal dispersant application (e.g., multiple dispersant applications).
6. Spotter airplanes are essential for good slick targeting for large scale aerial applications (e.g., C-130), so their use should be continued.
7. In order to most effectively use the assets available, the appropriate vessels or aircraft should be selected based on the size and location of the slick and condition of oil. Vessels and smaller aircraft should be used to treat smaller slicks and the weathered DWH oil because they can target more accurately and repeatedly. Larger aircraft should be used for larger fresh oil slicks offshore except in the exclusion zone around the source. A matrix of oil location, oil patch slicks size and condition, dispersant technique/dosage, visual guidance, requirements for success/confirmation has been developed by the dispersant assessment group in Houma incident command. This matrix should be reviewed by the RRTs.

<u>Risks of Input for RRTs:</u>

Dispersants will not be 100% effective. The matrix referenced above contains information to maximize the efficacy of dispersant application on different states of the DWH oil. Dispersants redistribute the oil from the surface to the water column which is a tradeoff decision to be made by the RRT.

<u>Benefits of Input for the RRTs:</u>

Dispersing the oil reduces surface slicks and shoreline oiling. The use of chemical dispersants enhances the natural dispersion process (e.g., the smaller droplet size enhances potential biodegradation). Dispersing the oil also reduces the amount of waste generated from mechanical containment and recovery, as well as shoreline cleanup.

<u>Possible Monitoring Protocols for Surface Water Application:</u>

1. There is a good correlation between Tier 1 SMART observations and Tier 2 field fluorometry data. There has been sufficient Tier 1 and 2 data collected for the DWH incident to indicate monitoring is not required for every sortie.
2. Going forward it is important to now focus on assessing the extent of the 3D area after multiple applications of dispersant at the surface. A sampling and monitoring plan to do this has been developed by the dispersant assessment group based in the Houma command center and initial implementation has begun. The RRT 6 should review this plan.

<u>Input to RRTs: Group A2 – Subsurface Application:</u>

1. The subsurface dispersant dosage should be optimized to achieve a Dispersant to Oil Ratio (DOR) of 1:50. Because conditions are ideal (i.e., fresh, un-weathered oil) a lower ratio can be used, reducing the amount of dispersant required. The volume injected should be based on the minimum oil flowrate, however an accurate volumetric oil flowrate is required to ensure that the DOR is optimized.
2. If we assume a 15,000 bbls/day oil rate and a 1:50 DOR, then actual dispersant flowrate is roughly similar to the current application rate of 9 GPM.

3. To further optimize dispersant efficacy, the contact time between dispersant and oil should be maximized. Longer contact time ensures better mixing of oil and dispersant prior to being released into the water, and should result in better droplet formation.
4. Contact time can be increased by shifting the position of the application wand deeper into the riser, optimizing nozzle design on the application wand to increase fluid sheer, and increasing the temperature of the dispersant to lower viscosity.
5. Effectiveness should be validated by allowing for a short period of no dispersant application followed by a short time of dispersant usage to look for visual improvements in subsurface plume.

Risks of Input for RRTs:

Dispersants are never 100% effective. The flow rate of oil out of the damaged riser is not constant, and significant amounts of methane gas are being released. Because the effective DOR is a function of oil flow rate, changes in the oil flow rate may significantly impact the actual DOR. If the DOR is too low, dispersion may not be maximized, while if it is too high, dispersant will be unnecessarily added to the environment. Assumptions are based on knowledge at standard temperatures and pressures (STP), while conditions at the riser are significantly different. Group members suggested that the oil escaping the damaged riser may be in excess of 100°C, and it is unclear what effect this has on the dispersant, or the efficacy or effectiveness of droplet formation. These conditions may drastically alter fluid behavior. Finally, there is an opportunity cost of changes to application wand position and development and deployment of a new nozzle.

Benefits of Input for the RRTs:

When optimized, subsurface dispersant application may reduce or eliminate the need for surface dispersant application, and will reduce surfacing and resurfacing of oil. Optimized subsurface dispersant application will likely promote formation of smaller, more stable droplets of oil, theoretically allowing quicker biodegradation.

Possible Monitoring Protocols for Subsurface Application:

1. Measurement should be made on the surface and subsurface to detect dispersant and dispersed oil to gauge the effectiveness of subsurface dispersant application. Currently, no known technique exists for accurately measuring part per billion concentrations of dispersant in seawater, and novel applications of GC-MS/GC-FID or UVFS + LISST may be required.
2. Tier 1 (SMART) visual monitoring at the surface with quantification of oil with aerial remote sensing
3. Visual monitoring may be able to qualitatively demonstrate differences between dispersant application and no application (e.g., plume shape, color).

B. Physical Transport/ Chemical Behavior of Dispersed Oil

Group B was focused on the physical transport and chemical behavior of dispersed oil. While the initial goal was to look at these characteristics for chemically dispersed oil, the scope of the deepwater horizon incident required looking at both chemically and naturally dispersed oil.

Group members included:

Group Lead: Bruce Hollebone, Environment Canada
Recorder: Tyler Crowe, Coastal Response Research Center
Les Bender, Texas A&M
Mary Boatman, Minerals Management Service
Michel Boufadel, Temple University
Robert Carney, Louisiana State University
Jim Churnside, U.S. EPA
Greg Frost, U.S. EPA
Jerry Galt, Genwest
Buzz Martin, Texas General Land Office
Allan Mearns, NOAA
Scott Miles, Louisiana State University
Erin O'Riley, Minerals Management Service
Jim Staves, U.S. EPA

Information Required to Make an Assessment and Knowledge Gaps:

- Contact efficiency between dispersant and oil at the sea floor
- Release rate of oil and gas
- Dispersion efficiency at injection point on sea floor
- Mixing energy at injection point on sea floor
- Effects of increased pressure and temperature on dispersion efficiency
- Temperature of released oil
- Degree or rate of weathering of oil in rising plume (e.g., dissolution, vapor stripping)
- Emulsion formation and dispersion in the rise zone, under pressure
- Destabilization of emulsions as pressure decreases
- Biodegradation rate on droplets at pressure and at bottom temperature
- Sedimentation of dispersed oil from depth
- Biological uptake, particularly in demersal and benthic organisms
- Surface Langmuir circulation potential for mixing
- Surface advection rates versus oil discharge to determine buildup potential
- BTEX levels above oil slick
- Suppression of airborne VOCs when using dispersants
- Airborne concentrations of 2-butoxy ethanol from spring
- Atmospheric breakdown and toxicity of 2-butoxy ethanol and other products
- Improved NEBA for dispersant use

Current State of Knowledge:

- Surface models are effective and continuously improving
- SMART protocols are improving
- Increase of sampling at depth
- Well researched region (oceanographic and ecological studies)
- Well established baseline data
- Airborne application protocols are established

Suggestions to Address Knowledge Gaps:

- Review Norwegian experiments (Deep Spill, 2000)
- Review literature on IXTOC I
- Increase in remote sensing of the dispersed area (check for oil resurfacing)
- Use of smaller grid sizes or nested grids on models
- Increased offshore surface sampling independent of SMART at fixed stations in the operational zone
- Establishment of criteria for discontinuance of dispersant operations
- Further research on the contact efficiency between dispersant and oil at the subsurface injection point
- Better understanding of release rate and temperature of oil and gas
- Quantification of mixing energy at injection point
- Better coupling between offshore (ocean/pelagic) and onshore (estuarine or riverine) hydrodynamic models (LaGrangian vs. Eulerian)
- Laboratory investigation of effects of elevated pressure and temperature on dispersion efficiency at depth (e.g., study in pressure cells)

Input for RRTs:

1. Create an on-scene environmental review committee to advise SSCs that will be responsible for providing immediate operational and scientific advice, and aid in dispersant decisions. This committee should be comprised of government agencies and academia that meet regularly.
2. Clearly define geographic area/water volume of concern. This will improve estimates for scale of impact (1st order approximation). This is important for NEBA analysis, and is based on current application rates, and maximum concentrations in the water volume.
3. Establishment of a more comprehensive sampling and monitoring program to understand transport of oil on the surface and potential for long-term increases to TPH, TPAH, oxygen demand, or lowering of DO with continued dispersant application. This could be done by implementing off-shore water (first 10 m) monitoring stations (e.g., fixed stationary positions such as other drill rigs).

Risks of Input for RRTs:

Continued dispersant use trades shoreline impacts for water column impacts. This increases the uncertainty of the fate of the oil, and potentially increases the oil sedimentation rate on the bottom.

Benefits of Input for the RRTs:

Continued dispersant use reduces the threat distance, protects shorelines, likely increases the biodegradation rate of the oil, inhibits formation of emulsions, reduces waste management, and potentially reduces buildup of VOCs in the air.

Possible Monitoring Protocols for Subsurface Application:

1. Measure size and shape of the plume with and without subsurface injection of dispersant in order to have a better understanding of the efficacy. Sonar

monitoring of plume size and morphology (tilt) can be used; increases in plume size or longer "tail" of droplets suggest greater dispersion

2. Additional monitoring in the rising plume at a variety of depths to improve transport modeling and development of boundaries and constraints on estimates.
3. Additional subsurface monitoring of water temperature, particle size distribution, fluorescence monitoring of dispersant concentration, and total petroleum hydrocarbons (TPH) to define subsurface plume concentrations and boundaries.
4. Increase surface layer water quality monitoring (profile of upper 10 m) to address concerns of cumulative loading of water with oil and dispersant. Size of the monitoring zone will vary with advection and dispersant application. Should monitor for TPH, PAHs, dissolved oxygen, salinity, temperature, biological oxygen demand (BOD), VOA, and if feasible, surfactant monitoring and toxicity testing.
5. Further air monitoring of surface water quality zone to gain a better understanding of volatilization and risk to responders. Monitoring should include BTEX and VOC concentrations, and while COREXIT 9527 is being used, 2-butoxy ethanol.

C. Biological Effects of Dispersants on Deep Ocean Species

Group C discussed exposure pathways of dispersants applied to the subsurface and subsequent biological effects. Group members included:

Group Lead: Zachary Magdol, Coastal Response Research Center
Recorder: Mike Curry, Coastal Response Research Center
Adriana Bejarano, Research Planning Inc.
Richard Coffin, Naval Research Laboratory
William Conner, NOAA Office of Response and Restoration
Charlie Henry, NOAA, Scientific Support Coordinator for USCG District 8
Ken Lee, Environment Canada
Jeffrey Short, Oceana
Ron Tjeerdema, University of California

Information Required to make assessment:

- Receptor species/species at risk
- Identify species at risk including their migration, feeding habits, life histories, reproductive strategies/recruitment
- Dispersant effect on oxygen and other electron acceptor availability on key biogeochemical cycles in the deep water ecosystem
- Assess the maximum rates of dispersant application to balance treatment of the spill and a low environmental impact
- Determine the impact on nutrient recycling, general efficiency of food chain
- What is the particle size distribution as a function of depth, and if these changes affect key elemental absorption and feeding strategies
- Oil biodegradation rates, microbial community structure and ecosystem function in the presence and absence of the dispersant
- Evaluate the seasonal and spatial variation in the deep ocean oxygen demand in the presence and absence of the dispersant

- Scavenging particle interactions, oil-mineral aggregate formation at source and throughout water column
- Vertical and horizontal transport dynamics of deep water ocean currents for an overview of the oil and dispersant transport and dilution
- Unknown indirect effects (e.g., persistence) on the food chain and key elemental cycles
- Biogeochemical and habitat data about ecosystems near natural deep water petroleum seeps to evaluate the cycling rates and community structure
- Percent effectiveness of the seafloor dispersant application relative to the surface application
- Determine the changes in the petroleum layer through the water column with application of the dispersant
- Changes in microbial degradation due to selective metabolism from addition of dispersants (e.g., is there a preferred dispersant degradation that will pathway that will limit petroleum degradation?)
- Effectiveness of natural dispersion
- Knowing the downstream flux of oil residue from the spill to the seafloor to contribute to a net balance of the oil fate

Current State of Knowledge:

- Minerals Management Services, Gulf of Mexico deep water studies/reports: http://www.gomr.mms.gov/homepg/regulate/environ/deepenv.html
- Natural hydrocarbon seepage in the Gulf of Mexico approximately 40 million gallons per year
- Some knowledge and past studies on deep water species in the Gulf of Mexico
- Preliminary modeling
- Preliminary monitoring data (Fluorometry data, Particle size analysis, Temperature, Salinity, D.O., Hydrocarbon, Acute toxicity , Acoustic data, sonar, Genomics)
- None of the information listed above is considered "complete"

Knowledge Gaps:

- Preliminary models not validated
- Life history of benthic biota
- Migratory patterns and residence time of deep water species
- Microbial degradation rates on deep ocean hydrocarbon seeps
- Dispersant and dispersed oil byproducts
- Chronic toxicity of benthic biota
    - Comparison of bioaccumulation/bioavailability between different droplet sizes
    - Comparison of toxicity and environmental impact of natural vs chemically enhanced dispersed oil
- Species avoidance of oil

Suggestions to Address Knowledge Gaps:

- Formulation of biogeochemical rates with respect to fuel transport and sedimentation

- Early life stage studies, laboratory or cage studies
- Robust toxicity studies for deep water species
- Spatial and temporal variation in the ecosystem oxygen and alternate electron acceptor availability

Input for RRTs:

1. Dispersant risk assessment should consider volume of DWH incident relative to natural seepage
2. There is a net benefit to continued subsurface dispersant use and application should continue

Risks of Input for RRTs:

Dispersant use increases the extent of biological impacts to deep water pelagic and/or benthic organisms, including oxygen depletion, release of VOCs into the water column, and toxicity. This may lead to changes in the diversity, structure and function of the microbial community, leading to changes in trophic level dynamics and changes to key biogeochemical cycles.

Benefits of Input for the RRTs:

- Surface water column and beach impacts vs. vertical water column impacts
- Observed reduction in volatile organics at surface
- Enhances the interaction between oil and suspended particulate material
- Accelerated microbial degradation through increased bioavailability
- Rapid recovery of downward sulfate diffusion and upward methane diffusion related to shallow sediment geochemistry
- Based on current knowledge, subsurface dispersant use confines the aerial extent of impact
    - Current impact zone is less than 50 km radius
- Reduction in emulsified oil at the surface
- Reduction of phototoxic impacts

Possible Monitoring Protocols for Surface Water Application:

1. Robust deep ocean toxicity studies
    - Application of research done with acute toxicity on foraminifera, possibility of chronic studies (LC50, EC50)
    - Identify control areas, in terms of system ecology, physical ocean properties, and biogeochemical parameters
    - Cage studies in the plume
    - Identify surrogate/indicator species for impacts over a range of trophic levels
    - Identify key species of concern (migratory species)
    - Microbial genomics to survey changes in the community structure that changes key elemental cycles
    - Long term biological effects for resident species with baseline information
2. Biogeochemical monitoring
    - Petroleum degradation rates (C14 labels)

  - Microbial production and function (3H thymidine/leucine and Genomics)
  - Community diversity (16S RNA)
  - Background parameters (DOC, POC, DIC, concentration and $\delta^{13}C$)
  - Bioavailability of the oil as a function of particle size
3. Physical/chemical parameters
  - UV fluorometry (Including FIR)
  - Monitor the particle size distribution of the oil as function of space and time (LISST particle counters)
  - Current velocity (ADCP)
  - Chemical properties CTD (oxygen, salinity, pH, SPM)
  - Chemical and source properties of the oil as a function of space and time (GC-MS and IRMS)
  - Potential of acoustic monitoring (3.5 and 12 khz)

D. Biological Effects of Dispersants on Surface Water Species

Group D focused on the effects of surface dispersant application on species in the top ten meters of the water column. Group members included:

Group Lead: Nicholle Rutherford, NOAA
Recorder: Heather Ballestero, University of New Hampshire
Carys Mitchelmore, University of Maryland
Ralph Portier, Louisiana State University
Cynthia Steyer, USDA
Mace Barron, U.S. EPA
Les Burridge, St. Andrews Biological Stn, Fisheries and Oceans Canada
Simon Courtenay, Gulf Fisheries Centre, Fisheries and Oceans Canada
Bill Hawkins, Gulf Coast Research Laboratory, University of South Mississippi
Brian LeBlanc, Louisiana State University
Jeep Rice, NOAA
Doug Upton, MS DEQ
Terry Wade, Texas A&M University

Information Required to make assessment:

- Spatial location of oil, dispersants, and species
- The levels of concern need to be noted (e.g., sensitive species life stages, exposure pathways, LC50's oil and dispersant constituents)

Current State of Knowledge:

- The oil is being dispersed in the top ten meters of the water column from surface dispersant application (fluorescence methods)

Knowledge Gaps:

- Effectiveness of dispersant
- Long term effects of dispersant exposure (carcinogenicity)
- Dispersed oil effects in an estuarine/riverine/pelagic environment
- Bioavailability, bioaccumulation

Suggestions to Address Knowledge Gaps:

- Develop a clearinghouse to facilitate access to baseline data being collected

- Know dose of exposure, effects, species present and tradeoffs with habitat protection
- Understand differences between dispersed vs. non-dispersed oil

Input for RRTs: Effects of Dispersant in the top 10 M.

1. Surface application of dispersants is acceptable. Transferring the risk from the surface to the top 10 m is the lesser of the many evils.
2. Additional monitoring is required to better model where dispersed oil is going. Long term (monthly) monitoring is required at a minimum, and should be conducted in a grid formation inshore to open ocean. Passive samplers (i.e., SPME) should be used in selected areas, while a active water sampling program should be implemented to measure dispersant and dispersed oil, dissolved oxygen, and standard CTD + chlorophyll concentrations, as well as selected bioassays.

Possible Monitoring Protocols:

1. Monitor below 10 m
2. Monitor surface to bottom across a transect from the shore to source
3. Deploy semi-permeable membrane device (SPMD), passive sampling, or oysters
4. Monitor concentration and exposure time to get a better understanding of effective dose
5. Use state-of-the-art toxicity tests

E. Bibliography:

1. Adams, E.E. and S. A. Socolofsky. 2005. Review of Deep Oil Spill Modeling Activity Supported by the Deep Spill JIP and Offshore Operator's Committee. Final Report. http://www.mms.gov/tarprojects/377/Adams%20Review%204.pdf

2. Atlas, R.M.,"Fate of oil from two major oil spills: Role of microbial degradation in removing oil from the Amoco Cadiz and IXTOC I spills", (1981) Environment International, 5 (1), pp. 33-38.

3. Bedinger Jr., C.A., Nulton, C.P., "Analysis of environmental and tar samples from the nearshore South Texas area after oiling from the Ixtoc-1 blowout", (1982) Bulletin of Environmental Contamination and Toxicology, 28 (2), pp. 166-171.

4. Boehm, P.D., Flest, D.L., Mackay, D., Paterson, S.,"Physical-chemical weathering of petroleum hydrocarbons from the ixtoc I blowout: Chemical measurements and a weathering model", (1982) Environmental Science and Technology, 16 (8), pp. 498-505.

5. Boehm, P.D., Fiest, D.L., Kaplan, I., Mankiewicz, P., Lewbel, G.S., "A natural resources damage assessment study: The Ixtoc I blowout", 2005) 2005 International Oil Spill Conference, IOSC 2005, p. 5035.

6. Boehm, P.D., Fiest, D.L., Kaplan, I., Mankiewicz, P., Lewbel, G.S., "A natural resources damage assessment study: The Ixtoc I blowout", (2005) 2005 International Oil Spill Conference, IOSC 2005, p. 5035.

7. Boehm, P.D., Fiest, D.L., "Subsurface distributions of petroleum from an offshore well blowout. The Ixtoc I blowout, Bay of Campeche", (1982) Environmental Science and Technology, 16 (2), pp. 67-74.

8. Coastal Response Research Center (2006) Research & Development Needs For Making Decisions Regarding Dispersing Oil. http://www.crrc.unh.edu/dwg/dispersant_workshop_report-final.pdf

9. Cordes, C., Atkinson, L., Lee, R., Blanton, J.,"Pelagic tar off Georgia and Florida in relation to physical processes", (1980) Marine Pollution Bulletin, 11 (11), pp. 315-317.

10. Delikat, Donald S., "IXTOC I OIL SPILL & ATLANTIC RIDLEY TURTLE SURVIVAL.", (1980) Proceedings of SOUTHEASTCON Region 3 Conference, 1, pp. 312-319.

11. DeepSpill 2000: Johansen, Ø., Rye, H., Cooper, C. "DeepSpill-Field study of a simulated oil and gas blowout in deep water", (2003) Spill Science and Technology Bulletin, 8 (5-6), pp. 433-443.

12. Haegh, T., Rossemyr, L.I., "A comparison of weathering processes of oil from the Bravo and Ixtoc blowouts.", (1980) Proc. twelfth annual offshore technology conference, Houston, Texas, May 1980, pp. 237-244.

13. Haegh, Thor, Rossemyr, Leif I., "COMPARISON OF WEATHERING PROCESSES OF OIL FROM THE BRAVO AND THE IXTOC BLOWOUTS.", (1981) Proceedings of the Annual Offshore Technology Conference, 1, pp. 237-244

14. Hall, R.J., Belisle, A.A., Sileo, L., "Residues of petroleum hydrocarbons in tissues of sea turtles exposed to the Ixtoc I oil spill.", (1983) Journal of wildlife diseases, 19 (2), pp. 106-109.

15. Jernelov, A., Linden, O., "Ixtoc I: A case study of the world's largest oil spill", (1981) Ambio, 10 (6), pp. 299-306.

16. Johansen, O., et al. 2001. Deep Spill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000. Final Technical Report http://www.mms.gov/tarprojects/377/DeepSpill%20Final%20Report.pdf

17. Johansen, O., et al. 2001. Deep Spill JIP – Experimental Discharges of Gas and Oil at Helland Hansen – June 2000. Final Cruise Report. http://www.mms.gov/tarprojects/377/DeepSpill%20Cruise%20Report.pdf

18. Johansen, O., et al. 2001. ROV Sonar and Pictures from Project “Deep Spill” - June 2000. Final Data Report. http://www.mms.gov/tarprojects/377/DeepSpill%20ROV%20Report.pdf

19. Kalke, R.D., Duke, T.A., Flint, R.W., "Weathered IXTOC I oil effects on estuarine benthos", (1982) Estuarine, Coastal and Shelf Science, 15 (1), pp. 75-84.

20. Linton, T.L., Koons, C.B., "Oil dispersant field evaluation. Ixtoc 1 blowout, Bay of Campeche, Mexico", (1983) Oil and Petrochemical Pollution, 1 (3), pp. 183-188.

21. Lizarraga-Partida, M.L., Rodriguez-Santiago, H., Romero-Jarero, J.M., "Effects of the Ixtoc I blowout on heterotrophic bacteria", (1982) Marine Pollution Bulletin, 13 (2), pp. 67-70.

22. Macko, S.A., Winters, J.K., Parker, P.L.,"Gulf of Mexico dissolved hydrocarbons associated with the IXTOC I mousse", (1982) Marine Pollution Bulletin, 13 (5), pp. 174-177

23. Masutani, S.M., Adams, E., 2001 Study of Multi-Phase Plumes with Application to Deep Ocean Oil Spills, Hawaii Natural Energy Institute, University of Hawaii, http://www.mms.gov/tarprojects/377/UH_MIT_Final_2001.pdf

24. Patton, J.S., Rigler, M.W., Boehm, P.D., Fiest, D.L.,"Ixtoc 1 oil spill: Flaking of surface mousse in the Gulf of Mexico", (1981) Nature, 290 (5803), pp. 235-238.

25. Slade, G.J., "Effect of Ixtoc I crude oil and Corexit 9527 dispersant on spot (Leiostomus xanthurus) egg mortality", (1982) Bulletin of Environmental Contamination and Toxicology, 29 (5), pp. 525-530.

26. Waldichuk, M.,"Retrospect of the Ixtoc I blowout", (1980) Marine Pollution Bulletin, 11 (7), pp. 184-186.

APPENDIX A

DEEPWATER HORIZON DISPERSANTS MEETING

May 26 – 27, 2010

Cook Center
Louisiana State University, Baton Rouge, LA

AGENDA

Tuesday, May 25		
	Arrival and Check-In	

Wednesday, May 26		
8:00	Continental Breakfast	
8:30	Welcome and Introductions	**Nancy E. Kinner, UNH Co-Director: Coastal Response Research Center**
		David Westerholm, Director: Office of Response & Restoration: National Oceanic and Atmospheric Administration **James Hanzalik, USCG; RRT 6** **Craig Carroll, EPA; RRT 6**
8:45	Background and Meeting Goals Workshop Structure, Logistics & Outcomes	**Nancy E. Kinner, CRRC**
9:00	Participant Introductions	
10:00	Break	
10:15	Plenary Session: Setting the Stage	
	Deepwater Horizon Spill Overview *Dispersant application for DWH spill (aerial and subsurface application)*	**Charlie Henry, NOAA SSC**
	Dispersant use in previous spill responses	**Kelly Reynolds, International Tanker Operators Pollution Fund (ITOPF)**
	Field evaluation of alternative dispersants	**Tom Coolbaugh: Exxon Mobil**
	Monitoring dispersant efficacy	**Ken Lee, Paul Kepkey, Zhangkai Li:: Bedford Institute of Oceanography**
12:15	**Lunch**	
1:00	**Commissioning of Groups** **Discussion of Common Starting Points**	**Nancy E. Kinner, CRRC** **Charlie Henry, NOAA**

DEEPWATER HORIZON DISPERSANTS MEETING

May 26 – 27, 2010

Wednesday , May 26		
1:15	Breakout Session I	
	Group A: Dispersant efficacy and effectiveness	**Leader: Joe Cunningham, CRRC**
	Group B: Physical Transport/ Chemical Behavior of dispersed oil	**Leader: Bruce Hollebone, Environment Canada**
	Group C: Biological effects of dispersants on deep ocean species	**Leader: Zachary Magdol, CRRC**
	Group D: Biological effects of dispersants on surface water species	**Leader: Nicolle Rutherford, NOAA OR&R**
3:15	Break	
4:15	Plenary Session: Group Reports	
5:15	Wrap-Up	**Nancy E. Kinner, CRRC**
5:30	**Adjourn**	

Thursday, May 27		
8:00	Continental Breakfast	
8:20	Overview and Review/Recalibrate	**Nancy Kinner**
8:30	Breakout Session II	
	Group A1: Dispersant efficacy and effectiveness: Deep Ocean Application	**Leader: Joe Cunningham, CRRC**
	Group A2: Dispersant efficacy and effectiveness: Surface Application	**Leader: Nancy E. Kinner, CRRC**
	Group B: Physical Transport/ Chemical Behavior of dispersed oil	**Leader: Bruce Hollebone, Environment Canada**
	Group C: Biological effects of dispersants on deep ocean species	**Leader: Zachary Magdol, CRRC**
	Group D: Biological effects of dispersants on surface water species	**Leader: Nicolle Rutherford, NOAA OR&R**
10:00	Break (as necessary)	
11:15	Plenary Session: Breakout Group Reports	
12:15	Lunch	
1:00	Plenary Session: Development of Input and Protocols for RRTs and Next Steps	**Nancy E. Kinner, CRRC**
4:30	**Adjourn**	

APPENDIX B

NAME		AFFILIATION
Mace	Barron	U.S. EPA
Adriana	Bejarano	Research Planning, Inc
Les	Bender	Texas A&M
Marie	Benkinney	Exponent
Mary	Boatman	U.S. Minerals Management Service
Michel	Boufadel	Temple University
Les	Burridge	St. Andrews Biological Stn, Fisheries and Oceans Canada
Robert	Carney	Louisiana State University
Craig	Carroll	EPA, RRT 6
Jim	Churnside	NOAA
Richard	Coffin	Naval Research Laboratory
William	Conner	NOAA, ORR, ERD
Tom	Coolbaugh	ExxonMobil
Simon	Courtenay	Gulf Fisheries Centre, Fisheries and Oceans Canada
Per	Daling	SINTEF
Ronald	DeLaune	Louisiana State University
Christopher	D'Elia	Dean, School of Coast and Environment, LSU
J.T.	Ewing	Texas General Land Office
Ben	Fieldhouse	Environment Canada
Greg	Frost	NOAA
Jerry	Galt	NOAA, Genwest
Judy	Gray	NOAA
Christopher	Green	Louisiana State University
Chantal	Guenette	Canadian Coast Guard
James	Hanzalik	USCG, RRT6
Bill	Hawkins	Gulf Coast Research Laboratory, USM
Ann	Hayward Walker	SEA Consulting
George	Henderson	FL Fish & Wildlife
Charlie	Henry	NOAA, ORR, SSC
Bruce	Hollebone	Environment Canada
Lek	Kadeli	U.S. Environmental Protection Agency (ORD)
Paul	Kepkay	Bedford Institute of Oceanography - Fisheries & Oceans Canada
Nancy	Kinner	Coastal Response Research Center
Brian	LeBlanc	Louisiana State University
Ken	Lee	Bedford Institute of Oceanography
Ed	Levine	NOAA, ORR, SSC
Zhengkai	Li	Bedford Institute of Oceanography - Fisheries & Oceans Canada
Buzz	Martin	Texas General Land Office
Alan	Mearns	NOAA, ERD
Scott	Miles	Louisiana State University
Carys	Mitchelmore	University of Maryland, CES
Joe	Mullin	US Minerals Management Service
Tim	Nedwed	ExxonMobil
Duane	Newell	U.S. Environmental Protection Agency
John Andrews	Nyman	Louisiana State University
Erin	O'Reilly	U.S. Minerals Management Service, New Orleans
Christopher	Piehler	LA DEQ
Bob	Pond	U.S. Coast Guard
Ralph	Portier	Louisiana State University
Kelly	Reynolds	ITOPF
Jeep	Rice	NOAA, Auk Bay NMFS lab
Nicolle	Rutherford	NOAA, ERD
Jeffrey	Short	Oceana
Gus	Stacy	LA Oil Spill Coordinators Office (LOSCO)
Jim	Staves	U.S. Environmental Protection Agency
Cynthia	Steyer	USDA NRCS
Ron	Tjeerdema	University of California
Kenneth	Trudel	SL Ross
Doug	Upton	Mississippi DEQ
Albert	Venosa	U.S. Environmental Protection Agency
Terry	Wade	Texas A&M University
Dave	Westerholm	NOAA, ORR

COASTAL RESPONSE RESEARCH CENTER STAFF:	
Joseph	Cunningham
Joe	Corsello
Heather	Ballestero
Kathy	Mandsager
Tyler	Crowe
Zachary	Magdol
Eric	Doe
Mike	Curry
Beth	Potier

APPENDIX C

Breakout Sessions

Overarching Goals:

1. **Provide specific recommendations to the Region 4 and Region 6 Regional Response Teams (RRT) on the advisability of continuing the current level of dispersant operations, including changes in dispersant use and application methods for the spill.**
2. **Identify possible monitoring protocols in the event of continuing aerial and subsurface dispersant application.**

Breakout Session I: Wednesday afternoon

1. What do we need to know in order to make recommendations regarding dispersant operations and to identify possible monitoring protocols?
2. What is the current state of knowledge regarding the DWH spill?
3. What are the gaps in our knowledge or information?
    a. Can these gaps be addressed using information from past experience and/or the literature?
    b. If not, what information should be collected in the short and long term to support these recommendations?

Breakout Session II: Thursday morning

1. Develop specific recommendations for aerial and subsurface dispersant use if the DWH release continues.
    a. What are the tradeoffs (risks/benefits) associated with these recommendations?
2. Identify possible monitoring protocols in the event of continuing dispersant use.

APPENDIX D

Breakout Groups

Group A:Efficacy and Effectiveness	Group B: Physical Transport and Chemical Behavior
Room: Abell Room	**Room: Anderson Room**
Group Lead: Joe Cunningham *Recorders: Joe Corsello + Eric Doe* Tom Coolbaugh Craig Carroll Per Daling J.T Ewing Ben Fieldhouse Chantal Guenette Ann Hayward Walker Lek Kadeli Paul Kepkay Ed Levine Zhengkai Li Joe Mullin Duane Newell Bob Pond Kelly Reynolds Al Venosa	Group Lead: Bruce Hollebone *Recorder: Tyler Crowe* Les Bender Mary Boatman Michel Boufadel Jim Churnside Robert Carney Greg Frost Jerry Galt Buzz Martin Allan Mearns Scott Miles Erin O'Reilly Jim Staves

Group C: Biological Effects: Deep Ocean	Group D: Exposure and Effects: Non-commercial
Room: Shelton Room	**Room: Cook Room**
Group Lead: Zachary Magdol *Recorder: Mike Curry* Adriana Bejarano Richard Coffin Bill Conner Charlie Henry Ken Lee Jeff Short Ron Tjeerdema	Group Lead: Nicholle Rutherford *Recorder: Heather Ballestero* Carys Mitchelmore Ralph Portier Cynthia Steyer Mace Barron Les Burridge Simon Courtenay Bill Hawkins Brian LeBlanc Jeep Rice Doug Upton Terry Wade

APPENDIX E

RECORDER NOTES – GROUP A1 – MAY 26, 2010

Breakout Session I: Wednesday afternoon

1. What do we need to know in order to give input regarding dispersant operations and to identify possible monitoring protocols?

Way for oil to be dispersed
Effectiveness of dispersants – surface and subsea
Fluorometer use – indecisive
Where effectiveness high and low
Continued use good for right oil – remove tier 1 to get particle size – overall picture everyday
Oil is dispersible
Continuous monitoring of water column rather than discrete events
Surface vs subsurface dispersant – amount of weathering
Tier 2 – not specific data
GPS routes – see if boats are located where near planes are
Tier 1 = Eyeball aerial observation
Tier 2 = Fluorometry at 1 m below
Tier 3 = multiple depths
C3 = Fluorometer
Small aircraft, Big aircraft, sampling vessels
Better placement of tier 2 sampling vessels
Tier 1 and 3 are best – big boat tier 3
Property of oils on surface – weathering of source out to get properties and thickness of layer
Visual profile of oil
Treated and non-treated oil properties
Increasing amount of energy for dispersants – turbulence 1, 2 hrs after
Different levels of monitoring for different levels oil weathering
Fresh oil – tier 1
Tier 2 – proof of performance
Weathering profile – transitional phase - to see when dispersant is no longer needed
Emulsified oil as indicator of dispersant use
Deep water plume – know where is it
Amount of dispersant:flowrate of oil
Ratio of dispersant to oil – deep water
Droplet size – deep water
Temperature effect on dispersion
Amount of mixing energy and time – deep water
Emulsion may be dispersible with multiple applications of dispersant – needs to be researched
What is causing the small droplets at the surface?

2. What is the current state of knowledge regarding the DWH spill?

Location of plume: 1100 – 1300 ft moving SW direction
DWH oil high in alkanes, PAH similar to reference oil, up to C30
14-21% emulsified oil – may have come from skimmer
10-15% natural water and oil – surface oil (redish brown)
Less than C15 volatilizing
Max = 200,000 centistoke
Emulsified 5500-8500 centistoke
Need to know how oil is weathering on surface
Oil emulsion is non dispersible (15-20%) and when redish brown
Mousse is dispersing- not as good as before
Emulsion may be destabilizing (50-60%)
Take sample, add dispersant, shake, see if dispersed
Resurfacing – samples needed for what is resurfacing
C3 – calibration needed
C3 (fluorometer) gives relative trends – no level of total oil or degree of dispersion
(Need quick field tests)

3. What are the gaps in our knowledge or information?

Similar to #1
Can emulsions be dispersed with multiple applications?
When is the endpoint of effective dispersance? Look at data
Should other dispersant application methods be considered besides air (boat, subsurface)
Oil flowrate – max, min
Size of plume (volumetric)
Leaching rate from small droplets
    Leaching rate - soluble components in oil
Rate of dispersant in subsurface application (how well will it disperse)
Is the plume of oil and dispersant rising together?

   a. Can these gaps be addressed using information from past experience and/or the literature?

Lack of research on top surface

Data to collect:

Short Term – methane at surface, dispersant (if any), chemical dispersance vs. natural dispersance

   b. If not, what information should be collected in the short and long term?

Measure concentrations of oil and dispersants through water column

RECORDERS NOTES – GROUP A1 – MAY 27, 2010

Breakout Session II: Thursday morning

1. Develop input for the RRTs on subsurface dispersant use if the DWH release continues.

   MIXING -

   -Dosage required – better understanding of required ratio (more systematic)

   -Maximize contact time period between oil and dispersant from riser (shift wand position)

   -Optimized mixing in riser – wand position (deeper is better – double or more), smaller nozzle on wand to increase fluid sheer (mixing on the small scale)

   -Increase temperature of dispersant to lower viscosity – use oil to naturally heat dispersant? (collect data of droplet size as oil exits riser)

   -oil is at 100 degrees C

   -oil vs dispersant temperature experiments for best conditions?

   -Short time of no dispersant (record data) followed by short time of dispersant usage (record data) and look for improvement to validate effectiveness

   DOSAGE –

   -If mixing is optimal dispersant dose may be high

   -Use minimum flowrate to derive DOR

   Optimal in lab = 1:25

   Measure oil flow (estimated 15,000 barrels/day ~450gpm)

   Lower DOR is better (1:50 ~ 9gpm)

   -If use the assumed 15,000 barrels/day AND 1:50 DOR, then actual dispersant flowrate stays roughly the same

   a. What are the tradeoffs (risks/benefits) associated with this input?

- Dosage
  - Risks

  If too low DOR, will not be getting maximized dispersion

  If high DOR, adding more dispersant to environment

  Are we doing enough dispersion?

  - Benefits

  Cut down need to add surface dispersants

  Protect shoreline

  Create smaller droplets that may degrade faster

  Avoid surfacing

- Mixing
    - Risks

      Lab results are based on STP and actual conditions differ (5,000ft and 100 C)
      Opportunity cost of having to make a new “nozzle” and deployment

    - Benefits

      More stable
      Kept below surface
      Lower droplet size
      More efficient delivery of dispersant

2. Identify possible monitoring protocols in the event of continuing dispersant use.

   Monitor for:
   Dispersant present on surface from subsurface injection
   Dispersant in water column
   Surface and depth for chemically dispersed vs. physically dispersed oil

   Potentially measured using GCMS/GCFID
   UVFS and LISST

   Tier 1 visual monitoring at surface with quantification of oil with aerial remote sensing

   Collect images

   Technique for surface and depth detection of dispersant
   No reference control monitoring of dispersion at depth
   Visual monitoring may demonstrate differences between dispersant application and no application – plume shape, color

RECORDER NOTES – GROUP A2 – MAY 27, 2010

Overall input:

1. **Surface application of dispersants has been demonstrated to be effective for the DWH incident and should continue to be used.**
2. **The use of chemical dispersants is needed to augment other response options because of a combination of factors for the DWH incident: 1) continuous, large volume release, 2) Relative proximity to sensitive wetlands, 3) winds and currents which may move the oil toward sensitive wetlands, and 4) Limitations of mechanical containment and recovery and in-situ burning.**
3. **Weathered DWH oil may be dispersible. Further lab and field studies are needed to assess the efficacy and effectiveness and optimal dispersant application (e.g., multiple dispersant applications).**
4. **Spotter airplanes are essential for good slick targeting for large scale aerial application (e.g., C130), so their use should be continued.**
5. **In order to most effectively use the assets available, the appropriate vessels or aircraft should be selected based on the size and location of the slick and condition of the oil. Vessels and smaller aircraft should be used to treat smaller slicks and the weathered DWH oil because they can target more accurately and repeatedly. Larger aircraft should be used for larger fresh oil slicks offshore except in the exclusion zone around the source. A matrix of oil location, oil patch slicks size and condition, dispersant technique/dosage, visual guidance, requirements for success/confirmation has been developed by the dispersant assessment group in Houma incident command. This matrix should be reviewed by the RRT.**

What are the tradeoffs (risks/benefits) associated with this input?

Risks: Dispersants will not be 100% effective. The matrix citied in #5 of overall input section above contains information to maximize the efficacy of dispersant

application on different states of the DWH oil. Dispersants redistribute the oil from the surface to the water column which is a tradeoff decision to be made by the RRT.

Benefits: Dispersing the oil reduces surface slicks and shoreline oiling. The use of chemical dispersants enhances the natural dispersion process (e.g., smaller droplet size enhances biodegradation). Dispersing the oil also reduces the amount of waste generated from mechanical containment and recovery and shoreline cleanup.

Relevant literature and field study information:

1. **Field data (tier 1 and tier 2) at the DWH site demonstrate that under calm seas aerial application of the dispersant is effective.**
2. **OHMSETT testing in calm seas and non-breaking waves on fresh oil demonstrated that dispersant will stay with oil and if energy subsequently increases, the oil will disperse. If it remains calm over a period of days, a fraction of the dispersant may leave the oil and dissolve in the water column (this is a function of underlying currents).**

Caveats:

1. **There are logistical difficulties in getting tier 2/3 (fluorometry) data for aerial application because of the 2 mile safety restriction on any vessel after the plane has sprayed. It may be 20-30 mins before the boat starts moving towards the perceived area of application. This may mean that the sampling vessels do not collect data where the dispersant was applied. This operational issue should be addressed.**
2. **The RRTs should develop criteria for discontinuing or altering dispersant operations.**

Question 2: Identify possible monitoring protocols in the event of continuing dispersant use.

Protocols:

1. **There is good correlation between tier 1 observations and tier 2 field fluorometry data. There has been sufficient tier 1 and 2 data collected for the DWH incident to indicate monitoring is not required for every sortie.**
2. **Going forward it is important to now focus on assessing the extent of the cumulative extent of the 3D area after multiple applications of dispersant on the surface. A sampling and monitoring plan to do this has been developed by the dispersant assessment group based in the Houma command center and initial implementation has begun. The RRT6 should review this plan.**

REPORT OUT – GROUP A1- MAY 26, 2010

Breakout Session I: Wednesday afternoon

1. What do we need to know in order to give input regarding dispersant operations and to identify possible monitoring protocols?

Where effectiveness is high and low or none
Continued use good for right oil – remove tier 1 to get particle size – overall picture everyday
Continuous monitoring of water column rather than discrete events
Surface vs subsurface dispersant – amount of weathering
GPS routes – see if boats are located where planes are near
Better placement of tier 2 sampling vessels
Property of oils on surface – weathering of source out to get properties and thickness of layer
Visual profile of oil
Treated and non-treated oil properties
Increasing amount of energy for dispersants – turbulence 1, 2 hrs after
Weathering profile – transitional phase - to see when dispersant is no longer needed
Deep water plume – know where is it
Amount of dispersant:flowrate of oil - DOR
Droplet size – deep water
Temperature effect on dispersion
Amount of mixing energy and time – deep water
Emulsion may be dispersible with multiple applications of dispersant – needs to be researched
What is causing the small droplets at the surface?
Oil emulsion is non dispersible (15-20%) and when reddish brown

Tier 1 = Eyeball aerial observation
    Fluorometer confirms aerial observations
Tier 2 = Fluorometry at 1 m below
Tier 3 = multiple depths
C3 = Fluorometer
Fresh oil – tier 1
Tier 2 – proof of performance

2. What is the current state of knowledge regarding the DWH spill?

Location of plume: 1100 – 1300 m deep moving SW direction
DWH oil high in alkanes, PAH similar to reference oil, up to C30
14-21% emulsified oil – may have come from skimmer
10-15% natural water and oil – surface oil (redish brown)
Less than C15 volatilizing
Emulsified 5500-8500 centistoke
Mousse is dispersing- not as good as before
Emulsion may be destabilizing (50-60%)

C3 – calibration needed
C3 (fluorometer) gives relative trends – no level of total oil or degree of dispersion
(Need quick field tests)

3. What are the gaps in our knowledge or information?

   Similar to #1
   Can emulsions be dispersed with multiple applications?
   When is the endpoint of effective dispersance? Look at data
   Should other dispersant application methods be considered besides air (boat, subsurface)
   Oil flowrate – max, min
   Size of plume (volumetric)
   Leaching rate from small droplets
   Leaching rate - soluble components in oil
   Rate of dispersant in subsurface application (how well will it disperse)
   Is the plume of oil and dispersant rising together?
   Resurfacing – samples needed for what is resurfacing

   a. Can these gaps be addressed using information from past experience and/or the literature?

      Lack of research on top surface

   Data to collect:
   Short Term – methane at surface, dispersant (if any), chemical dispersance vs. natural dispersance

   b. If not, what information should be collected in the short and long term?

      Measure concentrations of oil and dispersants through water column

Deep Water Efficacy and Effectiveness

Group A

Day 2

Develop input for the RRTs on subsurface dispersant use if the DWH release continues

MIXING –

- Dosage required – better understanding of required ratio (more systematic)
- Maximize contact time period between oil and dispersant from riser (shift wand position)
- Optimized mixing in riser – wand position (deeper is better – double or more), smaller nozzle on wand to increase fluid sheer (mixing on the small scale)
- Increase temperature of dispersant to lower viscosity – use oil to naturally heat dispersant? (collect data of droplet size as oil exits riser)
  - Oil is at 100 degrees C
  - Oil vs dispersant temperature experiments for best conditions?
- Short time of no dispersant (record data) followed by short time of dispersant usage (record data) and look for improvement to validate effectiveness

Question 1 (contd.)

DOSAGE –

- If mixing is optimal dispersant dose may be high
- Use minimum flowrate to derive DOR
  - Optimal in lab = 1:25
- Measure oil flow (estimated 15,000 barrels/day ~450gpm)
- Lower DOR is better (1:50 ~ 9gpm)
- If use the assumed 15,000 barrels/day AND 1:50 DOR, then actual dispersant flowrate stays roughly the same

What are the tradeoffs (risks/benefits) associated with this input?

Dosage Risks:

- If too low DOR, will not be getting maximized dispersion
- If high DOR, adding more dispersant to environment
- Are we optimizing dispersion?

Question 2 (contd.)

Dosage Benefits:

– Cut down need to add surface dispersants
– Create smaller droplets that may degrade faster
– Minimize surfacing

Mixing Risks:

– Lab results are based on STP and actual conditions differ
  • 5,000ft and 100 C (?)
– Opportunity cost of having to make a new “nozzle” and deployment

Mixing Benefits:

– More stable droplets
– Kept below surface
– Lower droplet size
– More efficient delivery of dispersant
– Potential for faster biodegradation (?)

Identify possible monitoring protocols in the event of continuing dispersant use

In the absence of reference control, monitor for:

– Visual monitoring may demonstrate differences between dispersant application and no application
  • Plume shape, color
– Surface and depth for chemically dispersed vs. physically dispersed oil and dispersant itself
  • Potentially measured using GCMS/GCFID
  • UVFS and LISST
– Tier 1 visual monitoring at surface with quantification of oil with aerial remote sensing
  • Collect images

RECORDERS NOTES – GROUP B – MAY 26, 2010

Breakout Session I: Wednesday afternoon

1. What do we need to know in order to give input regarding dispersant operations and to identify possible monitoring protocols?

   Unknowns at depth
   - Contact efficiency between dispersant and oil
   - Release rate of oil and gas
   - Dispersion efficiency
   - Mixing energy at injection point
   - Dispersion at depth (pressure effects)
   - Temperature of released oil
   - Weathering of oil in rising plume (dissolution, vapor stripping)
   - Emulsion formation and dispersion under pressure
   - Destabilization of emulsions as pressure decreases
   - Emulsion formation in the rise zone before it hits the surface
   - Biodegradation rate on droplets at pressure and at bottom temperature
   - Movement at depth
   - Sedimentation of dispersed oil from depth
   - Biological uptake

   Unknowns at the surface
   - Langmuir circulation potential for mixing
   - Is advection fast enough to eliminate buildup

   Unknowns for airborne fate
   - BTEX levels above oil slick
   - Suppression of VOCs when using dispersants
   - Levels of 2-butoxy ethanol from spring
   - Atmospheric breakdown and toxicity of 2-butoxy ethanol and other products

2. What is the current state of knowledge regarding the DWH spill?
   - Surface models are effective and continuously improving
   - SMART protocols are improving
   - Increase of at depth sampling
   - Well researched region (oceanographic and ecological studies)
   - Well established baseline data
   - Airborne application protocols are established
   - Improved NEBA for dispersant use

3. What are the gaps in our knowledge or information?
    a. Can these gaps be addressed using information from past experience and/or the literature?
        - Norwegian experiment
        - Ixtoc 1

    b. If not, what information should be collected in the short and long term?

Short Term

- Remote sensing of the dispersed area
- Nested models
- Smaller grid sizes on models
- Further offshore surface sampling, either as increased SMART sampling or separate sampling regime
- Fixed stations or boat station monitoring sensing in the operational zone(continuous monitoring, water quality monitoring)
- Establishing criteria for cease of dispersant operations
- Guidelines for surface turbulence and dispersant effectiveness
- Contact efficiency between dispersant and oil
- Release rate of oil and gas
- Mixing energy at injection point
- Temperature of released oil

Long Term

- Better coupling between offshore and onshore hydrodynamic models (LaGrangian vs. Eulerian) L
- Dispersion efficiency
- Dispersion at depth (pressure effects)

RECORDERS NOTES – GROUP B – MAY 27, 2010

Breakout Session II: Thursday morning

1. Develop input for the RRTs on aerial and subsurface dispersant use if the DWH release continues.

   a. What are the tradeoffs (risks/benefits) associated with this input?

Benefits

Reduces threat distance and protects shorelines
Probable increase of biodegradation rate (result of smaller particles)
Inhibits emulsion formation=reduces bulk volume of pollutants
Reduces waste management
Potential reduction of VOC in air

Risks

Trades shoreline impact for water column impact
Increases uncertainty of fate
Increased sedimentation rate

2. Identify possible monitoring protocols in the event of continuing dispersant use.

- Measure Size and shape of plume
  - With and without subsurface injection of dispersant
  - Sonar monitoring of plume size and morphology (tilt)
    - Plume size increasing= greater dispersion=better effectiveness
  - More plume monitoring in the rising plume at a variety of depths
  - Important for transport modeling
    - Development of boundaries and constraints on estimates
  - Measures needed
    - Water Temperature
    - Particle size distribution
    - Fluorescence monitoring of dispersant
    - TPH

- Define geographic area/water volume of concern
  - Estimates for scale of impact (first order approximation)
    - Based on current application rates
    - Based on maximum concentration in that volume (worst case scenarios)
    - Scenarios for surface water, onshore, deepwater plumes
  - Important for NEBA analysis

- Create an environmental review committee to advise SSCs
    - Clearinghouse for environmental data
    - Multi-agency and academia
    - Meeting regularly
    - Focused on immediate operational and scientific advice
    - eg. Rapid evaluation of dispersant options
        - Product selection based on:
            - Effectivenesss
            - Toxicity
            - Modeling
            - NEBA
            - Environmental conditions

- Surface layer water quality monitoring (profile of upper 10 m)
    - Concerns of cumulative loading of water (oil, dispersant)
    - Size of monitoring zone
        - Based on anticipated advection and dispersant application
    - Tests of concern
        - TPH
        - TPAH
        - DO
        - Salinity/ Temperature
        - VOA
        - BOD
        - Surfactant monitoring (possible?)
        - Tox testing (?)

- Air monitoring of same surface water quality zone
        - BTEX/VOC levels
        - 2-butoxy ethanol (in case of corexit 9527)
    - Aerial spectral monitoring

REPORT OUT – GROUP B – MAY 26, 2010 (USED RECORDERS NOTES)

Breakout Session I: Wednesday afternoon

1. What do we need to know in order to give input regarding dispersant operations and to identify possible monitoring protocols?

   Unknowns at depth

   - Contact efficiency between dispersant and oil
   - Release rate of oil and gas
   - Dispersion efficiency
   - Mixing energy at injection point
   - Dispersion at depth (pressure effects)
   - Temperature of released oil
   - Weathering of oil in rising plume (dissolution, vapor stripping)
   - Emulsion formation and dispersion under pressure
   - Destabilization of emulsions as pressure decreases
   - Emulsion formation in the rise zone before it hits the surface
   - Biodegradation rate on droplets at pressure and at bottom temperature
   - Movement at depth
   - Sedimentation of dispersed oil from depth
   - Biological uptake

   Unknowns at the surface

   - Langmuir circulation potential for mixing
   - Is advection fast enough to eliminate buildup

   Unknowns for airborne fate

   - BTEX levels above oil slick
   - Suppression of VOCs when using dispersants
   - Levels of 2-butoxy ethanol from spring
   - Atmospheric breakdown and toxicity of 2-butoxy ethanol and other products

2. What is the current state of knowledge regarding the DWH spill?

   - Surface models are effective and continuously improving
   - SMART protocols are improving
   - Increase of at depth sampling
   - Well researched region (oceanographic and ecological studies)
   - Well established baseline data
   - Airborne application protocols are established
   - Improved NEBA for dispersant use

3. What are the gaps in our knowledge or information?
    a. Can these gaps be addressed using information from past experience and/or the literature?
        - Norwegian experiment
        - Ixtoc 1

    b. If not, what information should be collected in the short and long term?

Short Term

- Remote sensing of the dispersed area
- Nested models
- Smaller grid sizes on models
- Further offshore surface sampling, either as increased SMART sampling or separate sampling regime
- Fixed stations or boat station monitoring sensing in the operational zone(continuous monitoring, water quality monitoring)
- Establishing criteria for cease of dispersant operations
- Guidelines for surface turbulence and dispersant effectiveness
- Contact efficiency between dispersant and oil
- Release rate of oil and gas
- Mixing energy at injection point
- Temperature of released oil

Long Term

- Better coupling between offshore and onshore hydrodynamic models (LaGrangian vs. Eulerian) L
- Dispersion efficiency
- Dispersion at depth (pressure effects)

Group B: Fate and Behavior

Fate And Transport: Benefits

- Reduces threat distance and protects shorelines
- Probable increase of biodegradation rate
- Inhibits emulsion formation
- Reduces pollutant bulk and waste management
- Potential reduction of VOC in air

Fate and Transport: Risks

- Trades shoreline impact for water column impact
- Increases uncertainty of fate
- Increased sedimentation rate

1. Create an environmental review committee to advise SSCs

- Clearinghouse for environmental data
- Multi-agency and academia
- Meeting regularly for entire course of spill
- Focused on immediate operational and scientific advice
- eg. Rapid evaluation of dispersant options
  - Product selection based on:
    - Effectivenesss
    - Toxicity
    - Modeling
    - NEBA
    - Environmental conditions

2. Measure Size and shape of Rising Plume

- With and without subsurface injection of dispersant
- Sonar monitoring of plume size and morphology (tilt)
  - Plume size increasing---greater dispersion---better effectiveness
- More plume monitoring in the rising plume at a variety of depths
- Important for transport modeling
  - Development of boundaries and constraints on estimates
- Measures needed
  - Water Temperature
  - Particle size distribution
  - Fluorescence monitoring of dispersant
  - TPH

3. Define geographic area/water volume of concern

- Estimates for scale of impact
- first order approximation
  - Based on current application rates
  - Based on maximum concentration in that volume (worst case scenarios)
  - Scenarios for surface water, onshore, deepwater plumes
- Important for NEBA analysis
- NOAA/EPA deep water sub surface dispersed plume monitoring

4. Surface layer water quality monitoring

- Profile of upper 10 m
  - Concerns of cumulative loading of water (oil, dispersant)
  - Size of monitoring zone
    - Based on anticipated advection and dispersant application
  - Tests of concern
    - TPH
    - TPAH
    - DO
    - Salinity/ Temperature
    - VOA
    - BOD
    - Surfactant monitoring (possible?)
    - Tox testing (?)

5. Air monitoring of same surface water quality zone

- BTEX/VOC levels
- 2-butoxy ethanol (in case of corexit 9527)
- Aerial spectral monitoring

RECORDERS NOTES – GROUP C – MAY 26 2010

Breakout Session I: Wednesday afternoon

1. What do we need to know in order to give input regarding dispersant operations and to identify possible monitoring protocols?
    - **Much less known about deep ocean systems compared to surface water**
    - **Biochemical, trophicdynamics effects of the dispersant rate**
    - What specifically is at risk?
    - What are the receptor species?
    - Life histories of local species, migration, feeding habits
    - **Identify species at risk (migration, feeding habits, life histories, reproductive/ recruitment strategies)**
    - What are the reproductive strategies/recruitment of the species affected?
    - What parts of the ecosystem are affected?
    -
    - **Dispersant effect of oxygen levels and cycling, modeling, maximum rates of application**
    - How much will it affect the nutrient recycling, general efficiency of food chain
    - **What is the particle size distribution as a function of depth, dispersant application rate**
    - Emphasis needs to be put on water scale when considering effects
    - **Understand the biodegradation rates, microbial structure and function**
    - Evaluate the need for another team for data analysis
    - Look at seasonal dynamics etc of oxygen demand
    - Naval research lab organics, hydrocarbons
    - Microbial structure and function
    - **Scavenging particle interactions, oil-mineral aggregate formation at source and throughout water column**
    - **Transport dynamics of deep water ocean currents**
    - Rate of water absorption
    - Unknown latent effects, persistence?
    - How much is the dispersant/spill affecting the oxygen demand compared to other natural seeps and sources?
    - Follow the fate
    - **Evaluate the tradeoffs between dispersant application costs vs surface reduction in oil**
    - Percent effectiveness of the seafloor dispersant application
    - **Further research on where dispersion occurs in the water column**
    - Transport to surface?
    - Does the addition of dispersant change the microbial degradation due to selective metabolism
    - Effectiveness of natural dispersion

- Knowing the downstream flux of oil residue from the spill to the seafloor

2. What is the current state of knowledge regarding the DWH spill?

- MMS report on gulf of mexico deep water resources (2000-049 Review of list for GOM including area, deep water fish, fauna and seepage)
- MMS – vulnerability of DW species to oil spills
- Natural hydrocarbon seepage in the GOM, 40 MG/year
- Receptor paper by Alan Mearns
- Existing reports e.g. MMS, NOAA
- Deep water species in the GOM, Kathys reference
- Preliminary modeling
- Preliminary monitoring data (Fluorometry data, Particle size analysis, Temperature, Salinity, D.O., Hydrocarbon, Acute toxicity , Acoustic data, sonar, Genomics)

- Looking at microbial structure, Berkley
- *None of the info listed above is considered "complete"

3. What are the gaps in our knowledge or information?
   i. Models not validated from #2
   ii. Life history of benthic biota
   iii. Migratory patterns, residence time
   iv. Incomplete data
   v. Microbial degradation rates in deep ocean on hydrocarbon seeps
   vi. Byproducts
   vii. Chronic toxicity of benthic biota
      1. Leads to community and ecosystem effects
      2. Comparison of bioaccumulation/bioavailability between different droplet sizes
      3. Comparison of toxicity and environmental impact of natural vs chemically enhanced dispersed oil
   viii. Weighing the costs/benefits, and tradeoffs
   ix. Species avoidance of oil?
   x. Evaluate the tradeoffs between dispersant application costs vs quantitative surface expression in oil
   xi.

   b. Can these gaps be addressed using information from past experience and/or the literature?

- Chronic and acute toxicology cannot apply to these deep water settings, some data but we have large gaps
- In many cases we can't trust previous techniques
    - Advances in microbiology technology
- Existing studies concerning deep water toxicity of pesticides on forams

c. If not, what information should be collected in the short and long term?
    - Formulation of biogeochemical rates wrt fuel transport and sedimentation
    - Early life stage studies, laboratory or caging

RECORDERS NOTES – GROUP C – MAY 27 2010

Breakout Session II: Thursday morning

1. Develop input for the RRTs on subsurface dispersant use if the DWH release continues.
    a. What are the tradeoffs (risks/benefits) associated with this input?

BENEFITS

- Offshore/nearshore biological tradeoffs
- Surface impacts vs. water column impacts
- Initial evidence of greater efficiency with subsurface/point source application vs. aerial application
- Observed reduction in volatile organics at surface w.r.t. personnel safety
- Enhances the interaction between oil and suspended particulate material
- accelerated microbial degradation through increased bioavailability
- more rapid recovery of downward sulfate diffusion and upward methane diffusion related to shallow sediment geochemistry
- Based on current knowledge confines the aerial extent of impact
    - Current impact zone is far less than 50 km
- Reduction emulsified oil at the surface
- Reduction of phototoxic impacts

RISKS

- Increases the extent of impact at depth
    - Biological impacts to deep water pelagic/benthic organisms
    - Concern with oxygen depletion (Note: 0.7 μg C/L/day tPAH *Coffin)
    - Release of VOCs in the water column
- Change in microbial community diversity, structure, and function
    - Change in trophic level dynamics
    - Leading to changes in key biogeochemical cycles
- Risk assessment should consider volume of Horizon spill relative to natural seepage
- Future application rates unknown with future operations (small contained high concentration zone compared to larger lower concentration zone with the possibility of future growth)
- Re-coalescing and movement to surface remotely – surface slick
- Exhaust dispersant supply

Based on the net benefit, but recognizing incomplete information, the group agrees with subsurface dispersant injection as an immediate option.

2. Identify possible monitoring protocols in the event of continuing dispersant use.
    - Robust deep ocean toxicity studies

    - Application of research done with acute toxicity on forams, possibility of chronic studies (LC50, EC50)
    - Identify control areas
    - Caged studies in the plume
    - Identify surrogate/indicator species for impacts over a range of trophic levels
    - Identify key species of concern (migrating fauna?)
    - Microbial genomics
    - Long term biological effects for resident species with baseline information
- Biogeochemical monitoring
    - Petroleum degradation rates (C14 labels)
    - Microbial production and function (3H thymodine/Genomics)
    - Community diversity (16S RNA)
    - Background parameters (DOC, POC, DIC, concentration and dC13)
    - Bioavailability of the oil as a function of particle size

- Physical/chemical parameters
    - UV Fluorometry (Including FIR)
    - Monitor the particle size distribution of the oil as function of space and time (LISST particle counters)
    - Current velocity (ADCP)
    - Chemical properties CTD (oxygen, salinity, pH, SPM)
    - Chemical properties of the oil as a function of space and time (GC-MS)
    - Potential of acoustic monitoring (3.5 and 12 khz)

Use of data from all of the above for the development of predictive models.

- **Validation!**

Group C: Biological Effects on Deep Water Ecosystem; Subsurface Application

Report Out I: Wednesday, May 26, 2010

Deep Ocean: Needed Knowledge to Give Input to RRTs

- **Much less known about deep ocean systems compared to surface water**
- **Biochemical, trophic dynamics effects of the dispersant rate**
- **Identify species at risk (migration, feeding habits, life histories, reproductive/ recruitment strategies)**
- **Dispersant effect of oxygen levels and cycling, modeling, maximum rates of application**
- **What is the particle size distribution as a function of depth, dispersant application rate**
- **Understand the biodegradation rates, microbial structure and function**
- **Scavenging particle interactions, oil-mineral aggregate formation at source and throughout water column**
- **Transport dynamics of deep water ocean currents**
- **Evaluate the tradeoffs between dispersant application costs vs surface reduction in oil**
- **Further research on where dispersion occurs in the water column**

Deep Ocean: Current Knowledge

- Natural hydrocarbon seepage in the GOM, 40 MG/year
- Existing reports e.g. MMS, NOAA
- Preliminary modeling
- Preliminary monitoring data (Fluorometry data, Particle size analysis, Temperature, Salinity, D.O., Hydrocarbon, Acute toxicity , Acoustic data, sonar, Genomics)

Deep Ocean: Gaps In Knowledge

- Model validation of subsurface dispersion and biogeochemical cycles
- Byproducts
- Migratory patterns, residence time
- Comparison of toxicity and environmental impact of natural vs chemically enhanced dispersed oil
- Evaluate the tradeoffs between dispersant application costs vs quantitative surface expression in oil

Deep Ocean: Can These Gaps be Addressed?

- Chronic and acute toxicology cannot apply to these deep water settings, some data but we have large gaps
- In many cases we can't trust previous techniques
  - Advances in microbiology technology
- Existing studies concerning deep water toxicity of pesticides on forams

Group C: Biological Effects on Deep Water Ecosystem; Subsurface Application

Report Out II: Thursday, May 27, 2010

Tradeoffs of Subsurface Dispersant Application

RISKS

- **Increases the extent of impact at depth**
  - **Biological impacts to deep water pelagic/benthic organisms**
  - **Concern with oxygen depletion (Note: 0.7 μg C/L/day tPAH)**
  - **Release of VOCs in the water column**
- **Change in microbial community diversity, structure, and function**
  - **Change in trophic level dynamics**
  - **Leading to changes in key biogeochemical cycles**
- **Risk assessment should consider volume of Horizon spill relative to natural seepage**
- **Future application rates unknown with future operations (small contained high concentration zone compared to larger lower concentration zone with the possibility of future growth)**
- **Re-coalescing and movement to surface remotely – surface slick**
- **Exhaust dispersant supply**

Tradeoffs of Subsurface Dispersant Application

BENEFITS

- **Offshore/near shore biological tradeoffs**
- **Surface impacts vs. water column impacts**
- **Initial evidence of greater efficiency with subsurface/point source application vs. aerial application**
- **Observed reduction in volatile organics at surface w.r.t. personnel safety**
- **Enhances the interaction between oil and suspended particulate material**
- **Accelerated microbial degradation through increased bioavailability**
- **More rapid recovery of downward sulfate diffusion and upward methane diffusion related to shallow sediment geochemistry**
- **Based on current knowledge confines the aerial extent of impact**
  - **Current impact zone is far less than 50 km**
- **Reduction emulsified oil at the surface**
- **Reduction of phototoxic impacts**

Input!

- Based on the net benefit, but recognizing incomplete information, the group agrees with subsurface dispersant injection as an immediate option

Deep Ocean Monitoring Protocols

- Robust deep ocean toxicity studies
  - Application of research done with acute toxicity on forams, possibility of chronic studies (LC50, EC50)
  - Identify control areas
  - Caged studies in the plume
  - Identify surrogate/indicator species for impacts over a range of trophic levels
  - Identify key species of concern (migrating fauna?)
  - Microbial genomics
  - Long term biological effects for resident species with baseline information

Deep Ocean Monitoring Protocols

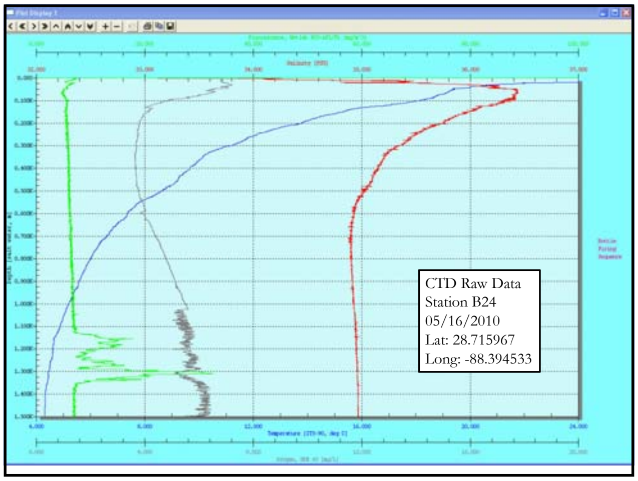
- Biogeochemical monitoring
  - Petroleum degradation rates (C14 labels)
  - Microbial production and function (3H thymodine/Genomics)
  - Community diversity (16S RNA)
  - Background parameters (DOC, POC, DIC, concentration and dC13)
  - Bioavailability of the oil as a function of particle size

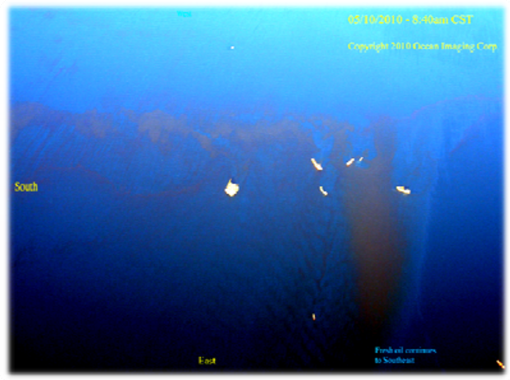
Deep Ocean Monitoring Protocols

- Physical/chemical parameters
  - UV Fluorometry (Including FIR)
  - Monitor the particle size distribution of the oil as function of space and time (LISST particle counters)
  - Current velocity (ADCP)
  - Chemical properties CTD (oxygen, salinity, pH, SPM)
  - Chemical properties of the oil as a function of space and time (GC-MS)
  - Potential of acoustic monitoring (3.5 and 12 khz)

Modeling

- Use of monitoring data for the development and validation of predictive models


CTD Raw Data
Station B24
05/16/2010
Lat: 28.715967
Long: -88.394533


05/10/2010 - 8:40am CST
Copyright 2010 Ocean Imaging Corp
South
East

RECORDERS NOTES – GROUP D - MAY 26 2010

Breakout Session I: Wednesday afternoon
Shallow water

1. What do we need to know in order to give input regarding dispersant operations and to identify possible monitoring protocols?
    - Chemical composition of oil and dispersants
        - Real toxicity is from oil not corexit
        - Test corexit toxicity-short term
    - Impact to health of fisheries resources
    - Potential impact to human health from consumption of seafood
        - Assessment tool for critical habitats
    - Spatial and temporal distribution of concentrations of oil constituents
        - Knowing dissolved phase and particulate hydrocarbon
        - Toxicity on species-bioassays
        - Comparing water composition of mixtures (oil:water)
        - 3D exposure environment (depth and from shore then moving towards spill)
    - Criteria tool for long term habitat monitoring
    - Submerged aquatic vegetation
    - Physical and chemical, exposure pathways, what is being exposed (surface vs depth;LC50, LD50)
    - Federal tests for platforms also apply to products used
    - Some constituents disperse naturally
    - Surface oil moves with wind, dispersed oil in water column moves with currents
    - Effects of riverine system on how dispersants work (salinity concentrations)
    - Toxicity in water column and where is it
        - Physical and chemical dispersion, proximity to dispersant application location
    - Acute vs chronic toxicity-what information is needed to decide whether dispersant use is or is not needed
    - Define benchmarks
    - Many exposure pathways, bioassays could benefit
    - Limit on concentrations and exposure/effects. Chemistry threshold
    - Toxicity – equilibrium partitioning, chronic effects concerns, safety factor of 10 to apply to standard benchmarks
    - *Toxicity tests using rototox (?), but only at deepwater dispersion*
        - *What is known and how a rototox test works*
    - *Federally mandated bioassays in Gulf of Mexico*
    - Effects to biological components- PAH residuals as benchmarks
        - New monitoring device aside from what is used
    - DO level
    - Photo-enhanced toxicity
        - Normal lab studies do not capture this

- What larvae are out there that will absorb oil and be subjected to those phototoxicity effects.
    - What depth are these species at
- What is the exact depth of surface dispersed oil plume
- Deeper than ten meters, physical and chemical aspect of oil droplets unknown
- Monitoring at 5,000ft depth, is there a plume?
    - –using fluorescence for subsurface dispersed patterns
    - Fluorescent transects will document what happened to decision that's been made
- Baseline data prior to the oil reaching that area
    - Trace PAHs in water column
    - Gaps- having enough transect profile data moving away from shoreline (baselines)
    - Some data has been collected
- Agreement among involved parties on toxicity benchmarks
- NOAA fisheries proposed studies and monitoring for seafood safety and levels of concern (conservative levels)
- Rate of degradation of oil vs. dispersed oil
    - Biproducts of degradation, and relative toxicity
    - True residence time of volatile fractions (dispersed vs. non)-present LSU studies
    - Seasonal factors
    - Other degradation factors (e.g., dead zone)
        - Will this in turn influence dead zone, DO, etc
- Species type- exposure duration, pathways, variations amongst species; if there are numbers, what are they based on (which tox tests)?
- Rototox assay is very general thing
- Dose- disperse compounds, how long do plumes persist, are they mixed in the water column. What level is negligible?
    - Undetectable limits but still have effects on species
- Spatial and temporal fluorescence for basic infrastructure. Assist in evaluating use of dispersants.
    - Is it toxic, what are the adverse effects
- Species out there, area, concentration, threshold levels, protecting which species
    - Area, number of species and concentrations in regions
- Continual spill, risks may equal out of effected species in water column to shoreline
- Seasonality distribution of species, larvae
- Influence top of water column that feed rest of food chain will eventually affect shoreline species anyway. Tradeoffs
- How long does it last, where does it go?
- Life periods of species and how they will be effected (e.g., killifish vs. blue fin tuna)
- What biota is in the vicinity of the dispersants
- Degradation components of dispersants not well known in terms of accumulation
- Persistent components of dispersants
- Are dispersants bioaccumulated

- Information be made available for decision makers
- How toxic is dispersant, how much in relation to oil, is oil more toxic when dispersed. Is this loss acceptable knowing that it may save the shoreline….tradeoffs
- Are dispersants giving us enough relief (looking at ERMA map)? How much of a reduction will we get in oil hitting the shoreline. Relative to total volume
- Does it make a difference in the end with total amounts of oil that will and would have reached the shore had it not have been dispersed.
- What is the oil that is coming ashore now? Not sure if oil moving on shore is exactly dispersed oil or non.

2. What is the current state of knowledge regarding the DWH spill?
   - Water samples with no oil concentrations came from inshore samples prior to oil making landfall
   - Fluorescence methods to monitor subsurface dispersed oil
   - Hypoxia-EPA-mapping hypoxic zone, just mapping it, not looking at influence on biodegradation potential
   - Good to disperse if it doesn't get into coastal zone
   - Persistence of dispersant is around 7days
   - Potential bioaccumulation on some aspects of dispersants (MSDS)
   - EPA PAH datas. Priority pollutants (not full range). Push for GCMS
   - Petroleum distillates in corexit: known animal carcinogen in the MSDS for petroleum distillates
   - If use dispersants, oil in top 10m of water column will cause injury to species in that area.
   - More oil is dispersed when using dispersants at wellhead.
   - Aerial application- effectiveness drops off
   - Oil that comes ashore hasn't been dispersed. Not likely to have recoalesced
   - RRT discussion on lifting restrictions on dispersant application areas

3. What are the gaps in our knowledge or information?
   1. Can these gaps be addressed using information from past experience and/or the literature?
      - Pulling data together and synthesizing
      - Water samples throughout depth up to 5,000ft (LSU)
      - Pharmaceutical products-endocrine disrupting properties
      - IXTOC -140M barrels of oil, 2M gallons of oil applied.
      - Exxon Valdez, oil that came ashore, still have a fraction of it after 20 years
      - Leave marsh alone, it cleans itself, what are the orders of magnitude

- How much oil gets onto marsh plants dictates lethality
- Want to keep it off the nursery ground
- State dependent upon species from these habitat areas
- Pelagic fish and organisms. Bluefin tuna exp. Will we lose that species (deep water species)

2. If not, what information should be collected in the short and long term?
    - EPA, BP data compilation
    - What is the distribution of sensitive species offshore
    - Distribution of dispersed oil
        1. larva data and commercial species
- oyster and mussel examples for monitoring
- SPMD monitoring (30days-has some biofouling)
    - Benefit future dispersant decisions
-

Breakout Session II: Thursday morning

1. **Develop input for the RRTs on aerial and subsurface dispersant use if the DWH release continues.**
    a. **What are the tradeoffs (risks/benefits) associated with this input?**

- Report 50% loss of fisheries (menhaden-spawn in marshes, life in open ocean)
- Commercially important species –top ten meters (location marshes to open ocean)
- San Bernard shoals type of oil (dispersed or non) doesn't matter, area is already compromised
- Major fisheries in open oceans
- MSDS states no toxicity tests required
- **Consider offshore fisheries (one species against the other-inshore fisheries and shrimping grounds vs. offshore)**
- First hit for summer fishing season will be menhaden
- Southeast fisheries science center has information on species location
- No environmental impact statement required for this location
- **Scrutinize MMS document (bluefin tuna and menhaden)**
- MSDS for corexit has LC50 (consider dose)
- Does the dispersant make oil more toxic because it's more available? More animals see more of the oil. If dilution is fast enough, the species will see less of it (dose)
- Theory: increase oil in water column then "go away"
- Oil slick-worry about birds, etc, if you disperse it goes to top ten meters of water column and threatens those species. Then habitat concerns
- **Transfer risk from surface to subsurface, then worry about habitat contamination if it comes ashore**

- Lessons from Persian gulf, no concentrations in water, but dig into sediments to find oil there
- **Long term effects as opposed to short term acute effects.**
- Half life and concentration. Creating a different effect than the MSDS sheet has information for
- Subsurface water and surface water move in different directions which lowers the dose (of oil?)
- Dispersants speed up natural process which lowers the dose. Could wipe out phyto and zooplankton in dispersant areas. Fluorescence shows oil location and how effective oil dispersion is.
- Corexit breaks down relatively quickly (in a lab)
- Propylene glycol dissolves in water, dilutes rapidly, can adhere to particulates (?), its solubility is affected by propylene distillates.
- Microbes degrade soluble and non-soluble components
- **Toxicity as lethality and not so much long term chronic effects. Risk and uncertainty in terms of how much over what area, what species are there.**
- Sub lethal effects with long ranging impacts. If you contaminate habitat you extend the range of those impacts
- How much of a difference are we really making by using dispersants (looking at ERMA map)-small area of application
- What is the effectiveness of the dispersed treatment?
- Is it worth it if we're still going to have impacts to the exact habitat we're trying to protect?
    - Once you've added a volume it takes a certain time for the marsh to clear it, so the more oil there the more time.
    - 430,000gallon application with 10:1 ratio. You save approximately 1-10M gal of oil off the shore
    - Application may not be as efficacious as expected; dispersants may be over applied
    - 2 weeks ago, reevaluated dispersant application
    - EPA is pro deep dispersant application
    - Smart data shows that there is dispersion into the water column-only monitors down to 10m

    - Public perception is that the oil slick is dropped slightly into the water column, below surface, not that it is broken into small droplets.
- What is the application rate? Then you can calculate dilution rate
- Dispersant is less toxic than oil and applied in smaller concentration than oil. Thus, more worried about oil toxicity
- Dispersant may facilitate PAH uptake in organisms and increase dissolved phase of PAHs enhancing bioavailability
- Mechanisms of uptake and physical characteristics of dispersed oil (sticking to species). Bacterial degradation (much conflicting data on uptake and exposure routes)
- **Mechanisms of PAH availability and toxicity resulting from dispersant use and making PAHs more bioavailable**
- More dispersant-increase toxicity, not the dispersant itself, just what it does. Endocrine disruption, carcinogenicity
- Solely disperse deep water, need to fully know the efficacy and effects. Think they can get same dispersion with deep water injection. Believe dispersed oil will remain below pycnocline
- Halted surface water dispersion
- **Use of dispersants should continue to lessen extent of shoreline oiling. Tradeoffs with species in open ocean water column**
- Small reduction in oil (even 1%) is it beneficial? What is the objective of dispersant application
- How much of the slick are you actually getting to (about 1M gallon?)
- **Dose, duration, and spatial context**
- All an experiment, controlled or not
- A lot of marsh that hasn't been hit yet, small fraction of LA marshes have been oiled
- If you apply dispersants and it's just washing around, if it's effects are less than the oil, then what's the risk?
- If we spray it on open water, or it isn't effective, then what's downside to applying it? There is no real downside (aside from

potential unknowns of dispersants, their residence time, and toxicity)

- Can only apply dispersant when conditions are adequate (to create mixing)
- Currents, where things are going, where's the plume? Consistent plume? Kill the tight plume and not worry about everything else?
- Species sensitivity (e.g., corals would be killed by dispersed oil)
- What is your footprint damage
- More data on open oceans, how much harm is being done?
- Big uncertainty
- **Data gaps: what is being exposed, exposure time.**
- **If dispersant application mitigates a small percentage of oil in marshes, it may have a beneficial tradeoff. Are the beneficial tradeoffs acceptable?**
- Spatial mapping –not adequate density
- Too many unknowns-never going to get to a comfortable stage, even with a five year plan

2. Identify possible monitoring protocols in the event of continuing dispersant use.

- **Monitor deeper than 10meters (below 20meters or until no fluorescence doesn't work)**
- **Monitor surface to bottom across a transect from the shore to source**
  - **Gradation out from shore**
  - **If not in this spill, beneficial to future spills**
- Need grid
- **Deploy semi permeable membrane device (SPMD), passive sampling, or oysters**

- Oysters take about 30 days to reach equilibrium

- Objectives? Detailed species questions
- Damage assessment, tracking and exposure
- What limits microbes
- **Bioaccumulation monitors at selective points along transect**
- **Concentration monitoring (dose) and exposure time**
- **How big is the footprint of dispersed oil**? Is there naturally dispersed oil in other areas; compare and measure how much dispersant is in water.
- **Measure current (subsurface) prior to application**
- **Measure DO**
    - **pH, temp, pressure, salinity, particle size, fluorometry, turbidity**
- **Monitor/measure physical parameters, put into model to figure concentration to measure toxicity**
- **Biological species indicators (indicator species, chlorophyll,)**
    - eggs or larval abnormalities-long term monitoring
- coordination with NRDA
- oil vs dispersant effects
- shrimp moving out of marshes and into ocean now
- Baseline species and behavior verse effects from oil and dispersed oil
- **Hypoxic zone**
    - **M**atch up where chemical vs DO signal are
    - Correlation between river volume (flood) and hypoxic zone
    - Baseline data
- Need to prove where the oil and dispersed oil is
- **Track oil!**
    - **Where chemicals are going, exposure regimes**
    - **Dealing with uncertainty**
- Would this data help managers?

- What is the effect of the dispersant; is it an adverse effect? If so, how much?
    - Small and localized
    - Tradeoff for keeping oil out of the marsh
- **Ecosystems will recover after oil shock to system, open ocean ecosystems may rebound faster than marsh areas; worthwhile to apply dispersants**
- **Opportunity to learn**
- Tracking unknown oil in deep sea-
- **surface, start monitoring plan NOW. Start prior to potential future surface dispersant application**
    - Data set will be beneficial in damage assessment as well
    - Beneficial for dispersant or not
- **Toxicity tests-state of the art (standard 48hour tests)**
    - Bioassays; bioassay based decision tree
        - Important for public perception
    - 24 hour acute tox screen
    - Show public toxicity levels, ease concern
- Tox tests on underwater dispersion (rototox indicates not much toxicity)
- Don't know what tests to suggest (microtox)
- Manidya, mica, alga
- Public does care –sublethal effects, chronic effects
- **Selected bioassays at selected sampling points**
    - **Water**
    - **Sediment? If it comes ashore, definitely**
- Seafood safety-marketing
- Transfer risk to 10m is lesser of evils. Dispersant use on surface okay
- Water measurements dispersants and oil
- DO measurements
- Toxicity tests: selected bioassays
- **More confidence in where oil is going**

- **Mussel watch –time aspect, before and after oil spill**
    - Long term monitoring (monthly)

Sediment doesn't necessarily reflect dispersant use…need baseline and background for oil in sediment
Sediment baselines for future

Powerpoint presentation recommendations:

- Surface application of dispersants is ok
    - Transfer risk to 10m is lesser of evils
- Monitoring to provide more confidence in where oil is going
    - Long term monitoring (monthly); grid from inshore to open ocean (past oil slick edge)
    - Passive samplers in selected areas
    - Water measurements dispersants and oil
    - DO measurements
    - Toxicity tests: selected bioassays
    - Standard CTD tests plus chlorophyll measurements

Q1: What do we need to know in order to give input regarding dispersant operations and to identify possible monitoring protocols?

- Location, location, location
  - Oil, dispersants, critters
- Levels of concern?
  - E.g., sensitive life stages
  - Oil and dispersant constituents

Q2: What is the current state of knowledge regarding the DWH spill?

- Dispersed oil in shallow water (10m)

What are the gaps in our knowledge or information?

- Effectiveness of dispersant
- Long term effects of dispersant exposure (carcinogenicity)
- Dispersed oil effects in an estuarine/riverine/pelagic environment
- Bioavailability, bioaccumulation (SPMD)

Recommendations

- Clearinghouse for baseline data being collected
- Know dose of exposure, effects, species present and tradeoffs with habitat protection
  - Dispersed verse non dispersed oil

Recommendations

- Surface application of dispersants is ok
  - Transfer risk to 10m is lesser of evils
- Monitoring to provide more confidence in where oil is going
  - Long term monitoring (monthly); grid from inshore to open ocean (past oil slick edge)
  - Passive samplers in selected areas
  - Water measurements dispersants and oil
  - DO measurements
  - Toxicity tests: selected bioassays
  - Standard CTD tests plus chlorophyll measurements

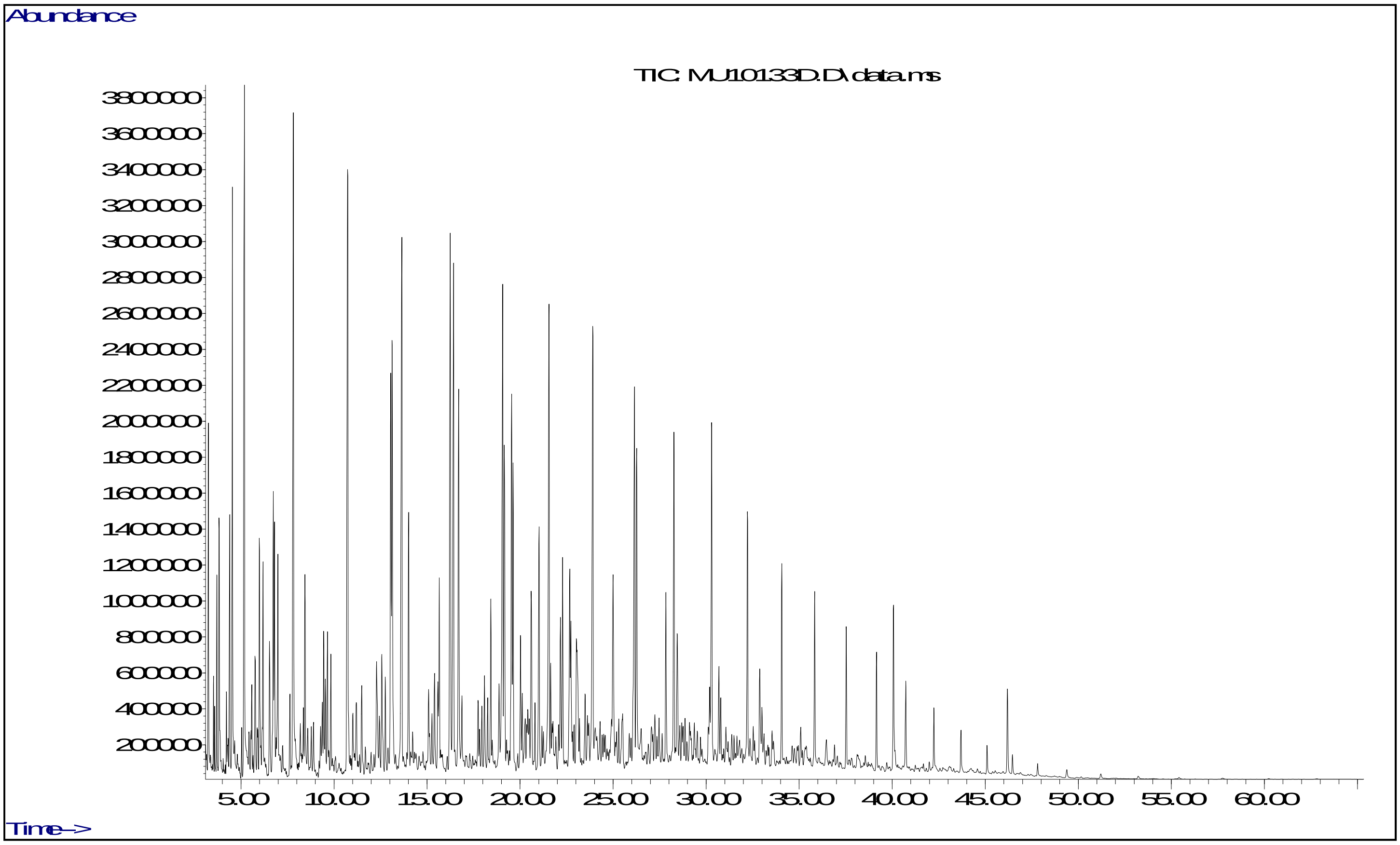
APPENDIX F

Data Courtesy School of the Coast and Environment, Louisiana State University

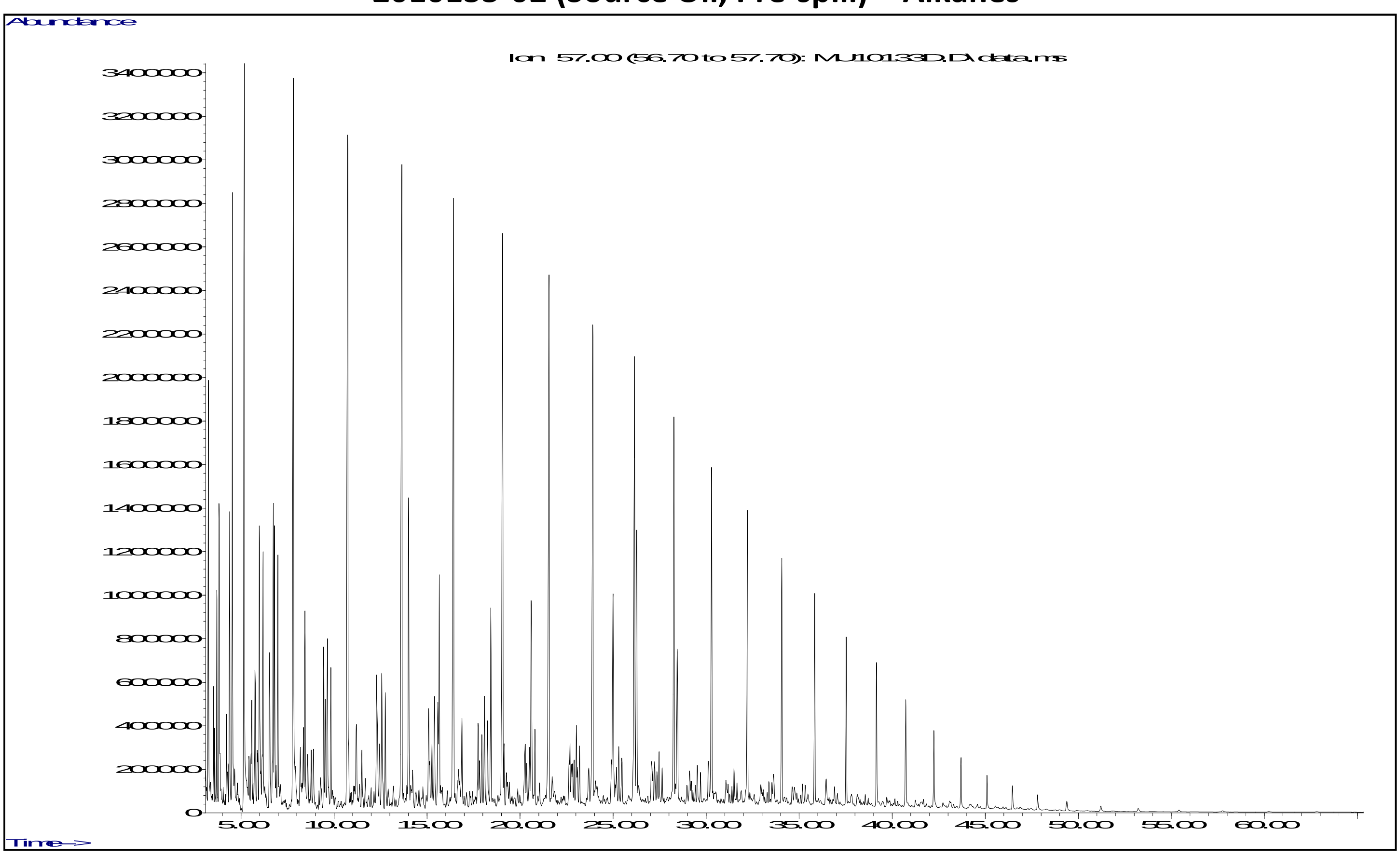
LSU ID#: 2010133-02 **Source Oil, Pre-spill** **Sample Weight:** 310 mg **Final Extracted Volume:** 30 mL		**LSU ID#: Lab Ref Oil** **South Louisiana Crude** **Sample Weight:** 500 mg **Final Extracted Volume:** 20 mL	
Alkane Analyte:	Concentration (ng/mg)	Alkane Analyte:	Concentration (ng/mg)
nC-10 Decane	2600	nC-10 Decane	2600
nC-11 Undecane	2600	nC-11 Undecane	2700
nC-12 Dodecane	2600	nC-12 Dodecane	2600
nC-13 Tridecane	2500	nC-13 Tridecane	2600
nC-14 Tetradecane	2400	nC-14 Tetradecane	2300
nC-15 Pentadecane	2000	nC-15 Pentadecane	2200
nC-16 Hexadecane	1800	nC-16 Hexadecane	2000
nC-17 Heptadecane	1700	nC-17 Heptadecane	1900
Pristane	960	Pristane	970
nC-18 Octadecane	1500	nC-18 Octadecane	1700
Phytane	770	Phytane	910
nC-19 Nonadecane	1300	nC-19 Nonadecane	1500
nC-20 Eicosane	1300	nC-20 Eicosane	1400
nC-21 Heneicosane	1100	nC-21 Heneicosane	1300
nC-22 Docosane	1000	nC-22 Docosane	1200
nC-23 Tricosane	940	nC-23 Tricosane	1100
nC-24 Tetracosane	890	nC-24 Tetracosane	1000
nC-25 Pentacosane	600	nC-25 Pentacosane	620
nC-26 Hexacosane	510	nC-26 Hexacosane	510
nC-27 Heptacosane	350	nC-27 Heptacosane	360
nC-28 Octacosane	300	nC-28 Octacosane	310
nC-29 Nonacosane	250	nC-29 Nonacosane	260
nC-30 Triacontane	230	nC-30 Triacontane	230
nC-31 Hentriacontane	150	nC-31 Hentriacontane	190
nC-32 Dotriacontane	120	nC-32 Dotriacontane	150
nC-33 Tritriacontane	100	nC-33 Tritriacontane	110
nC-34 Tetratriacontane	90	nC-34 Tetratriacontane	110
nC-35 Pentatriacontane	92	nC-35 Pentatriacontane	110
Total Alkanes	***30752***	***Total Alkanes***	***32940***

LSU ID#: 2010133-02 **Source Oil** **Sample Weight:** 310 mg **Final Extracted Volume:** 30 mL		**LSU ID#: Lab Ref Oil** **South Louisiana Crude** **Sample Weight:** 500 mg **Final Extracted Volume:** 20 mL	
Aromatic Analyte:	Concentration (ng/mg)	Aromatic Analyte:	Concentration (ng/mg)
Naphthalene	750	Naphthalene	710
C1-Naphthalenes	1600	C1-Naphthalenes	1300
C2-Naphthalenes	2000	C2-Naphthalenes	1500
C3-Naphthalenes	1400	C3-Naphthalenes	1100
C4-Naphthalenes	690	C4-Naphthalenes	590
Fluorene	130	Fluorene	100
C1-Fluorenes	340	C1-Fluorenes	270
C2-Fluorenes	390	C2-Fluorenes	270
C3- Fluorenes	300	C3- Fluorenes	240
Dibenzothiophene	53	Dibenzothiophene	56
C1-Dibenzothiophenes	170	C1-Dibenzothiophenes	210
C2-Dibenzothiophenes	220	C2-Dibenzothiophenes	280
C3- Dibenzothiophenes	160	C3- Dibenzothiophenes	240
Phenanthrene	290	Phenanthrene	200
C1-Phenanthrenes	680	C1-Phenanthrenes	360
C2-Phenanthrenes	660	C2-Phenanthrenes	340
C3-Phenanthrenes	400	C3-Phenanthrenes	200
C4-Phenanthrenes	200	C4-Phenanthrenes	84
Anthracene	6.1	Anthracene	6.2
Fluoranthene	4.2	Fluoranthene	4.5
Pyrene	8.9	Pyrene	7.1
C1- Pyrenes	68	C1- Pyrenes	43
C2- Pyrenes	84	C2- Pyrenes	31
C3- Pyrenes	96	C3- Pyrenes	31
C4- Pyrenes	54	C4- Pyrenes	20
Naphthobenzothiophene	11	Naphthobenzothiophene	7.8
C-1 Naphthobenzothiophenes	48	C-1 Naphthobenzothiophenes	30
C-2 Naphthobenzothiophenes	37	C-2 Naphthobenzothiophenes	30
C-3 Naphthobenzothiophenes	22	C-3 Naphthobenzothiophenes	25
Benzo (a) Anthracene	5.5	Benzo (a) Anthracene	5.4
Chrysene	36	Chrysene	14
C1- Chrysenes	100	C1- Chrysenes	28
C2- Chrysenes	100	C2- Chrysenes	27
C3- Chrysenes	54	C3- Chrysenes	18
C4- Chrysenes	19	C4- Chrysenes	5.6
Benzo (b) Fluoranthene	2.3	Benzo (b) Fluoranthene	1.7
Benzo (k) Fluoranthene	1.8	Benzo (k) Fluoranthene	1.5
Benzo (e) Pyrene	6.6	Benzo (e) Pyrene	2.9
Benzo (a) Pyrene	1.0	Benzo (a) Pyrene	1.0
Perylene	0.92	Perylene	0.89
Indeno (1,2,3 - cd) Pyrene	0.20	Indeno (1,2,3 - cd) Pyrene	0.22
Dibenzo (a,h) anthracene	1.3	Dibenzo (a,h) anthracene	0.92
Benzo (g,h,i) perylene	1.2	Benzo (g,h,i) perylene	1.1
Total Aromatics	***11203***	***Total Aromatics***	***8394***

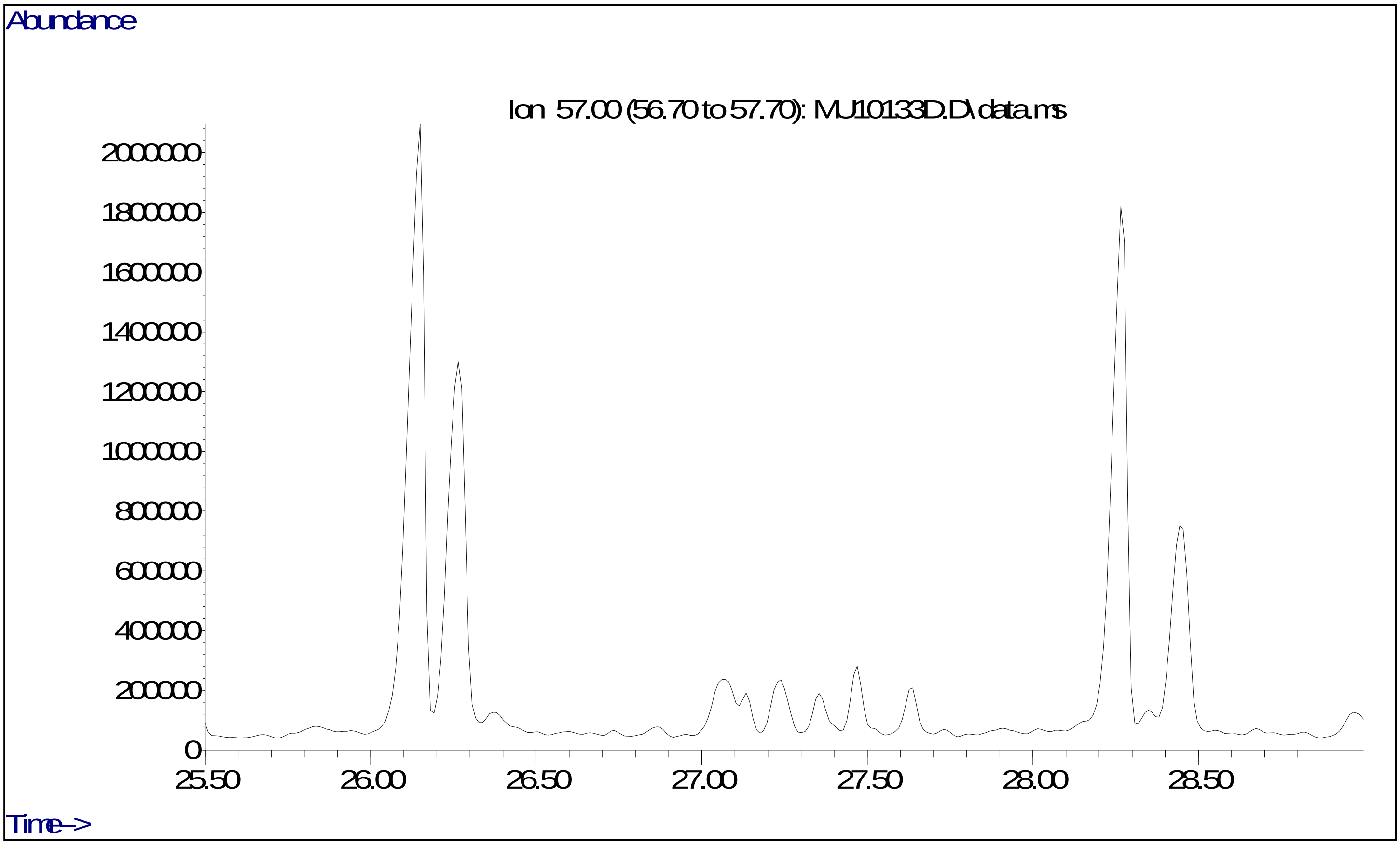
2010133-02 (Source Oil, Pre-spill) – TIC



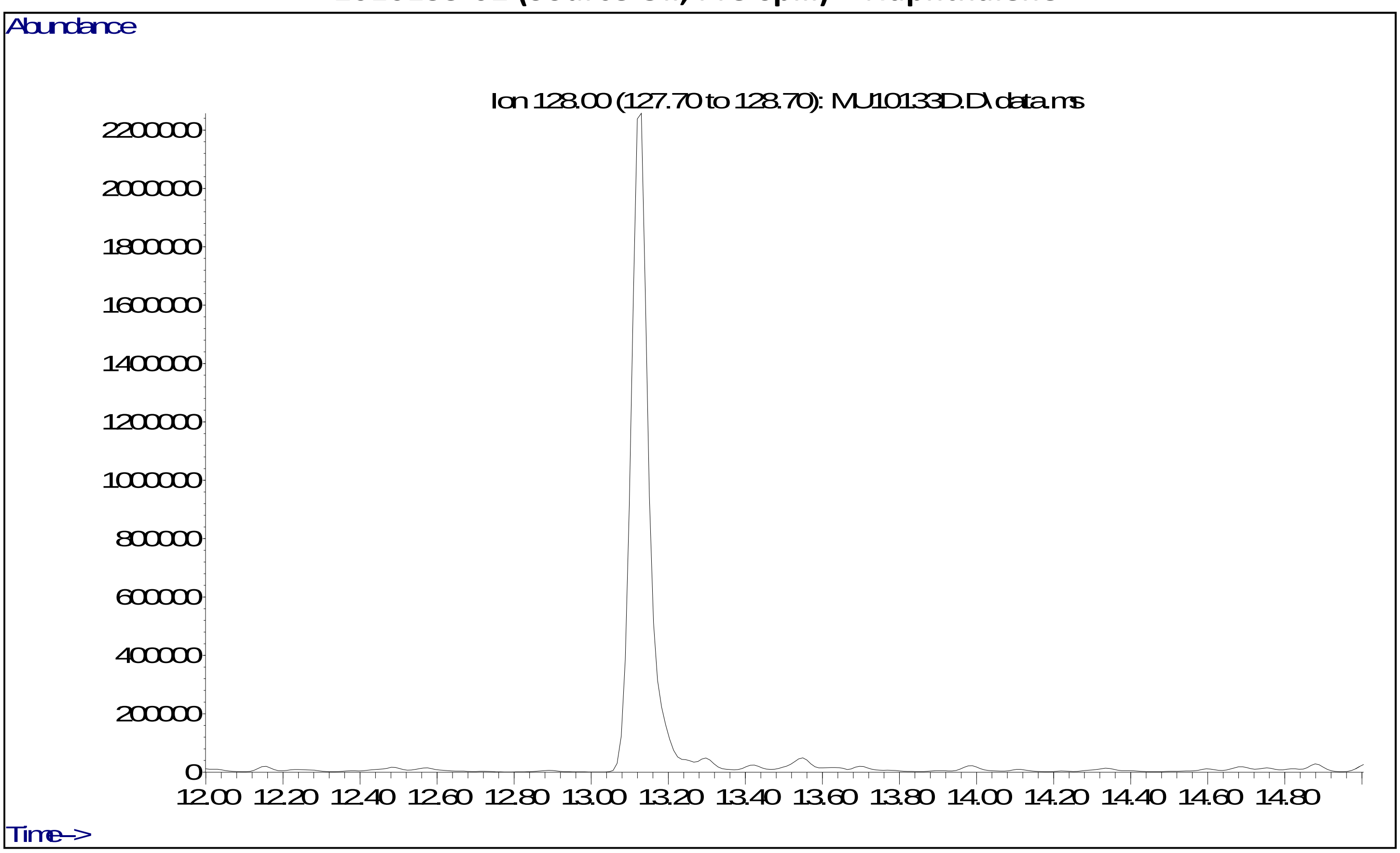
2010133-02 (Source Oil, Pre-spill) – Alkanes



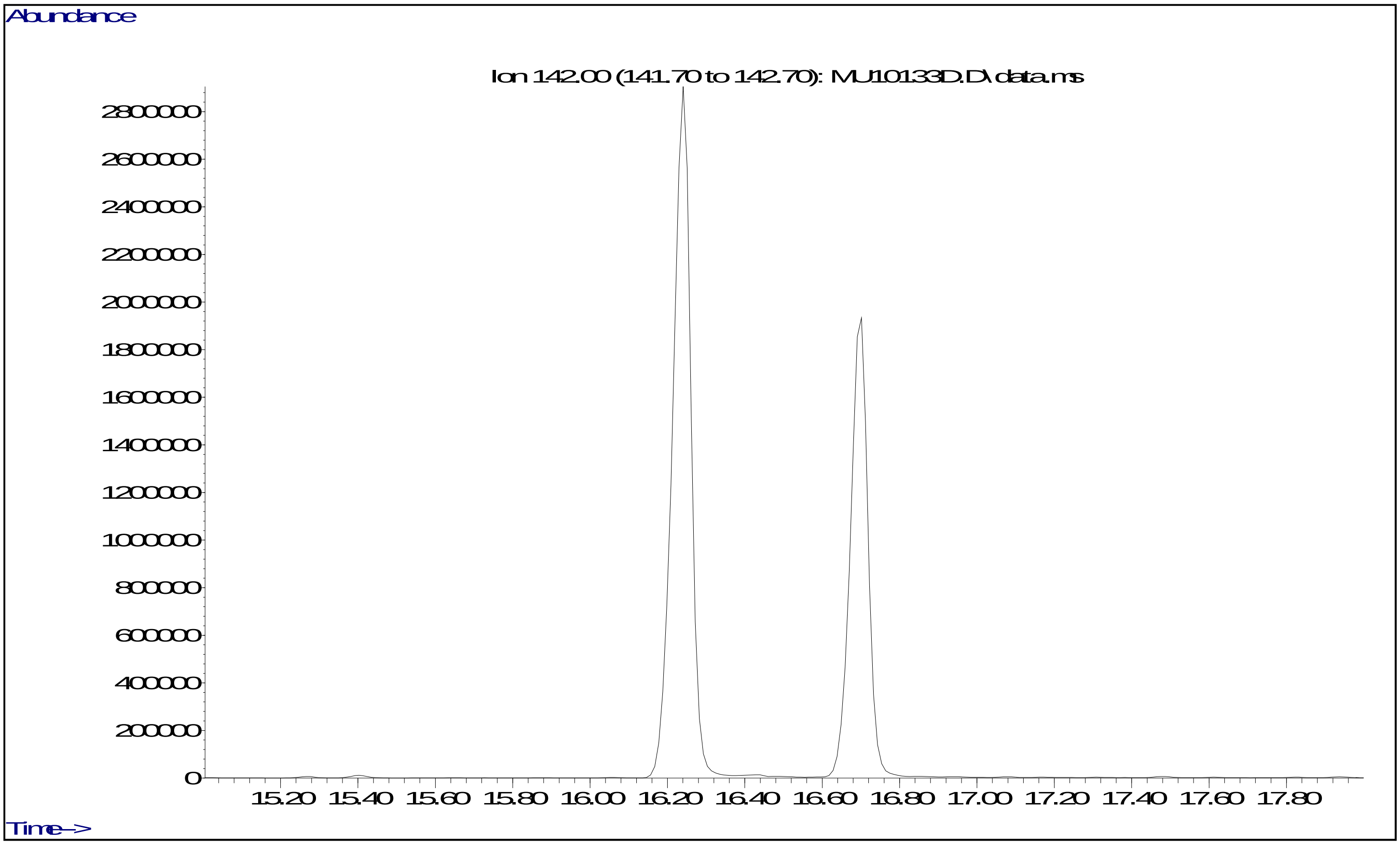
2010133-02 (Source Oil, Pre-spill) – C_{17}/Pristane, C_{18}/Phytane



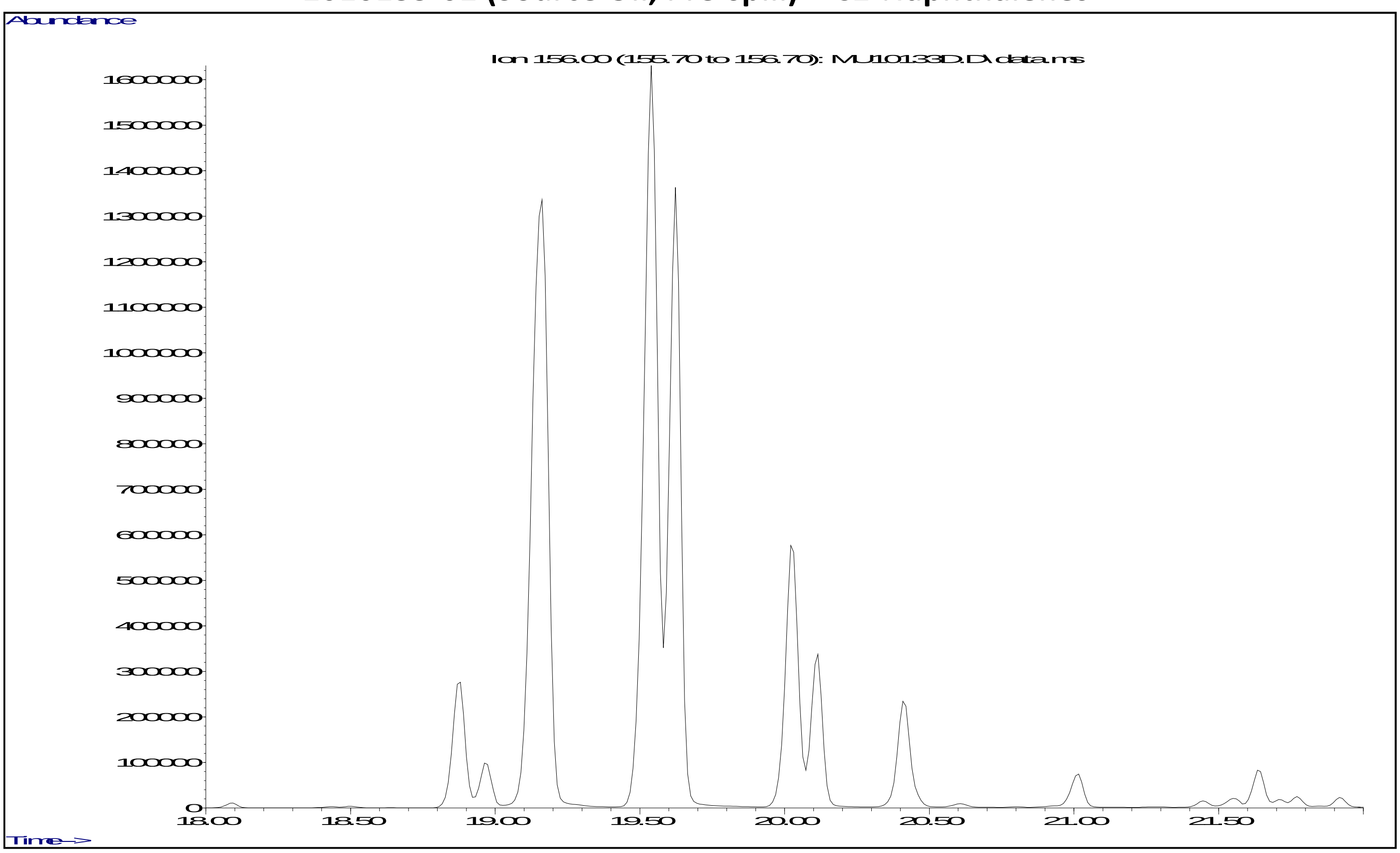
2010133-02 (Source Oil, Pre-spill) – Naphthalene



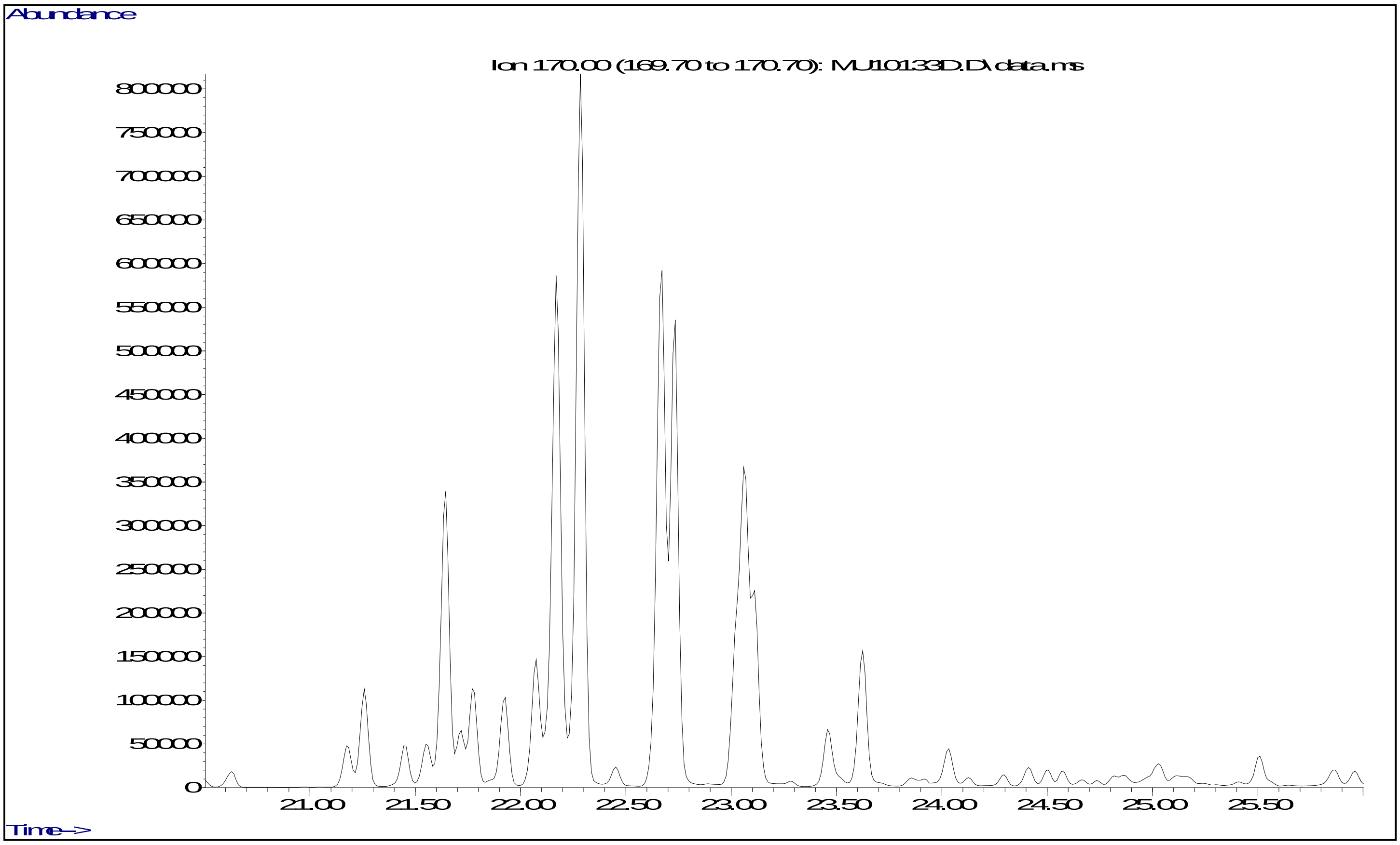
2010133-02 (Source Oil, Pre-spill) – C1-Naphthalenes



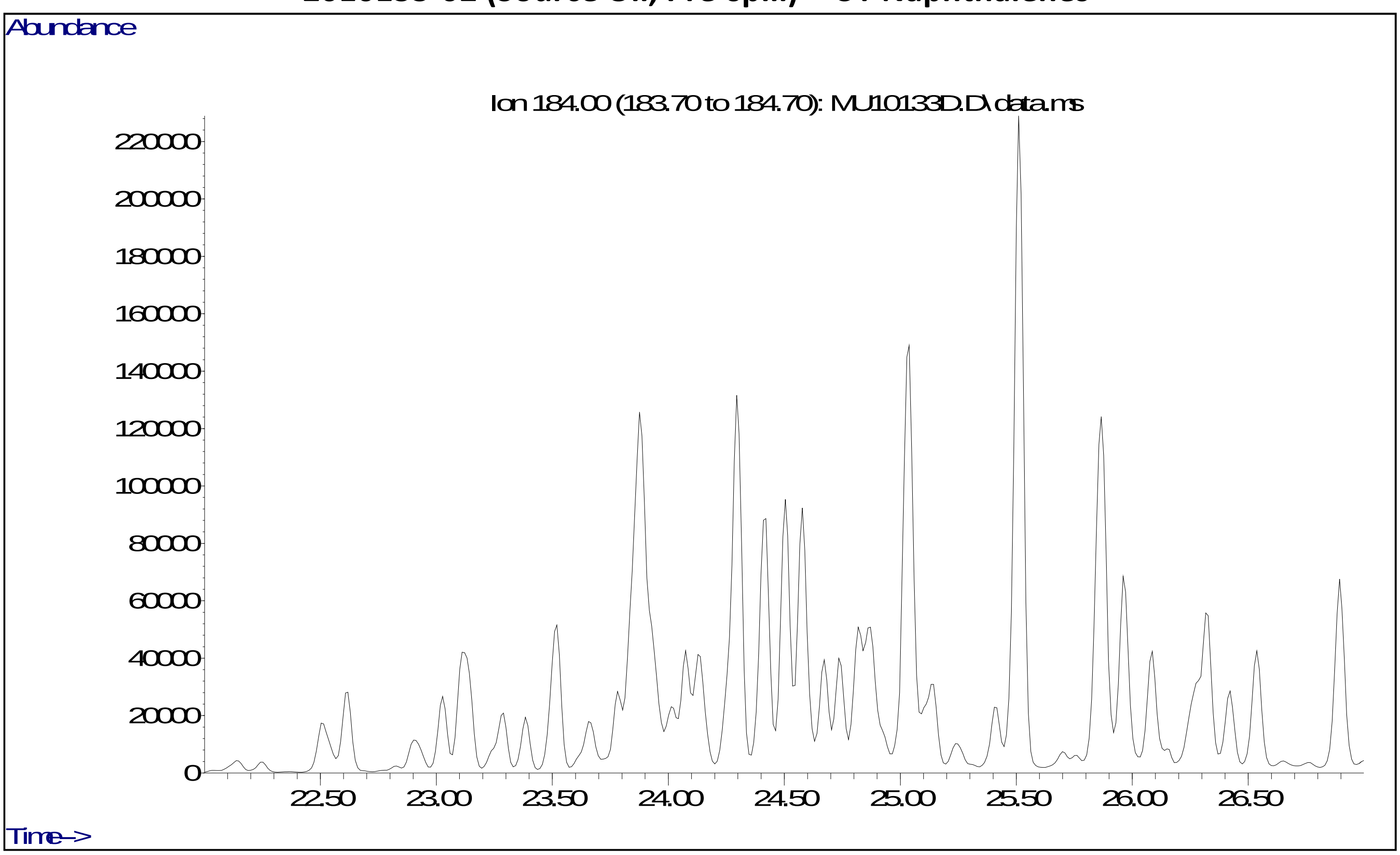
2010133-02 (Source Oil, Pre-spill) – C2-Naphthalenes



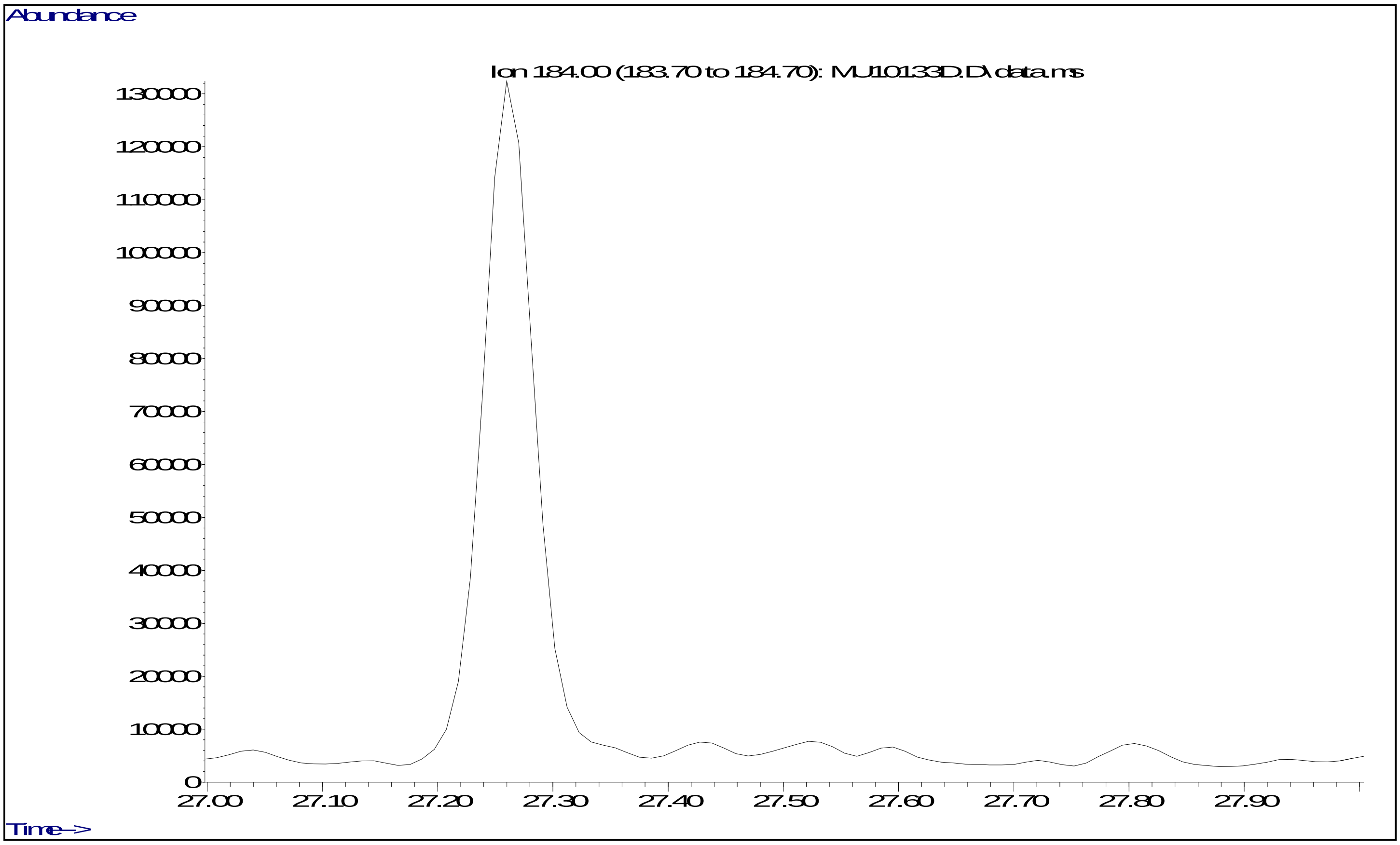
2010133-02 (Source Oil, Pre-spill) – C3-Naphthalenes



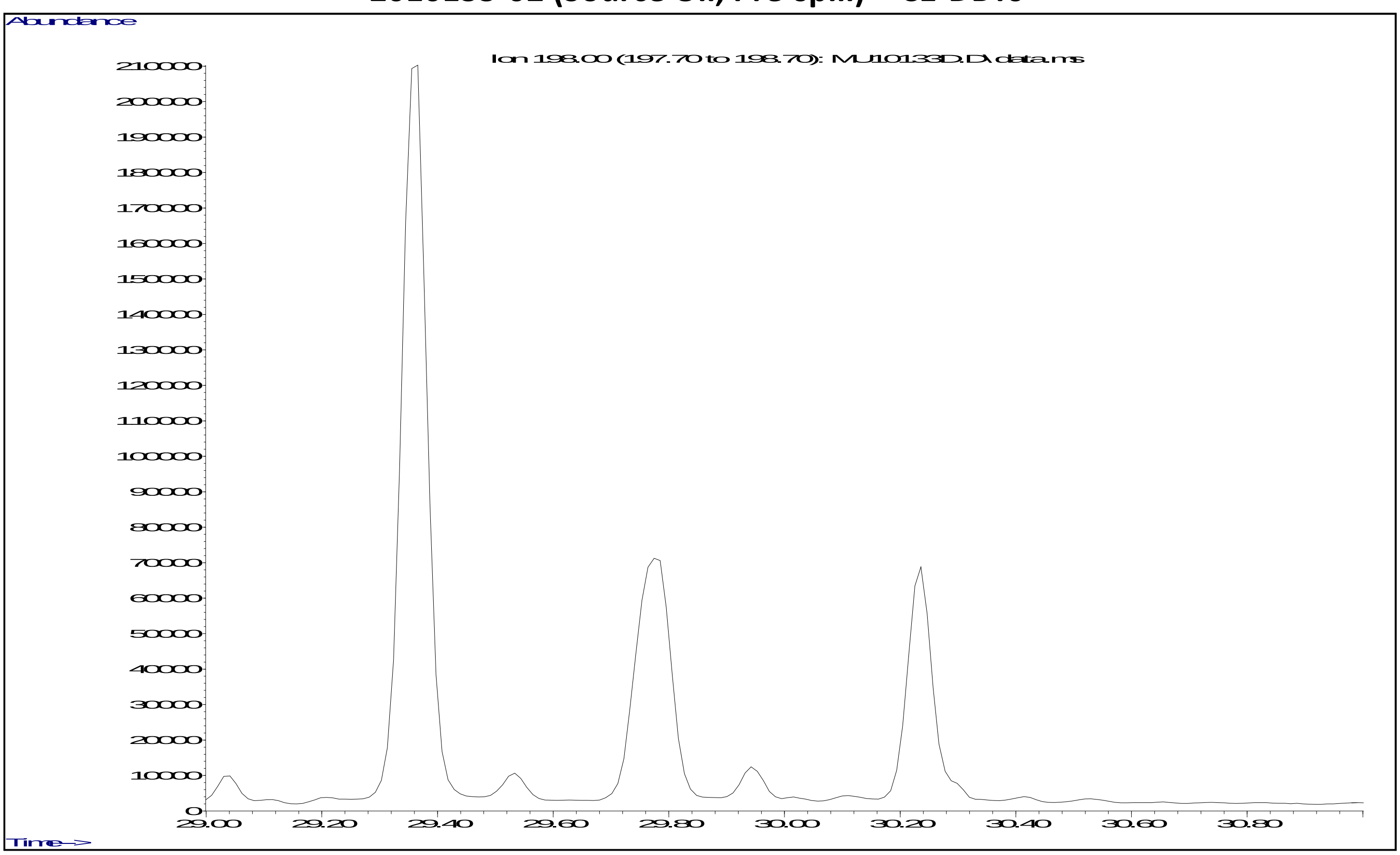
2010133-02 (Source Oil, Pre-spill) – C4-Naphthalenes



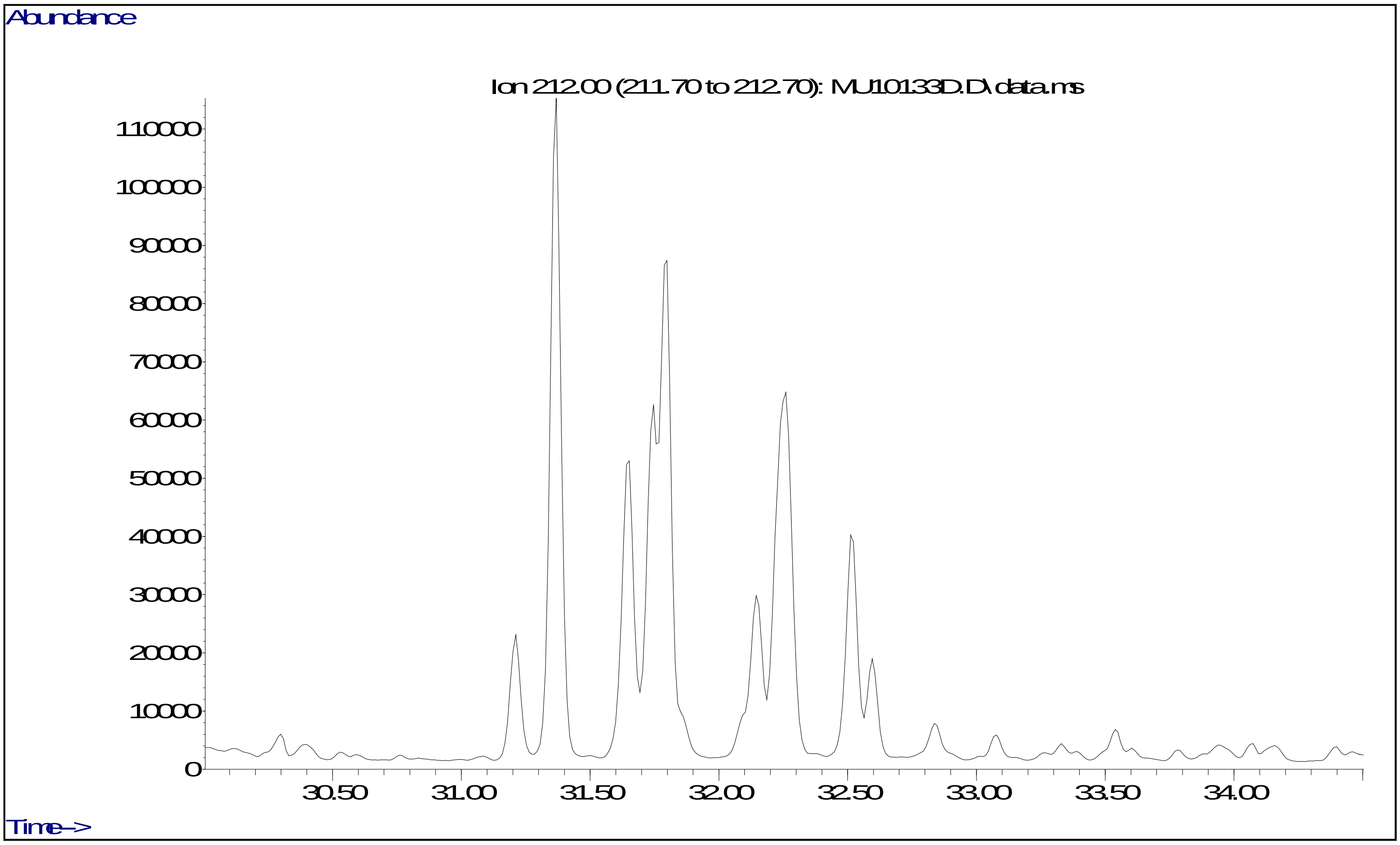
2010133-02 (Source Oil, Pre-spill) – DBT



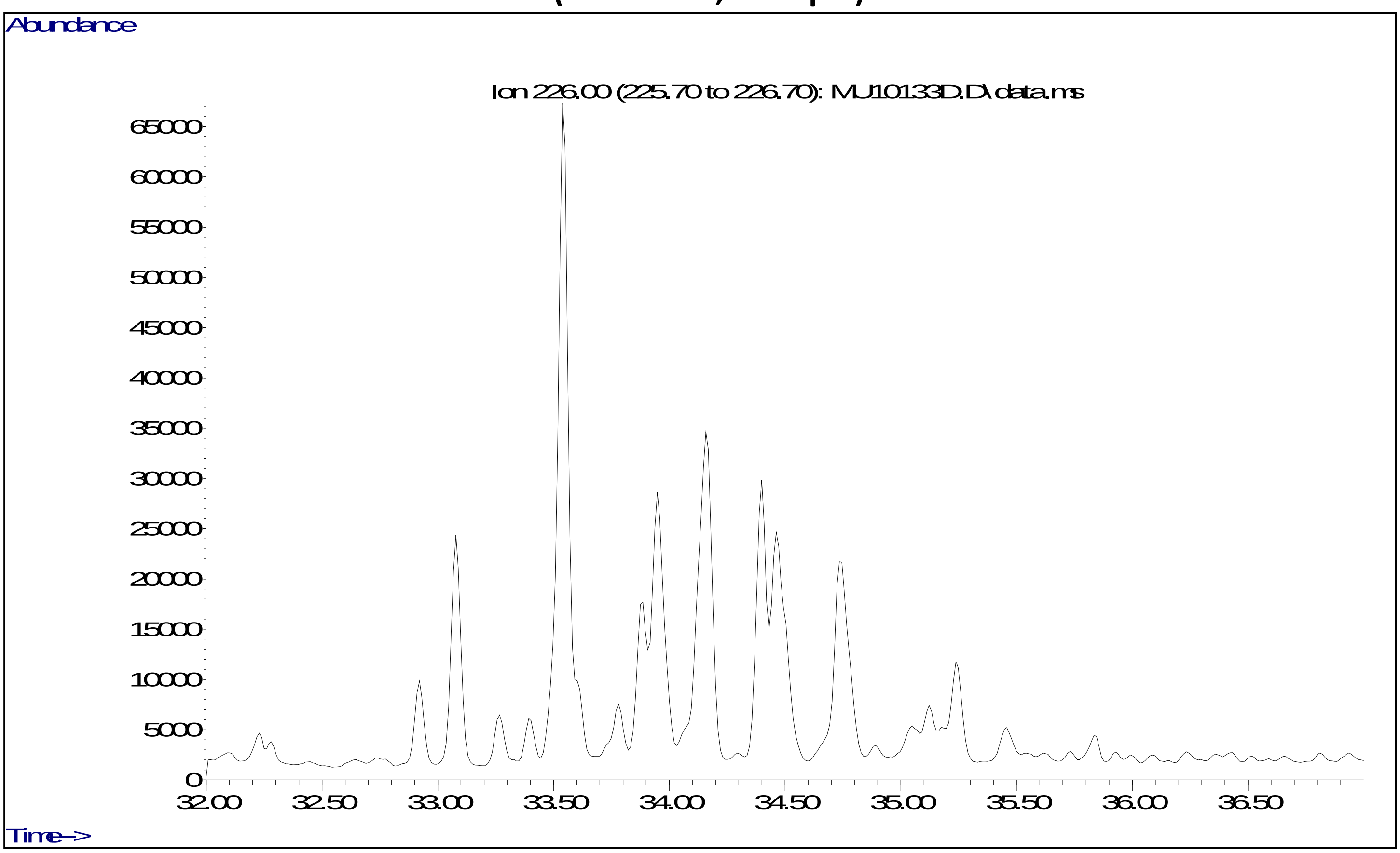
2010133-02 (Source Oil, Pre-spill) – C1-DBTs



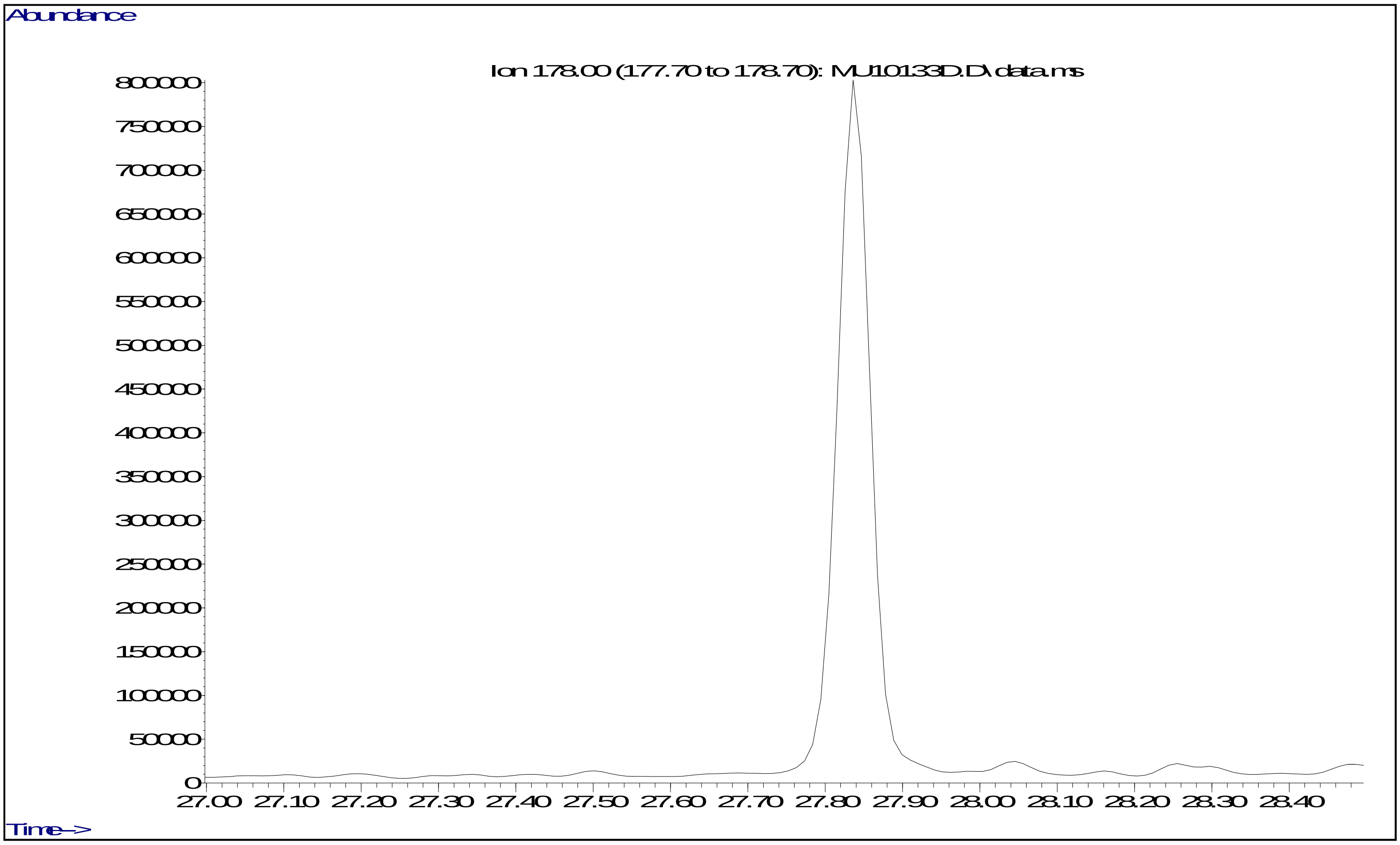
2010133-02 (Source Oil, Pre-spill) – C2-DBTs



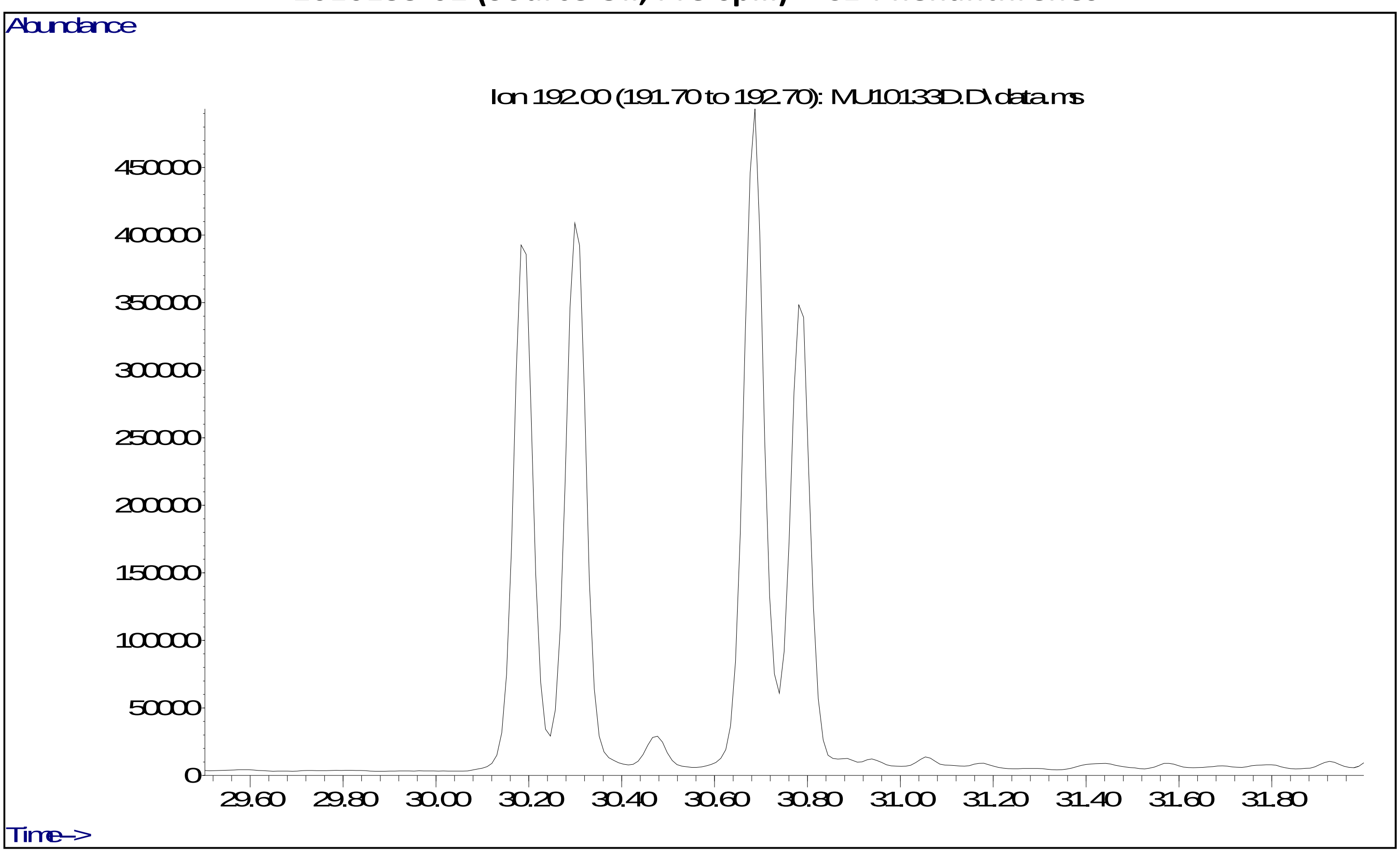
2010133-02 (Source Oil, Pre-spill) – C3-DBTs



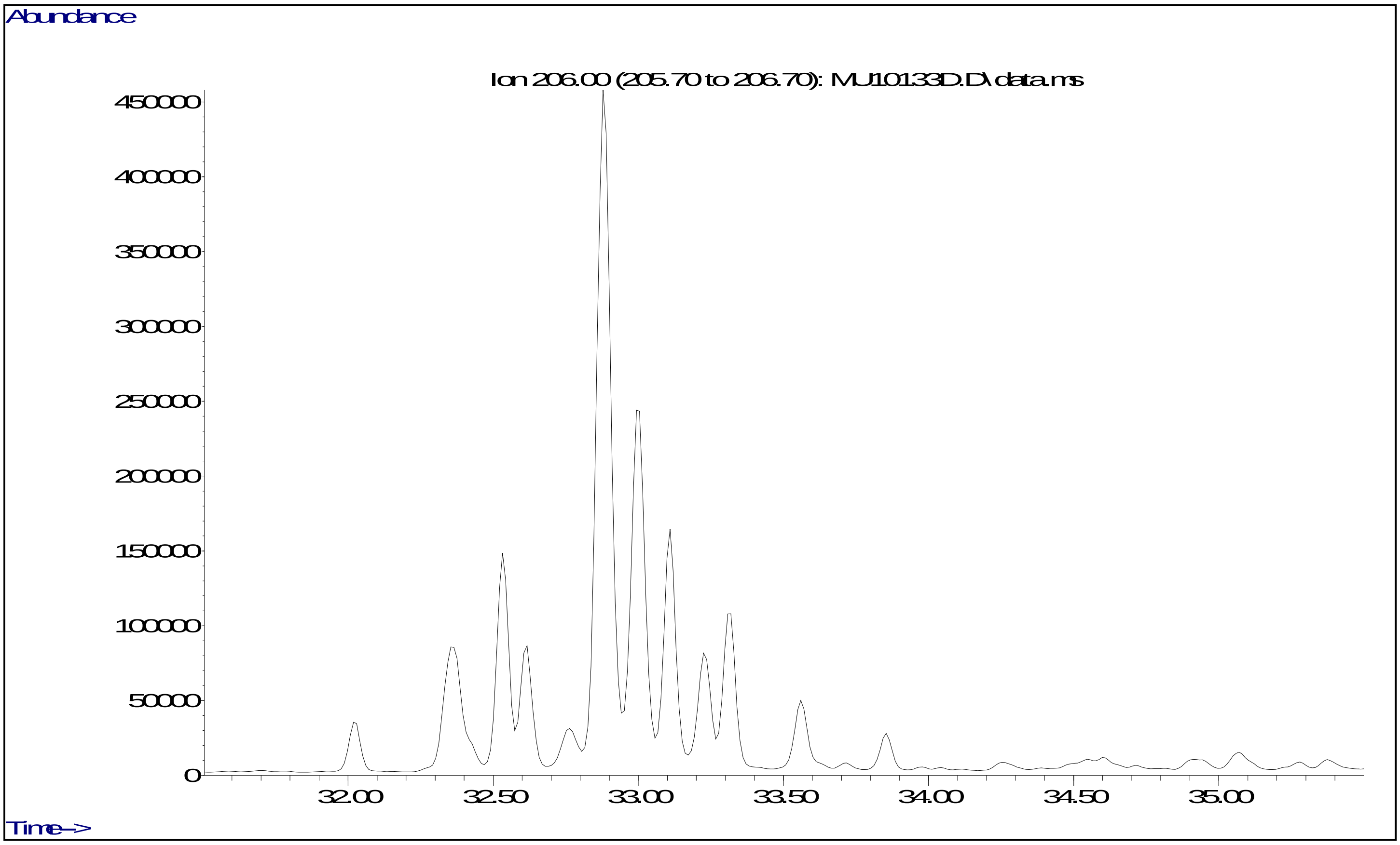
2010133-02 (Source Oil, Pre-spill) – Phenanthrene



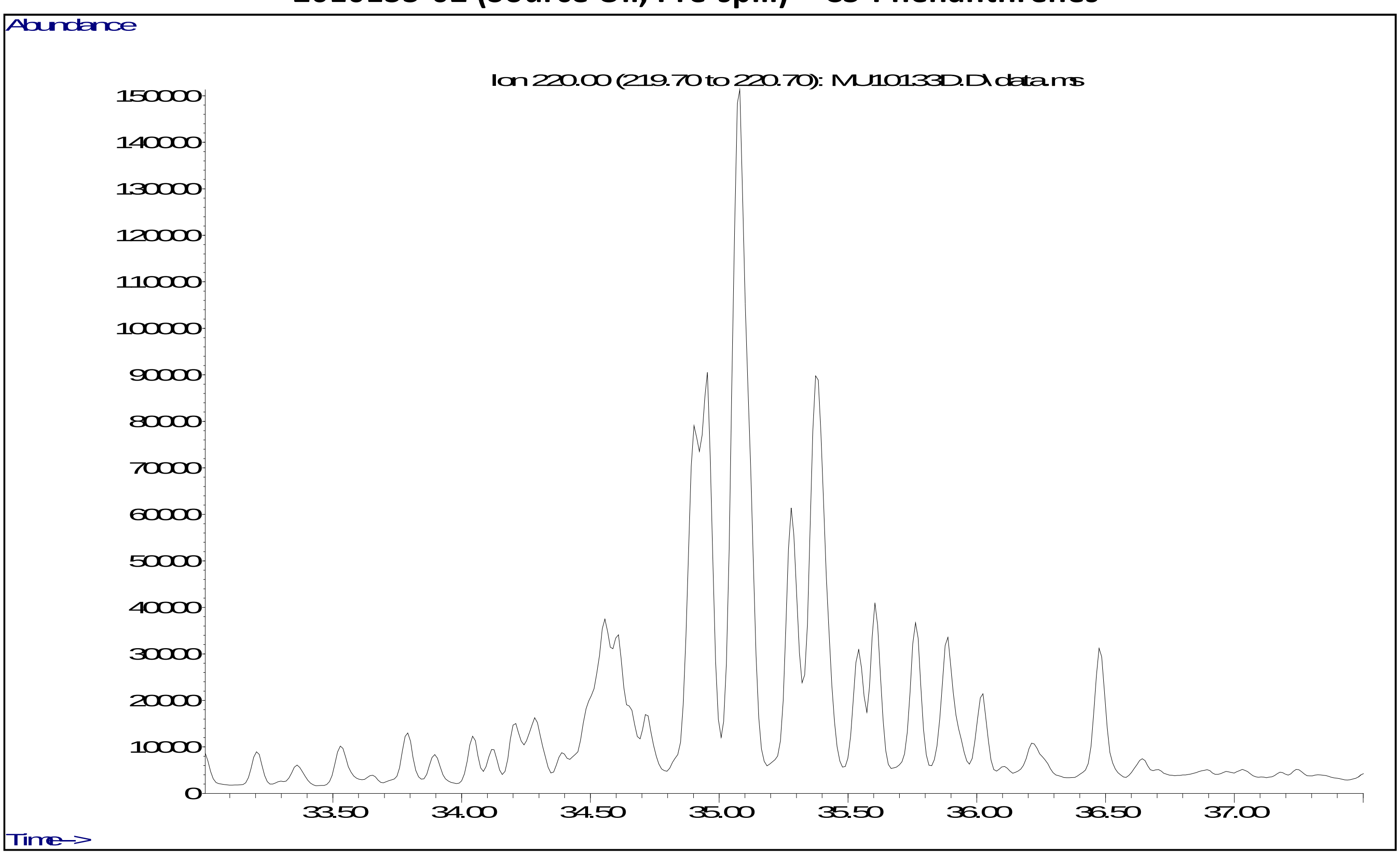
2010133-02 (Source Oil, Pre-spill) – C1-Phenanthrenes



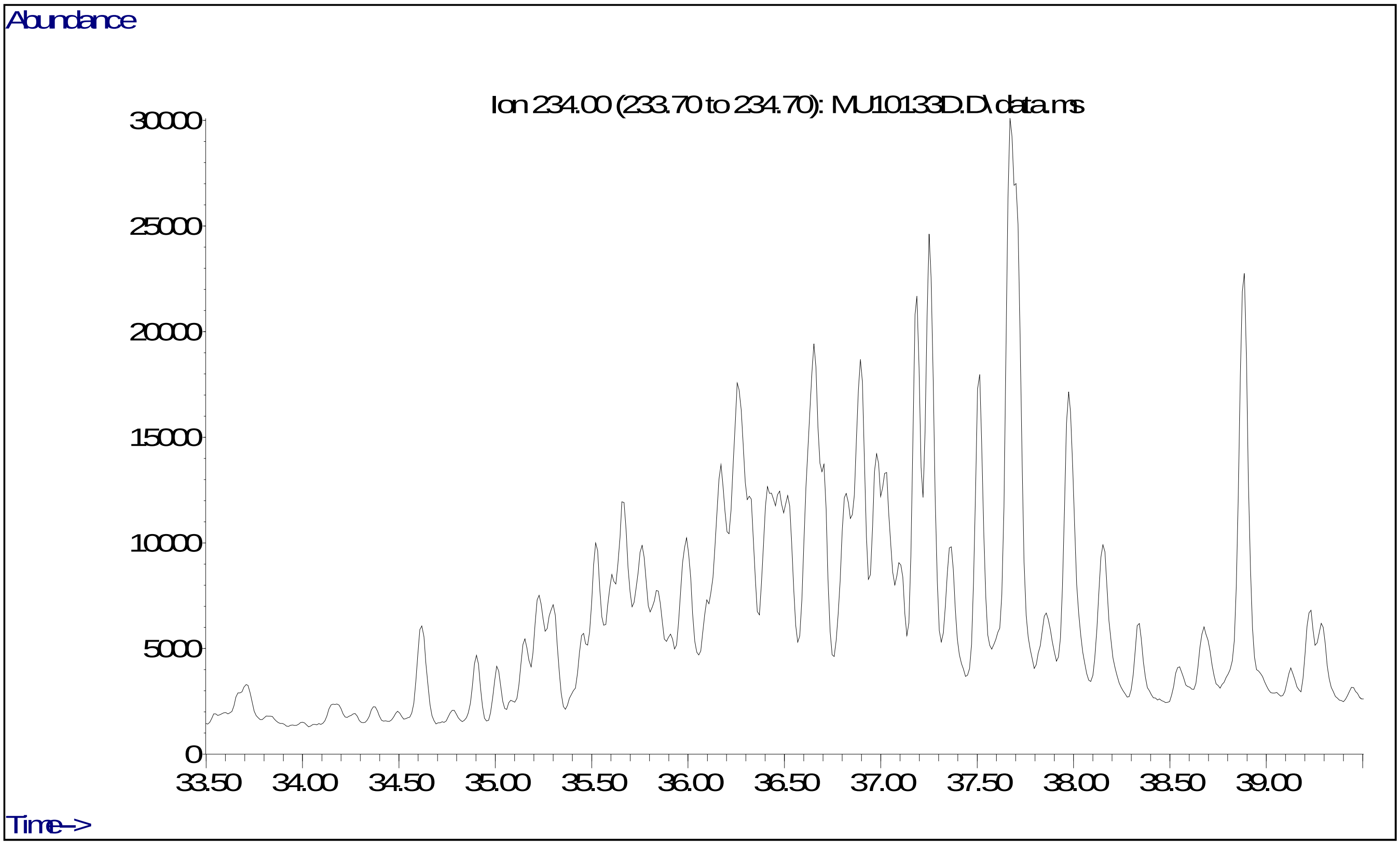
2010133-02 (Source Oil, Pre-spill) – C2-Phenanthrenes



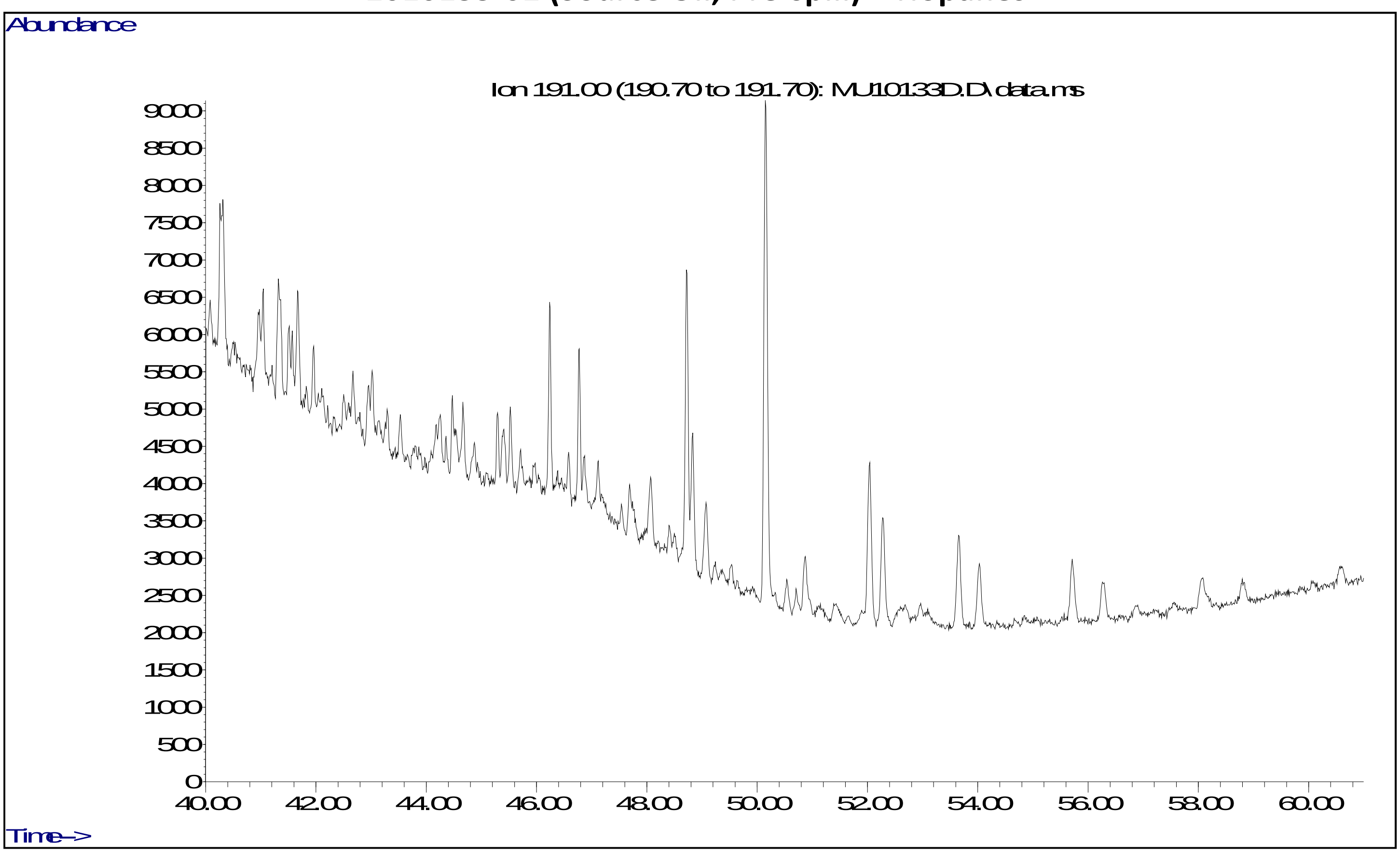
2010133-02 (Source Oil, Pre-spill) – C3-Phenanthrenes



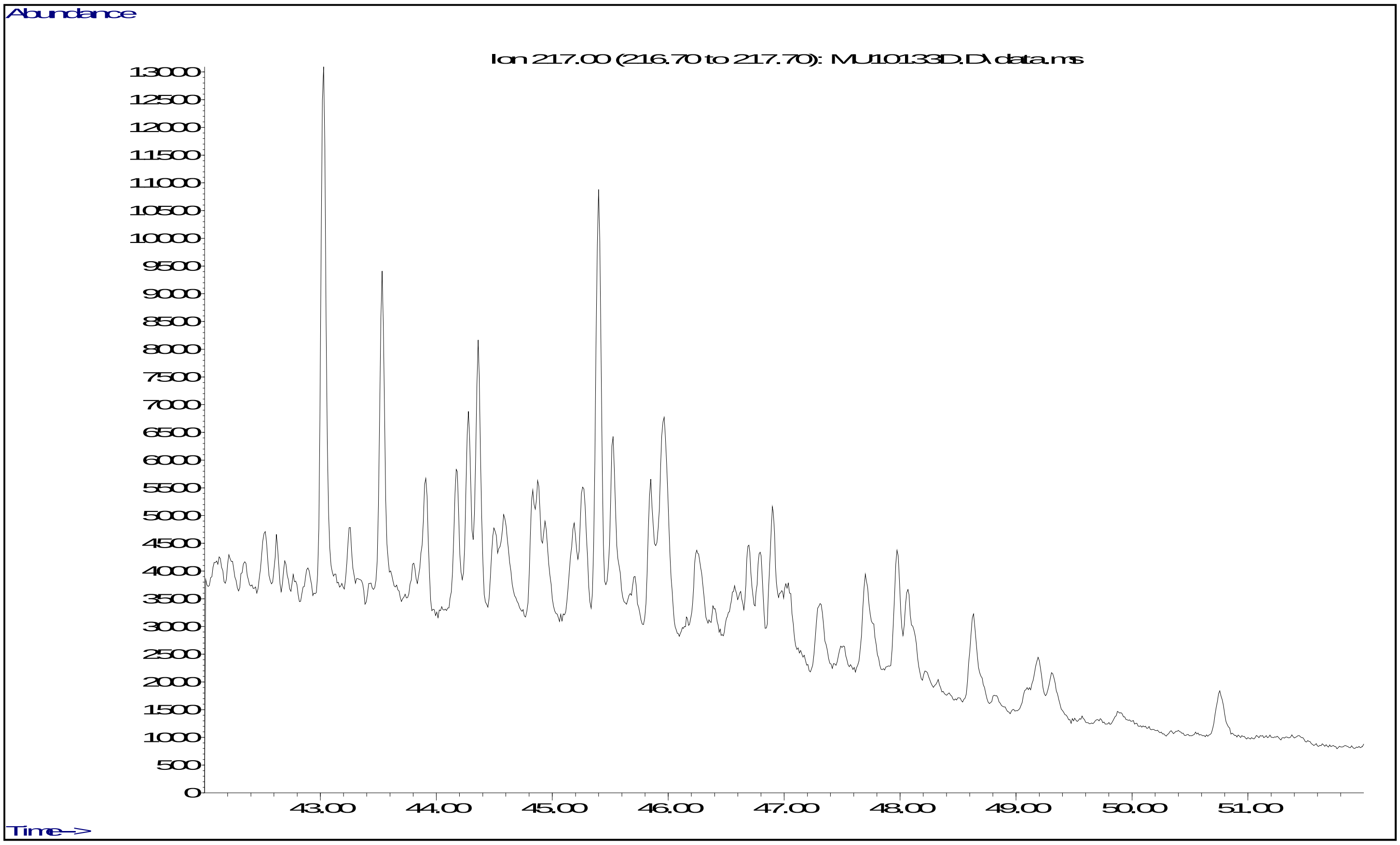
2010133-02 (Source Oil, Pre-spill) – C4-Phenanthrenes



2010133-02 (Source Oil, Pre-spill) – Hopanes



2010133-02 (Source Oil, Pre-spill) – Steranes



APPENDIX G

Welcome

Deepwater Horizon Dispersant Use Meeting

Deepwater Horizon Dispersant Use Meeting

May 26-27, 2010

Nancy E. Kinner
Coastal Response Research Center (CRRC)
UNH Co-Director

LOGISTICS

- Fire Exits
- Restrooms
- Location of breakout rooms
- Dining - breakfasts, lunches & snacks (outside meeting rooms)
- Evening Dinner:
  - Location: Mike Anderson's (directions on registration desk)
  - Cash bar available (beer and wine) - 6:30 pm
  - Buffet Dinner
- If you have any questions - check with staff at registration table

KEY CRRC STAFF

- Nancy Kinner - UNH Co-Director
- Joseph Cunningham - Research/Group Lead
- Zachary Magdol - Research/Group Lead
- Kathy Mandsager - Program Coordinator
- Heather Ballestero - Graduate Student/Recorder
- Mike Curry - Graduate Student/Recorder
- Tyler Crowe - Graduate Student/Recorder
- Joe Corsello - Undergraduate Student/Recorder
- Eric Doe - Undergraduate Student/Recorder

CRRC OVERVIEW

CRRC CREATION

- NOAA's Office of Response and Restoration (ORR)/UNH spill partnership in 2004
- Co-Directors:
  - UNH - Nancy Kinner
  - NOAA - Amy Merten
- Funding for oil spill research decreasing
  - Government
  - Private sector
- Many research needs exist regarding spill response, recovery and restoration

OVERALL MISSION

- Develop new approaches to response and restoration through research/synthesis of information
- Serve as a resource for ORR, NOAA and other agencies
- Serve as a hub for spill research, development and technical transfer for ALL stakeholders
  - Spill community (U.S. and internationally)

SPECIFIC CENTER MISSIONS

- Conduct and oversee basic and applied Research and outreach on spill response and restoration
- Transform research results into practice
- Educate/train students who will pursue careers in spill response and restoration

OUTREACH EFFORTS

- Workshops on hot topics to identify research priorities and partners
  - Dispersed Oil: Efficacy and Effects
  - Submerged Oil: State of the Practice
  - Human Dimensions of Spills
  - Dispersed Oil Research Forum
  - Integrated Modeling
  - PAH Toxicity
  - Environmental Response Management Application (ERMA®)
  - Environmental Response Data Standards
  - HEA Metrics Workshop
  - Opening the Arctic Seas: Envisioning Disasters & Framing Solutions
  - Oil Spill Research Needs
  - NRDA in Arctic Waters: The Dialogue Begins

CRRC DISPERSANT ACTIVITIES

- May 2005 - NRC Dispersed Oil Report
  - Highlighted need for R&D
- July 2005 - CRRC Hosted Dispersed Oil R&D Meeting
  - Federal & State Agencies, Industry, NGO's
- September 2005 - Dispersed Oil Workshop
  - 52 Participants Representing Cross Section of Stakeholders
  - 2006 R&D Needs Report Released

DISPERSANT R&D NEEDS IDENTIFED

- Chemical parameters that influence overall effectiveness
- Operational and hydrodynamic parameters that influence overall effectiveness
- Modeling integration of chemical, operational, and hydrodynamic parameters
- Fate of oil and dispersed oil in the water column and other habitats
- Realistic exposure regimes/toxicity testing
- Integration to make short and long term prediction of effects

DISPERSANT WORKING GROUP

- Formed to Coordinate Dispersants Research Funding
- ~26 Members - Major Funding Organizations
  - U.S. and International
- Public & Private Sector
  - Governmental Agencies, Industry, NGOs
- ~$8.3M in Dispersant R&D by DWG Members
- CRRC ~$2.4M - Focused on Transport, Behavior and Effects
  - NOAA Interests

DISPERSANTS WORKING GROUP

- Activity/Information on CRRC
  - www.crrc.unh.edu/dwg
- 2006 R&D Report
- 2007 Dispersants Forum Slides
- List of All Dispersants R&D Funded by DWG Members

Coastal Response Research Center 13

BACKGROUND FOR TODAY'S MEETING

- CRRC NRDA in Arctic Workshop: April 20-22, 2010
- April 20th DWH Blowout
- Dispersant Use - Large Volume
  - Aerial Sorties
  - Subsurface (5000 ft depth) Injection
- Largest Volume of Dispersants Ever Applied
- Unique Subsurface Injection into Plume at ~5000ft Depth

Coastal Response Research Center 14

STAKEHOLDER & PUBLIC CONCERN

- If Top Kill of Well Does Not Work This Week
  - Is Large Scale Aerial and Subsurface Dispersant Use Advisable for Another 2-2.5+ Months While Relief Well Is Completed?
  - What Monitoring Protocols Needed for Long-Term Use?

Coastal Response Research Center 15

CRRC ROLE IN TODAY'S DWH DISPERSANT MEETING

- CRRC History With Dispersants R&D
- CRRC Leadership of DWG
- CRRC: Independent and Honest Broker
  - NH not oil-producing state
  - UNH independent academic affiliation
  - Strong record of peer review
  - Known for bringing all stakeholders into discussions

Coastal Response Research Center 16

DWH DISPERSANT USE MEETING

- First Suggested Few Weeks Ago
- Should Be in a Gulf State
- Representatives of All Stakeholders
- Short Time Frame
- Final Clearance to go Forward = Saturday, May 20
  - ~96 hr Ago!!!!!!

PLANNING COMMITTEE

Carl Childs, NOAA ORR
Tom Coolbaugh, ExxonMobil
Dave Fritz, BP
Kurt Hansen, USCG, R&D Center
Charlie Henry, NOAA SSC
Bruce Hollebone, Environment Canada
Nancy Kinner, CRRC
Ken Lee, Fisheries & Ocean, Canada
Alan Mearns, NOAA ORR
Joe Mullin, MMS
Bob Pond, USCG HQ
Nat Scholz, NOAA,NMFS
Al Venosa, EPA

NATURAL RESOURCE FOCUS OF SPILL RESPONSE

- Minimize Damage to Natural Resources
- Focus on Individuals, Populations, Habitats, Ecosystems
- Question of Acute and Chronic Effects
- Therefore Need to Know Exposure Pathways
- Need to Know Contaminant Concentrations Biota Exposed to and Exposure Duration

CONCENTRATION AND TIME

- Based on Physical Transport and Chemical Behavior
  - Which is Based on Dispersant Efficacy and Effectiveness

FRAMEWORK OF DISCUSSION

Acute and Chronic Effects
Individuals → Populations

Attendant Habitat and Ecosystem Effects

↑

Physical Transport and Chemical Behavior

↑

Dispersant Efficacy and Effectiveness

MEETING GOALS

- Bring Together Experts on Biological Effects, Physical Transport and Chemical Behavior, and Dispersant Efficacy and Effectiveness
  - Scientists, Engineers, Practitioners
- Goal to Inform RRTs as They Make Decisions about When, Where and How to Use Dispersants in DWH Incident

MEETING GOALS

- Provide input to the Region 4 and Region 6 Regional Response Teams (RRT) on the use of dispersants going forward in DWH Incident
  - Also for Future Spill Responses
- Identify possible monitoring protocols in the event of continuing aerial and subsurface dispersant application

MEETING STRUCTURE

- **Wednesday AM plenary session overviews**
  - **1:15** Breakout Session I
  - **3:15** Break
  - **4:15** Plenary Session: Group Reports
  - **5:15** Wrap-Up
  - **5:30** Adjourn
- **Thursday**
  - **8:00** Continental Breakfast
  - **8:20** Overview and Review/Recalibrate
  - **8:30** Breakout Session II
  - **10:00** Break (as necessary)
  - **11:15** Plenary Session: Breakout Group Reports
  - **12:15** Lunch
  - **1:00** Plenary Session: Development of Recommendations and Protocols for RRTs and Next Steps
  - **4:30** Adjourn

MEETING STRUCTURE

- **Breakout Groups- Wednesday PM and Thurs AM**
  - *Group A: Dispersant efficacy and effectiveness* **Leader: Joe Cunningham, CRRC**
  - *Group B: Physical Transport/ Chemical Behavior of dispersed oil* **Leader: Bruce Hollebone, Environment Canada**
  - *Group C: Biological effects of dispersants on species with commercial interest* **Leader: Zach Magdol, CRRC**
  - *Group D: Biological effects of dispersants on non commercial species*

MEETING STRUCTURE

- **Wednesday AM Breakout Questions**
  - What do we need to know in order to give input regarding dispersant operations and to identify possible monitoring protocols?
  - What is the current state of knowledge regarding the DWH spill?
  - What are the gaps in our knowledge or information?
    - Can these gaps be addressed using information from past experience and/or the literature?
    - If not, what information should be collected in the short and long term?

Meeting Structure

- **Thursday AM Breakout questions**
  - Develop input for RRTs on aerial and subsurface dispersant use if the DWH release continues
    - What are the tradeoffs (risks/benefits) associated with this input?
  - Identify possible monitoring protocols in the event of continuing dispersant use.

MEETING STRUCTURE

- **Thursday PM- Plenary Session**
  - **Consensus on input to RRTs**
    - **Noting all views in discussion**
  - **Consensus on monitoring protocols**
    - **Noting all views in discussion**
  - **Next steps including R&D needs**
    - **Noting all views in discussion**

CRRC MEETING REPORT

- Report with input on use of dispersants going forward and suggested monitoring protocols
- Report contents include:
  - Participant list
  - Recorders notes
  - Group report out presentations
  - Plenary slide presentations

MEETING IS NOT MEDIA EVENT

- Dispersant use is “hot” media topic
- Meeting of Best Expertise on Inform RRTs as They Continue to Make Decisions about Dispersant Use
- Meeting only open to participants
  - Working meeting
  - Not public forum on dispersant use

“CIVIL” DISCUSSION

- LISTEN, LISTEN, LISTEN
- Speak forthrightly, not dismissively
- Be sure everyone gets heard
- Use language carefully and precisely
- Work hard, Stay loose

FINAL GUIDANCE

- We must give input to RRTs regarding dispersant use going forward
- Real world situation
  - Not table top exercise
- RRTs must make decision on if and how to continue dispersant use if “top kill” does not work
- Decision even if field and lab data are not conclusive

QUESTIONS ABOUT AND DISCUSSION OF MEETING FORMAT AND GOALS?

Coastal Response Research Center

33

Coastal Response Research Center Website

www.crrc.unh.edu

University of New Hampshire

Coastal Response Research Center

NOAA

34

PARTICIPANT INTRODUCTIONS

- **Name**
- **Affiliation**
- **Expertise**

Coastal Response Research Center

35

GOOD MORNING!

Deepwater Horizon Dispersant Use Meeting Day 2

Coastal Response Research Center

36

BREAKOUT GROUPS

- *Group A1: Dispersant efficacy and effectiveness : Deep Ocean* **Leader: Joe Cunningham, CRRC**
- *Group A2: Dispersant efficacy and effectiveness : Surface* **Leader: Nancy Kinner, CRRC**
- *Group B: Physical Transport/ Chemical Behavior of dispersed oil* **Leader: Bruce Hollebone, Environment Canada**
- *Group C: Biological effects of dispersants Deep Ocean* **Leader: Zach Magdol, CRRC**
- *Group D: Biological effects of dispersants: Surface Water Group Leader Nichole Rutherford, NOAA*

Coastal Response Research Center 37

EFFICACY AND EFFECTS

- **Surface BIG ROOM**
  - Tom Coolbaugh
  - J.T. Ewing
  - Chantal Guenette
  - Ann Hayward Walker
  - Ed Levine
  - Joe Mullin
  - Duane Newell
  - Kelly Reynolds
- **Deep Ocean**
  - Craig Carroll
  - Per Daling
  - Ben Fieldhouse
  - Lek Kadeli
  - Paul Kepkay
  - Zhengkai Li
  - Bob Pond
  - Al Venosa

Coastal Response Research Center 38

MEETING GOALS

- Provide input to the Region 4 and Region 6 Regional Response Teams (RRT) on the use of dispersants going forward in DWH Incident
  - Also for Future Spill Responses
- Identify possible monitoring protocols in the event of continuing aerial and subsurface dispersant application

Coastal Response Research Center 39

FINAL GUIDANCE

- We must give input to RRTs regarding dispersant use going forward
- Real world situation
  - Not table top exercise
- RRTs must make decision on if and how to continue dispersant use if "top kill" does not work
- Decision even if field and lab data are not conclusive

Coastal Response Research Center 40

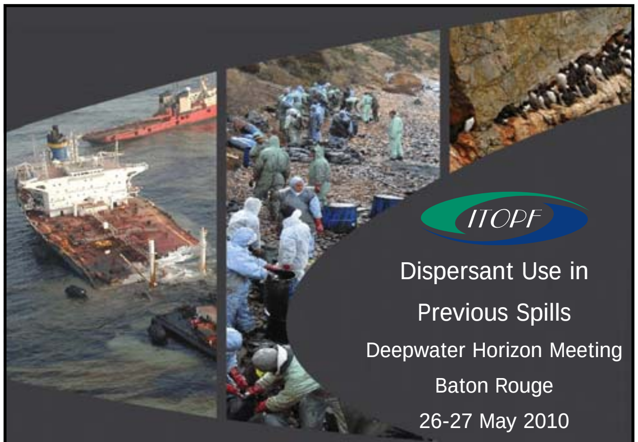
MEETING STRUCTURE

- **Thursday**
  - **8:00** Continental Breakfast
  - **8:20** Overview and Review/Recalibrate
  - **8:30** Breakout Session II
  - **10:00** Break (as necessary)
  - **11:15** Plenary Session: Breakout Group Reports
  - **12:15** Lunch
  - **1:00** Plenary Session: Develop Input and Protocols for RRTs and Next Steps
  - **4:30** Adjourn

Meeting Structure

- **Thursday AM Breakout questions**
  - Develop input for RRTs on aerial and subsurface dispersant use if the DWH release continues
    - What are the tradeoffs (risks/benefits) associated with this input?
  - Identify possible monitoring protocols in the event of continuing dispersant use.

QUESTIONS ABOUT AND DISCUSSION OF MEETING FORMAT AND GOALS?



Dispersant Use in Previous Spills

Deepwater Horizon Meeting

Baton Rouge

26-27 May 2010

INTRODUCTION TO ITOPF

- Established in 1968 after Torrey Canyon to administer TOVALOP
- Specialised technical advisory role began in early 1970's
- Main role is to provide advice on marine spills of oil & chemicals
- Primarily maintained by shipping industry & their P&I Insurers
- Operates as a non-profit making organisation
- Based in London but provides a global service

Role of ITOPF

ITOPF RESOURCES

- Collectively more than a century of hands-on experience of spills
- Attendance at over 600 incidents in 90 countries since 1972
- Worldwide network of contacts built over 40 years of history
- Comprehensive technical library and databases on oil & chemical spills
- 25 staff with 13 technical advisers on call 24 hrs a day

Role of ITOPF

RECENT INCIDENTS ATTENDED (JAN 09 – MAY 10)

Date of Incident	Vessel	Tanker	Location	Country	Spill type	Estimated Amount spilled
28/01/2009	ASSALAMA	N	Tarfaya	Morocco	None	None
13/02/2009	DUNLIN ARROW	N	Touched Bottom	Dominican Republic	IFO 380	40 m^3
20/02/2009	MARINE STAR	N	off Sakaide,	Japan	HFO	3.5 - 6 m^3
11/03/2009	PACIFIC ADVENTURER	N	Brisbane	Australia	IFO 380, Ammonium Nitrate	230 - 270 m^3 + 31 Containers
20/06/2009	ISOLA VERDE	Y	Izmir	Turkey	Fuel oil: M-100	10 m^3
27/06/2009	MARTI PRINCESS	N	Off Island Bozcaada	Turkey	None	None
14/07/2009	YM INCEPTION	N	Port Said	Egypt	Bunker	6.8 m^3
31/07/2009	FULL CITY	N	Langesund	Norway	IFO 180	200 m^3
07/08/2009	W-O BUDMO	Y	Heng Chun	Taiwan	None	None
08/08/2009	XIN DONG GUAN 3	N	Johor Bahru	Malaysia	IFO 380	10 m^3
26/08/2009	GULSER ANA	N	Faux Cap	Madagascar	IFO 180, Rock Phosphate	600 m^3, unknown
27/08/2009	CABO PILAR	Y	Madre De Deus	Brazil	IFO 380	50 m^3?
15/09/2009	AGIOS DIMITRIOS	N	Gaolan Do	China	IFO 380	50 m^3
02/10/2009	MV RED ROSE	N	Port of Dunkirk	France	IFO 380	20 m^3
23/10/2009	MV MARSTAN	N	Port of Hamburg	Germany	IFO 180	8 m^3
24/10/2009	LOWLANDS PROSPERITY	N	Caofeidian	China	HFO	126 m^3
28/10/2009	MSC SHENZHEN	N	Algeciras	Spain	IFO 380	280 m^3
01/11/2009	ZOORIK	N	Luhuashan,	China	IFO 180	500 m^3
05/12/2009	AFFLATUS	N	Weihai	China	IFO 380	Unknown
31/12/2009	SAMHO HERON	N	Off Imabara	Japan	Lube Base Oil S-96	300 m^3
05/01/2010	FURNESS MELBOURNE	N	El Jadida	Morocco	None	None
12/01/2010	HUASCO	N	Arica	Chile	IFO 180	4-5 m^3
24/01/2010	EAGLE OTOME	Y	Port Arthur	USA	Olmeca Crude-Sour	1400 m^3
26/01/2010	SEA ANGEL	N	Penghu Island,	Taiwan	Bunker	Unknown
19/02/2010	CMA CGM STRAUSS	N	Genoa	Italy	HFO 500	180 m^3

SPILLS INVOLVING THE USE OF DISPERSANTS (1995 – Present)

Date	Vessel	Location	Oil type	Approx. Spill Volume	Air/Vessel Application	Conditions
10/07/1995	IRON BARON	Australia	HFO	450te	?	winter
22/07/1995	SEA PRINCE	S Korea	mixed Arabian crude oils	1,400te	A	Strong shoreward winds
03/08/1995	YEO MING	S Korea	HFO	40te	?	
17/11/1995	HONAM SAPPHIRE	S Korea	Arabian Heavy crude	1,000te	Both	In berth
15/02/1996	SEA EMPRESS	UK	Forties Crude	76,000te	A	Entrance to dock
25/03/1996	LIVERPOOL BAY	Saudi Arabia	HFO	257te	V	outside port
09/08/1996	KRITI SEA	Greece	Arabian Light Crude	20-30te	V	
02/12/1996	TAIYOUNG JASMIN	S Korea	HFO, marine diesel & lube	<160te	V	50m deep
02/01/1997	NAKHODKA	Japan	IFO 180	6,200 - 8,000te	A	200m from shore (bow section)
08/02/1997	SAN JORGE	Uruguay	Canadon Seco crude	5,000te	Both	19 miles from shore, grounded
03/04/1997	OSUNG NO.3	Rep. of Korea	HFO	1,700te on board	V	70m deep
02/07/1997	DIAMOND GRACE	Japan	Umm Shaif (Abu Dhabi) light	500te	V	In bay and port
07/08/1997	KATJA	France	HFO	190te	V	In port, reaching beaches & marina
17/08/1997	MUTIARA	Indonesia	Sangatta crude	40-150te	V	
15/10/1997	EVOIKOS	Singapore	HFO		?	Tropical, 20-50m deep
18/09/1998	PRINCESS OF THE ORIENT	Philippines	Fuel oil (mostly HFO)	600te on baord	?	
15/10/1998	CHUN IL	Japan	Diesel and HFO	15te of each	?	Grounding
22/07/1999	MARY ANNE	Philippines	IFO	711te	V	57m deep

PREVIOUS DISPERSANT USE

SPILLS INVOLVING THE USE OF DISPERSANTS (1995 – present)

Date	Vessel	Location	Oil type	Approx. Spill Volume	Air/Vessel application	Conditions
24/07/1999	Irish Sea	Chile	IFO	40-100te	V	cold
24/01/2000	AL JAZIAH	UAE	Fuel oil (?)	100-200te	?	Nr port, 5m deep
22/06/2000	TREASURE	S Africa	fuel and lube oils	200te +	V	
29/08/2000	NORDLAND	Greece	IFO 180	110te	?	
03/10/2000	NATUNA SEA	Singapore	Nile Blend crude	7,000te	Both	
20/12/2000	RANDGRID	UK	Heidrun crude	12-15te	V	
10/07/2001	LUC NAM	India	IFO180, marine diesel & lube	<100te	V	Warm water
15/01/2002	EASTERN FORTITUDE	Thailand	IFO180	240te	V	
31/03/2002	AI GE	Japan	Heavy Bunker oil and LFO	115te	V	Cold, 12 miles out, open water
31/03/2002	AGATE	Singapore	Waxy Indonesian Crude	128te	?	Cold
12/06/2002	NEPTANK VII	Singapore	IFO 380	300te	V	
23/11/2002	TASMAN SEA	China	Brunei Crude Oil (light, volatile)	160-350te	V	Warm, moderate winds, 25m deep
27/07/2003	TASMAN SPIRIT	Pakistan	Iranian cude	30,000te	A	Near port
04/08/2003	ALMA ATA	Colombia	Coal and HFO 380	168te	Both	warm
22/02/2004	LONDON EXPRESS	Japan	IFO 380 bunkers	10te	V	In container berth
14/12/2004	AL SAMIDOON	Suez Canal	Kuwait medium crude	9000te	?	
07/04/2005	RATNA SHALINI	Kenya	Murban crude	150-180te	V	
08/04/2005	GG-CHEMIST	China	Diesel(MDO) oil (bunkers)	unknown	V	190km from Shanghai

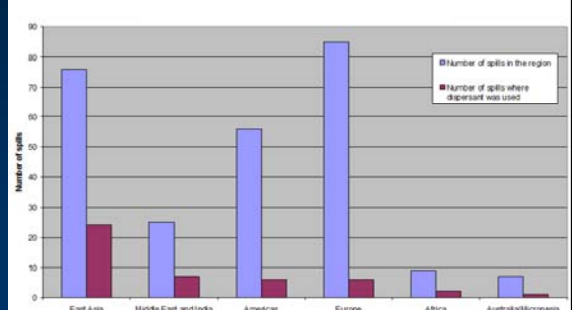
PREVIOUS DISPERSANT USE

SPILLS INVOLVING THE USE OF DISPERSANTS (1995 – Present)

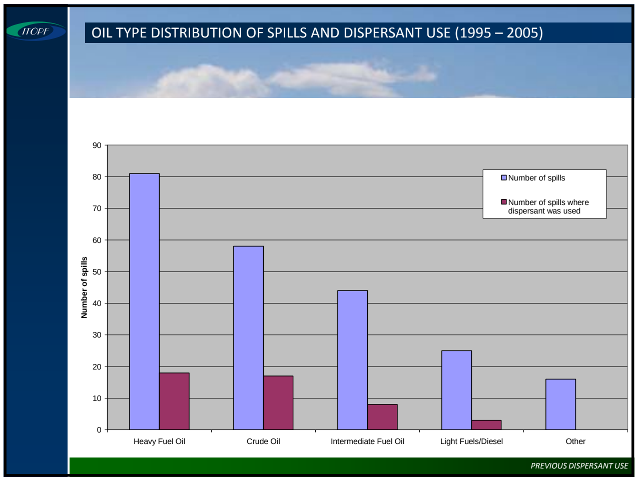
Date	Vessel	Location	Oil type	Approx. spill Volume	Air/Vessel application	Conditions
20/04/2005	SAETTA	Colombia	HFO (IFO 380)	27te	Both	
23/05/2005	ASTRO LUPUS	Iran	Kuwait Export Crude	560te	V	14-18nm from shore
22/09/2005	JUBILEE GLORY	China	IFO380/diesel oil	950m3 oily water	V	shallow brackish water
31/10/2005	EIDER	Chile	HFO (IFO 180)	<200m3	V	deep (continental shelf), near shore
13/04/2006	EASTERN CHALLENGER	Japan	IFO180		V	
04/2006	TITAN MERCURY	Saudi Arabia	Arabian Heavy Crude	50-300 m3	Both	
30/05/2006	OCEAN SERAYA	India	HFO	390te	?	
11/08/2006	SOLAR 1	Philippines	IFO	2000te	?	
20/01/2007	MSC NAPOLI	UK	Fuel Oil		V	
07/12/2007	HEBEI SPIRIT	South Korea	Crude	10500te	A	
14/07/2009	YM INCEPTION	Egypt	HFO	7te	V	in canal
15/09/2009	AGIOS DIMITRIOS	China	IFO 380	50te	V	
24/10/2009	LOWLANDS PROSPERITY	China	HFO	120te	V	
01/11/2009	ZOORIK	China	IFO 180	500te	V	
05/12/2009	AFFLATUS	China	IFO 380	Unknown	V	

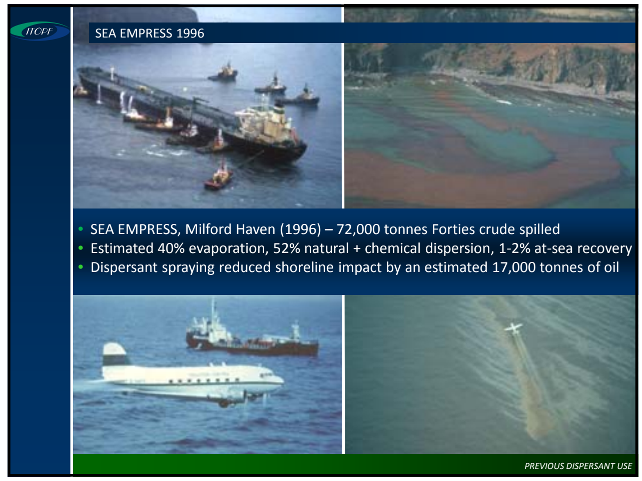
PREVIOUS DISPERSANT USE

REGIONAL DISTRIBUTION OF SPILLS AND DISPERSANT USE (1995 – 2005)

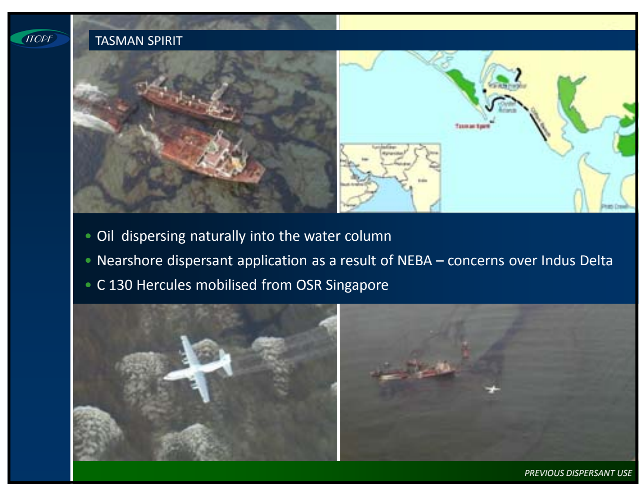


PREVIOUS DISPERSANT USE

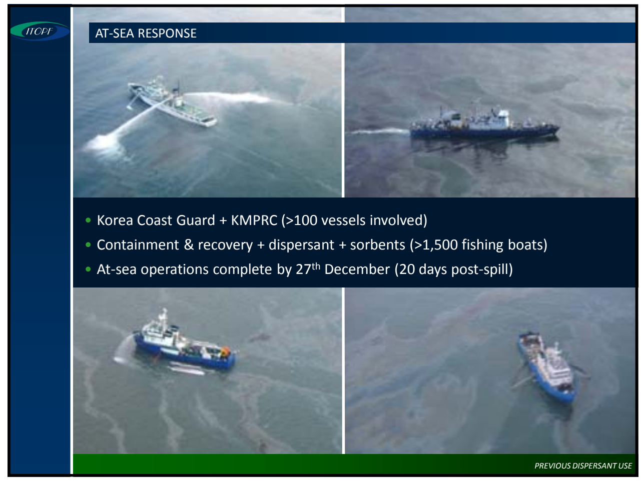

OIL TYPE DISTRIBUTION OF SPILLS AND DISPERSANT USE (1995 – 2005)
Number of spills
Number of spills where dispersant was used
Number of spills
0
10
20
30
40
50
60
70
80
90
Heavy Fuel Oil
Crude Oil
Intermediate Fuel Oil
Light Fuels/Diesel
Other
PREVIOUS DISPERSANT USE

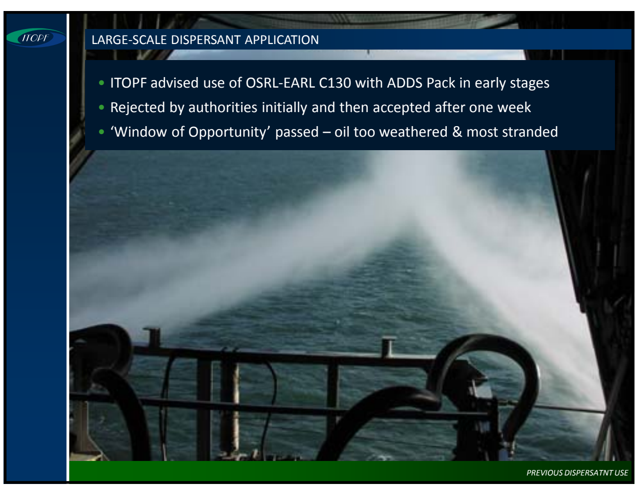

SEA EMPRESS 1996
• SEA EMPRESS, Milford Haven (1996) – 72,000 tonnes Forties crude spilled
• Estimated 40% evaporation, 52% natural + chemical dispersion, 1-2% at-sea recovery
• Dispersant spraying reduced shoreline impact by an estimated 17,000 tonnes of oil
PREVIOUS DISPERSANT USE


TASMAN SPIRIT
• Oil tanker loaded with 87,584 te of Iranian Light Crude Oil grounded at the entrance to Karachi Port on 27th July 2003
• Hull subject to stress from heavy swell due to south west monsoon. Cargo tanks ruptured but bunker tanks remained in tact
• Approx. 30,000 te of cargo lost, remainder (& 440 te of HFO) successfully offloaded
PREVIOUS DISPERSANT USE


TASMAN SPIRIT
• Oil dispersing naturally into the water column
• Nearshore dispersant application as a result of NEBA – concerns over Indus Delta
• C 130 Hercules mobilised from OSR Singapore
PREVIOUS DISPERSANT USE


ITOPF
HEBEI SPIRIT (7 DEC 2007)
Fully laden (264,000 MT) VLCC at anchor off Taean struck by drifting crane barge
3 port-side tanks damaged - 10,800 MT spill (Kuwaiti Export, Iranian Heavy & Upper Zakum)
ITOPF on site by 8th Dec at request of Skuld P&I & IOPC Fund
PREVIOUS DISPERSANT USE

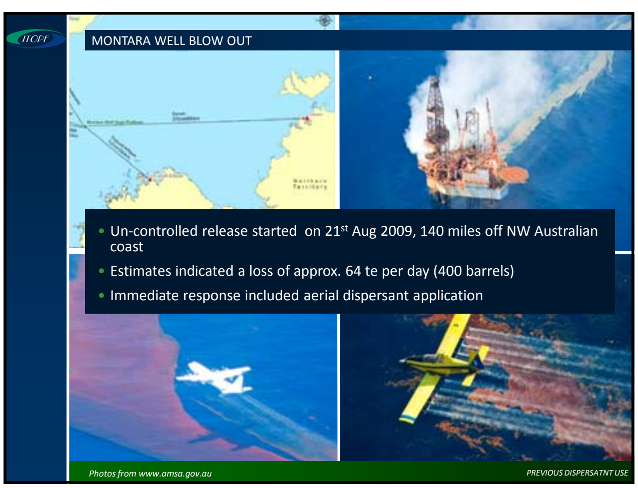

ITOPF
AT-SEA RESPONSE
Korea Coast Guard + KMPRC (>100 vessels involved)
Containment & recovery + dispersant + sorbents (>1,500 fishing boats)
At-sea operations complete by 27th December (20 days post-spill)
PREVIOUS DISPERSANT USE


ITOPF
LARGE-SCALE DISPERSANT APPLICATION
ITOPF advised use of OSRL-EARL C130 with ADDS Pack in early stages
Rejected by authorities initially and then accepted after one week
'Window of Opportunity' passed – oil too weathered & most stranded
PREVIOUS DISPERSATNT USE


ITOPF
MALIPO BEACH
PREVIOUS DISPERSATNT USE


NATUNA SEA
• Grounded in Singapore Straits, lost 7,000 te of Nile Blend Crude oil
• Initial aerial application of dispersant, with political pressure for further sorties
• Oil properties and weather conditions meant dispersants weren't effective
PREVIOUS DISPERSATNT USE


RECENT ITOPF EXPERIENCE OF DISPERSANT APPLICATION
PREVIOUS DISPERSATNT USE


MONTARA WELL BLOW OUT
• Un-controlled release started on 21st Aug 2009, 140 miles off NW Australian coast
• Estimates indicated a loss of approx. 64 te per day (400 barrels)
• Immediate response included aerial dispersant application
Photos from www.amsa.gov.au
PREVIOUS DISPERSATNT USE


www.itopf.com

Dispersant Monitoring and Assessment for Subsurface Dispersant Application

Kenneth Lee, Zhengkai Li and Paul Kepkay
Centre for Offshore Oil, Gas and Energy Research (COOGER)
Fisheries and Oceans Canada

Plume Monitoring and Assessment for Subsurface Dispersant Application (US EPA Directive – May 10, 2010)

PART 1: "Proof of Concept" to determine if subsurface dispersant operation is chemically dispersing the oil plume.

Following review by the RRT….

PART 2: Robust sampling to detect and delineate the dispersed plume based on the results of PART 1 and input from hydrodynamic modeling

All data provided to the United States Coast Guard (USCG)Federal On-Scene Coordinator, and the Environmental Protection Agency (EPA) Regional Response Team (RRT)

PART 1 – Proof of Concept

- Towed Fluorometer at 1 meter
- **LISST Particle Analysis at 3.5m depth transects and at various depths from surface down to 550 meters**
- Dissolved Oxygen at various intervals from surface to 550 meters
- CTD – Conductivity, Temperature, and Depth at various intervals from surface to 550 meters
- Water sampling from surface to 550 meters for PAH analysis
- Aerial Visual Observation

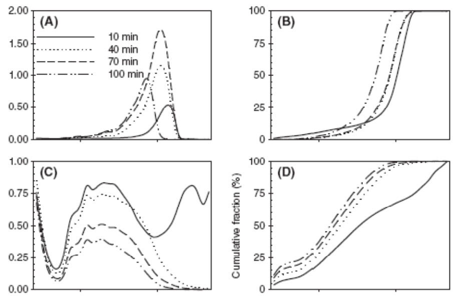
R/V Brooks McCall

PART 2 – Characterization Plan

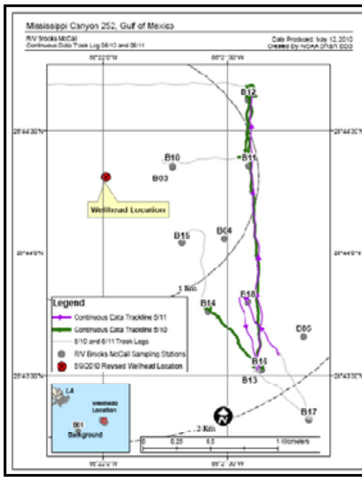
(Ongoing on R/V Brooks McCall and R/V Ocean Veritas

- **UV-Fluorometer casts – surface to sea floor**
- Implementation of the Special Monitoring of Applied Response Technologies ("SMART") Protocol
- **LISST Particle Analysis at various depths from surface to sea floor**
- Dissolved Oxygen, CTD (Conductivity, Temperature, and Depth) at various intervals from surface to sea floor
- Water sampling for PAH analysis
- Aerial Visual Observation
- Rototox toxicity testing
- **2D UV-Fluorescence testing to distinguish chemical vs. physical oil dispersion**

Oil Droplet Size Distributions under Regular Waves: LISST-100X

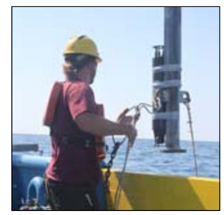


- Physical dispersion created mono-modal lognormal droplet size distributions
- Corexit 9500 formed multimodal lognormal size distribution
    - A larger number of small droplets and a wider range of size distribution



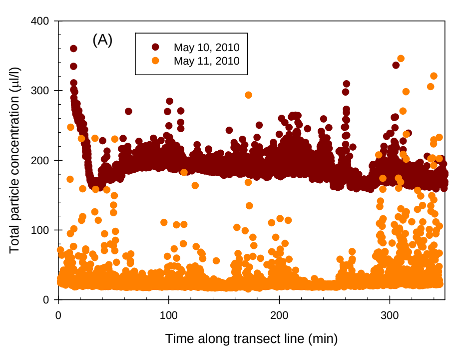
Deployment of LISST-100X at 3.5 m depth

Transect lines on May 10 and May 11, 2010 following subsurface injection of chemical dispersants



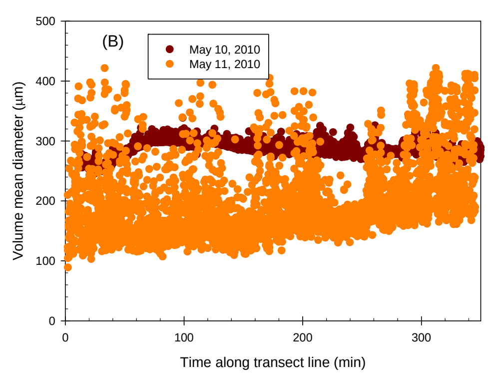
Total Oil Particle Concentration

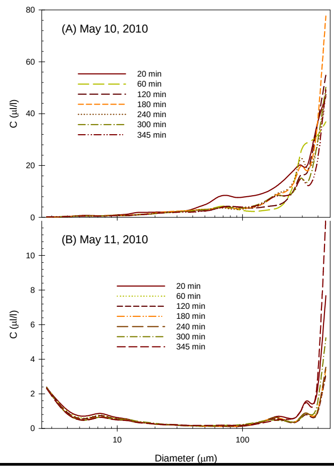
3.5 m depth LISST-100X transect lines



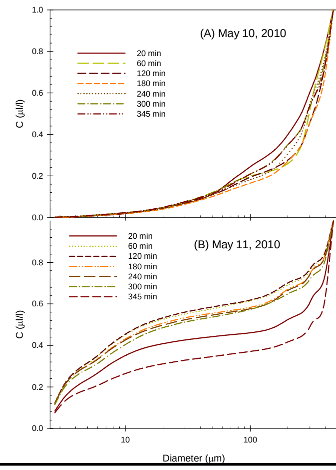
Volume Mean Diameter of Dispersed Oil

3.5 m depth LISST-100X transect lines

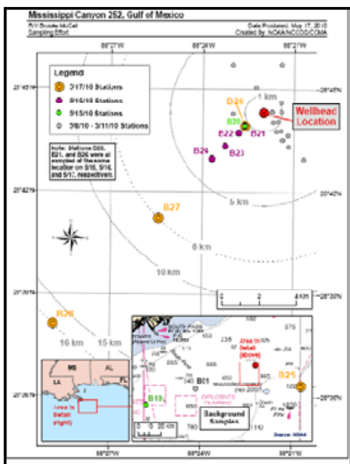




Particle Size Distribution Profiles (3.5 m depth)

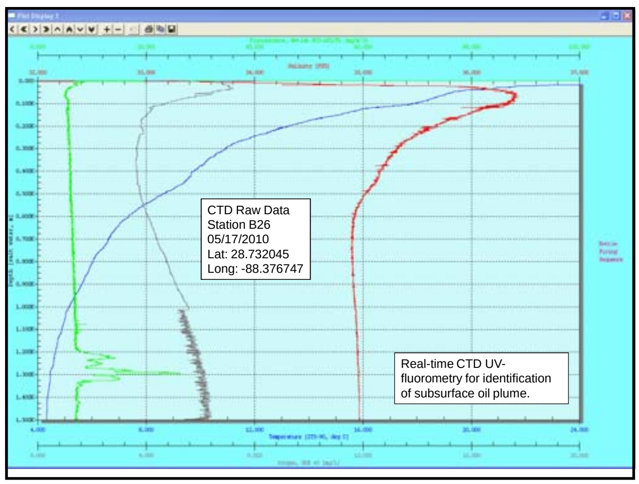


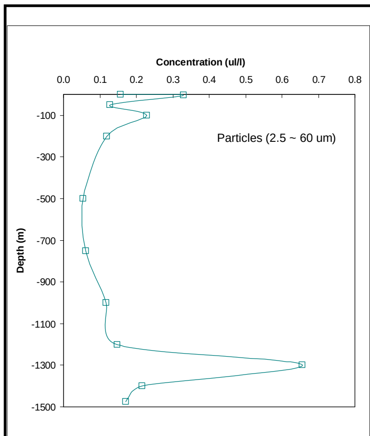
Cumulative Particle Size Distribution (3.5 m depth)



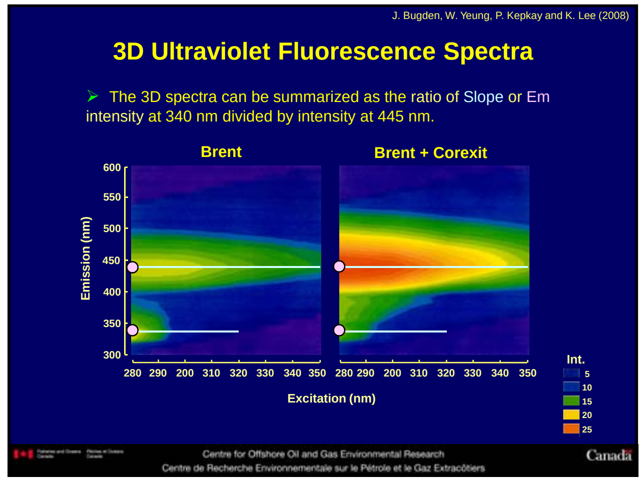
LISST-100X particle size, UV-fluorometry and GC/MS analysis of discrete water samples recovered by Niskin bottle casts

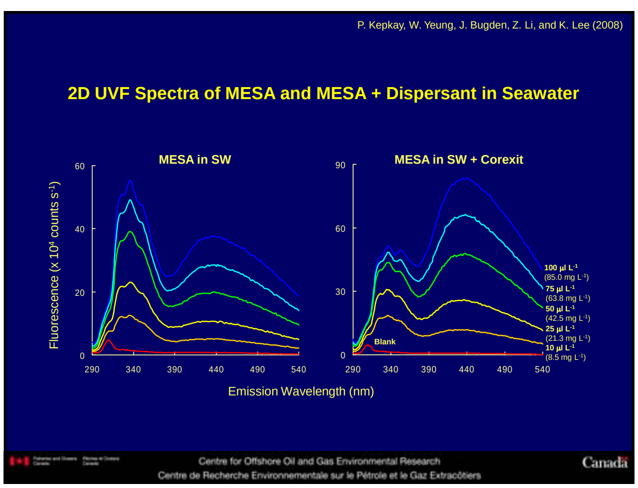
Depth profiles (surface to 1450m) from May 8 to 17, 2010

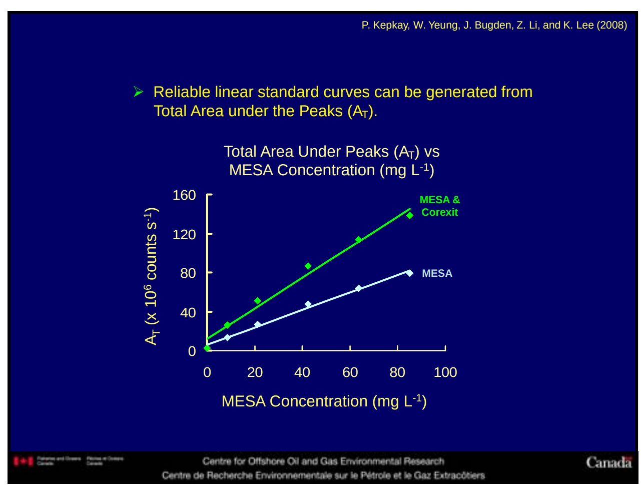


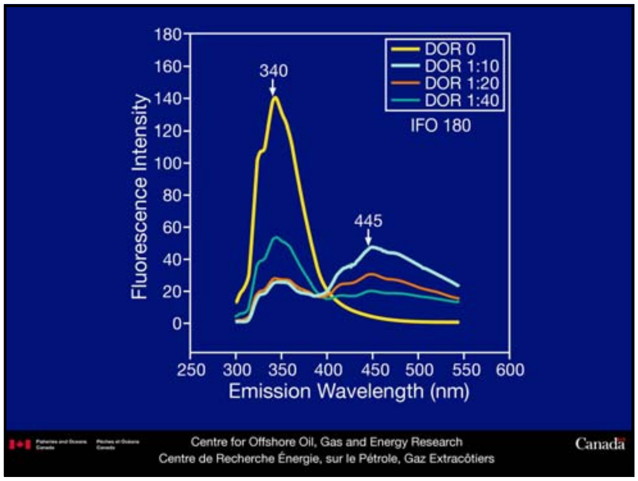


The small droplet (2.5 - 60µm) particle size data for different stations indicate the presence of subsurface plume









How Can Data-Rich 3D UVF (EEM) Spectra be Applied to the Dispersion of Oil Spills ?

- The simplification of a 3D spectrum to 2 measured emission intensities means that a technique can be developed which is based on a ratio (eg, $I_{340/445}$).
- This idea of following oil dispersion using a Fluorescence Intensity Ratio (FIR) is particularly important because the concentration of oil does not have to be measured.
- However, the ratio has to be compared to dispersion efficiencies established under standard conditions (where dispersion efficiency is the oil dispersed divided by the oil added (spilled).

Centre for Offshore Oil and Gas Environmental Research
Centre de Recherche Environnementale sur le Pétrole et le Gaz Extracôtiers
Canada