

Oil Spill Dispersant Research Workshop Report

**March 12 &13, 2013
Baton Rouge, LA**



**Center for Spills
in the Environment**

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ACKNOWLEDGEMENTS

This workshop was hosted by the Center for Spills in the Environment (CSE). The CSE was created in 2004 in conjunction with its affiliate, the NOAA-funded Coastal Response Research Center (CRRC). CSE focuses on issues related to hydrocarbon spills. Both centers are known for their independence and excellence in the areas of environmental engineering and marine science as they relate to spills. CSE has conducted numerous workshops bringing together researchers, practitioners and NGOs of diverse backgrounds to address issues in spill response, restoration and recovery.

The content for this workshop was developed by an organizing committee of researchers, federal and industry experts: Victoria Broje (Shell Oil), Thomas Coolbaugh (ExxonMobil), Jennifer Field (Oregon State University), Vijay John (Tulane University), Rhianna Macon (U.S. Coast Guard), David Westerholm (NOAA Office of Response and Restoration), and Robyn Conmy (U.S.EPA). Funding for this workshop was provided by the American Petroleum Institute's (API) Dispersants Coordination Project. This is the second in an annual series of workshops the CSE has hosted for this project.

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I. Problem

With increasing spill potential from inshore and offshore vessels, platforms, and pipelines, there should be coordination with research, technology, application and response to optimize dispersant efficacy and effectiveness. After the Deepwater Horizon oil spill, there was an increase of research on dispersants and dispersed oil, with a large amount of research coming from the Gulf of Mexico Research Initiative (GoMRI), the Bureau of Safety and Environmental Enforcement (BSEE) and industry. This workshop focuses on enhancing communication about dispersant related research and its application, use, and transition to spill response efforts.

The workshop was convened with the goal of encouraging, opening and continuing dialogue among principal investigators (PIs) of research related to dispersant use and response practitioners. The specific objective was to review prior and current research and development (R&D) conducted by academia, government agencies and industry and evaluate mechanisms for scientific exchange and coordination of these efforts. Specific objectives were to:

- Learn about on-going and newly funded R&D on dispersants and dispersed oil (DDO);
- Determine how on-going and new R&D on DDO can improve dispersant use (assuming that dispersants will continue to be a tool in some spill responses);
- Develop mechanisms for information exchange/interaction among researchers, practitioners and public/nongovernmental organizations (NGOs) regarding DDO;
- Explore data needs, tradeoffs, and decisions of practitioners regarding DDO before, during and after spills; and
- Identify potential R&D efforts on DDO that could improve dispersant use during future spills offshore.

Other goals were to (1) encourage and continue dialogue on DDO among researchers, spill practitioners and NGOs; (2) foster mechanisms for R&D to improve spill response, damage assessment and restoration, and (3) develop mechanisms to enhance public understanding and perception of dispersant use.

II. Workshop Organization

This workshop, entitled “Oil Spill Dispersant Research,” was held on March 12-13, 2013 and hosted by the Center for Spills in the Environment (CSE) at the Lod Cook Alumni Conference Center on the campus of Louisiana State University (LSU) in Baton Rouge. Participants at the workshop were individuals from public, private, local, regional, national, and international institutions who conducted dispersant research or have operational expertise (individuals listed in Appendix A). The format was to examine dispersant use and applications from a response perspective and a researcher perspective. Then, participants determined where researcher and practitioner perspectives overlapped, and how to move forward based on this collaborative approach.

The workshop consisted of group breakout and plenary discussions, and a panel discussion (Agenda in Appendix B). It commenced with initial introductions and presentations on:

- *Dispersants- How They Are Used in Response and How They Were Used in Deepwater Horizon,*

- *Dispersants- How They Work, and*
- *Research and Development Dispersant Initiatives.*

The group then split into four breakout groups based on the expertise of the individuals:

- Near-field Fate & Transport,
- Far-field Fate & Transport,
- Biological Effects, and
- Efficacy & Effectiveness.

During the first breakout session, each group developed diagrams for their respective topics relating to dispersant application from a response practitioner's perspective. Each group detailed the process practitioners use to determine the suitability of dispersant use and the acceptability of application. Then participants addressed the following questions (individual breakout group questions in Appendix C):

- Are there significant steps to determining acceptability?
- What is the timeline for determining adequacy for using dispersants as a tool?
- What information must be obtained from researchers to help practitioners address issues they have with respect to dispersants?

The results from each breakout group were summarized and presented to all participants during a plenary session.

In the second breakout session, the groups diagramed conceptual models that scientists/engineers have of the basic and applied research necessary for understanding the dispersant related topics. They then addressed the following questions:

- Are there significant parts of the model that are crucial steps for improving the dispersant related field?
- What is the timeline for researchers in the study of dispersants? Is there an orderly sequence of steps, how long will each take?
- What information must be obtained from practitioners to help researchers address components of the research conceptual model on the dispersant related topic? and
- What are the two areas of overlap with respect to researchers' and practitioners' perspectives?

The final question of the second breakout session identified interactions/ overlap of the perspectives and timelines. This includes identifying: (1) the research needed to improve effectiveness, understand and predict the fate and transport of DDO and minimize the biological effects when dispersants are used, (2) information/data needed from practitioners to assist researchers, and (3) issues that must be addressed to answer public/NGO questions and concerns, and how to move forward and continue interacting. The final breakout session discussed how to move forward. Each group presented main points of their discussions in a final plenary session. All participants discussed synthesis and next steps.

III. Workshop Introduction

The presentation on *Dispersants- How They Are Used in Response and How They Were Used in Deepwater Horizon* (Appendix E) discussed Subpart J of the U.S. National Contingency Plan and the decision process to apply dispersants. Applying dispersants focuses on the net environmental benefit and must be approved by individuals across multiple state and federal entities (e.g., Federal On-Scene Coordinator, Environmental Protection Agency, Department of the Interior, Department of Commerce, the specific state response agency, Regional Response Team), or pre-authorized for certain conditions. Dispersant application for offshore oil spills has been preapproved in the Gulf of Mexico (≥ 3 miles offshore and ≥ 10 m deep).

The Deepwater Horizon was the first time that dispersants were applied in the subsea environment. This prompted the U.S. National Response Team to develop interim subsea dispersant guidelines for application and monitoring. The decision to apply dispersants in the subsea still lies with the Regional Response Teams (RRT) and the Federal On-Scene Coordinator (FOSC).

The presentation *Dispersants- How They Work* (Appendix E) discussed dispersant composition, mechanisms of action, fate of dispersed oil, environmental impact of DDO, and application during the Deepwater Horizon. Dispersants are surfactants dissolved in a solvent. They reduce the oil: water interfacial tension, which allows an oil slick to break into small droplets and disperse with some wave energy. The timescale for dispersant effectiveness is typically minutes to achieve a concentration of <10 ppm in the water column, hours to achieve <1 ppm, and days to reach the ppb range. The dilution and small droplet size with a large surface area to volume ratio allows for rapid bacterial colonization and biodegradation without depletion of nutrients or oxygen.

Dispersants typically have lipophilic and hydrophilic ends which have an affinity for the oil and water, respectively. The oil droplets disperse with wave energy, then repel each other and usually do not coalesce. Ingredients in Corexit ® 9500, the dispersant used in response to the Deepwater Horizon Spill, are commonly found in every day products (e.g., skin cream, shampoo, food emulsifiers, lotions, cleaning products). The toxicity of the oil is greater than that of the dispersant, with the dispersant designed to facilitate the degradation of oil. The decision to apply dispersants is to maximize removal and net benefits from the response strategy (Net Environmental Benefit Analysis).

The R&D Initiatives presentations discussed current research from GoMRI, BSEE, industry, KillSpill, and California Fish and Wildlife Service's Oil Spill Prevention and Response program. All aforementioned presentations are available as PDFs in Appendix E.

IV. Results from Breakout Groups

a. Near-field Fate and Transport

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Near-field fate and transport focuses on dispersant research and application in the area close to the source where the DDO plume is more or less intact. This includes surface or subsea mixing zone/vertical movement.

The practitioners' decision to apply dispersants near-field depends on the location of the oil: surface (Fig. 1) versus subsurface (Fig. 2) release. Near-field surface release is where oil is near the surface, not necessarily near the source, but near where the dispersant is applied; with a temporal aspect before the process is beyond control. An initial assumption for surface dispersant use is that the oil must have some color to it (e.g., brown), so that it can be seen to target application. There must be adequate mixing energy (4-5 m/s wind speed), but too much energy is not beneficial. The dispersant to oil ratio that is preferred is around 1:90- 1:100. The decision to use dispersants depends on the impacts of dispersant use, type of oil, efficacy of dispersant for the type of oil, physical oil properties, dispersant availability, and natural resource tradeoffs.

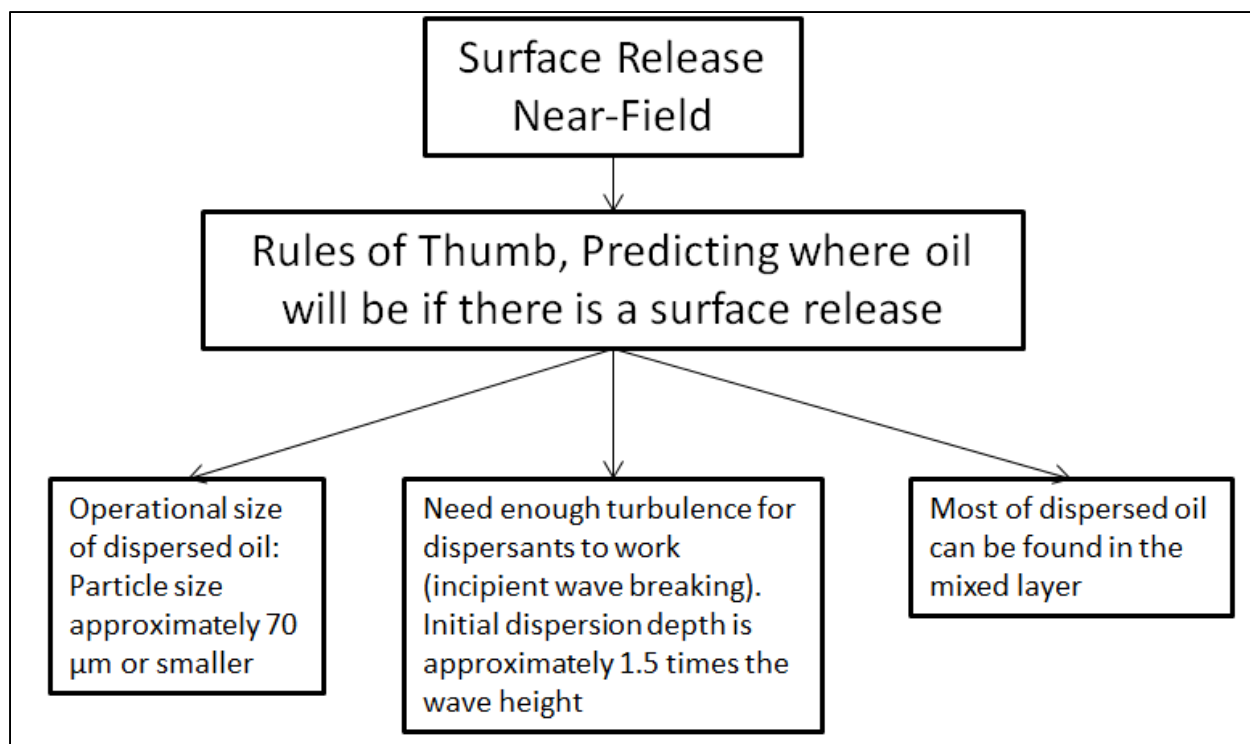


Figure 1: Response Practitioners' Near-field Surface Release Decision Diagram

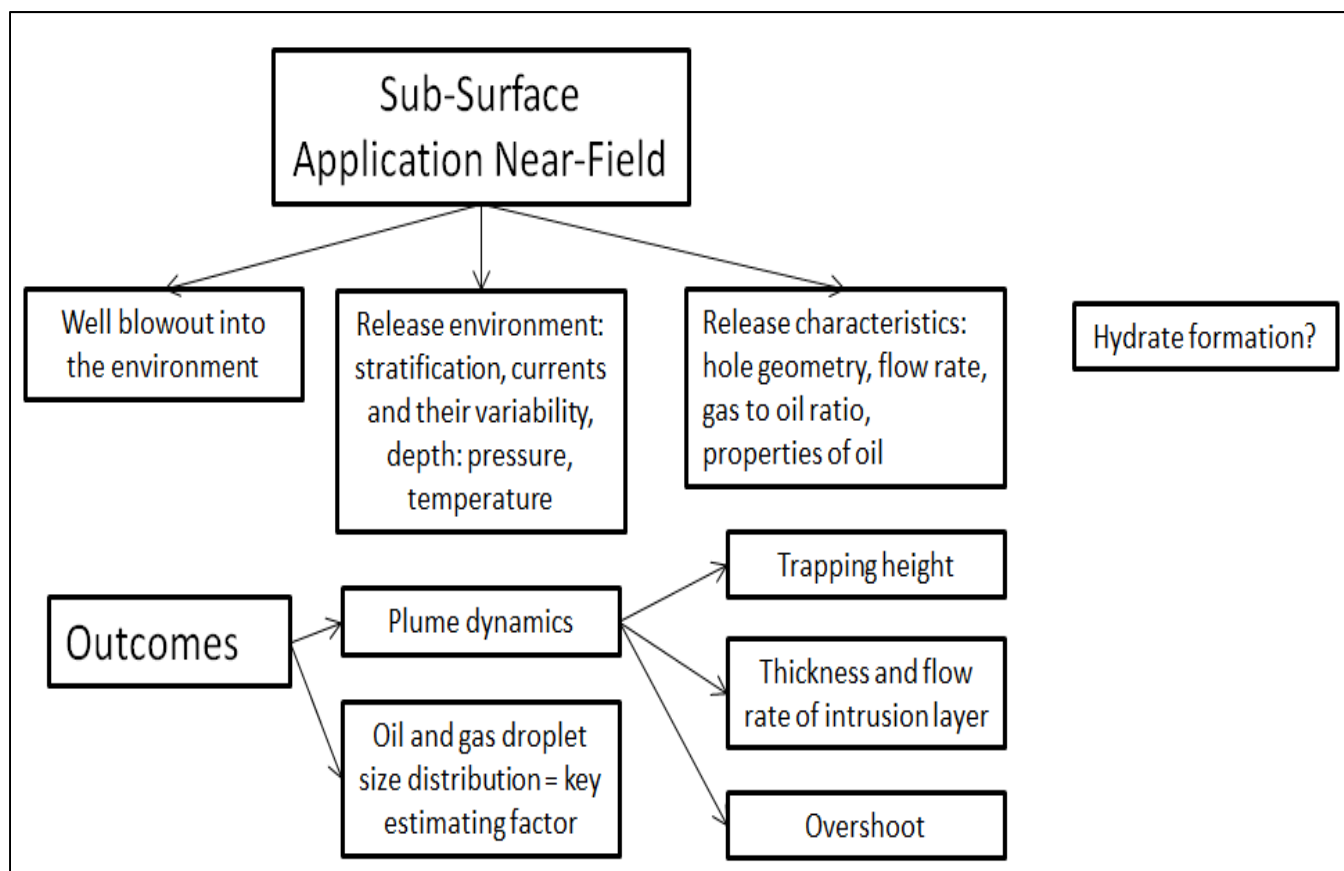


Figure 2: Response Practitioners' Near-field Subsurface Release Decision Diagram

Critical steps in the researchers' perspective (Fig. 3) for improving dispersant near-field fate and transport are understanding droplet size distribution, flocculation and sedimentation, modeling velocity and turbulence structure, and the wave current interaction near the surface. The timeline to study near-field fate and transport is about 20-50 years for ocean flows and 3-5 years for flocculation and sedimentation studies.

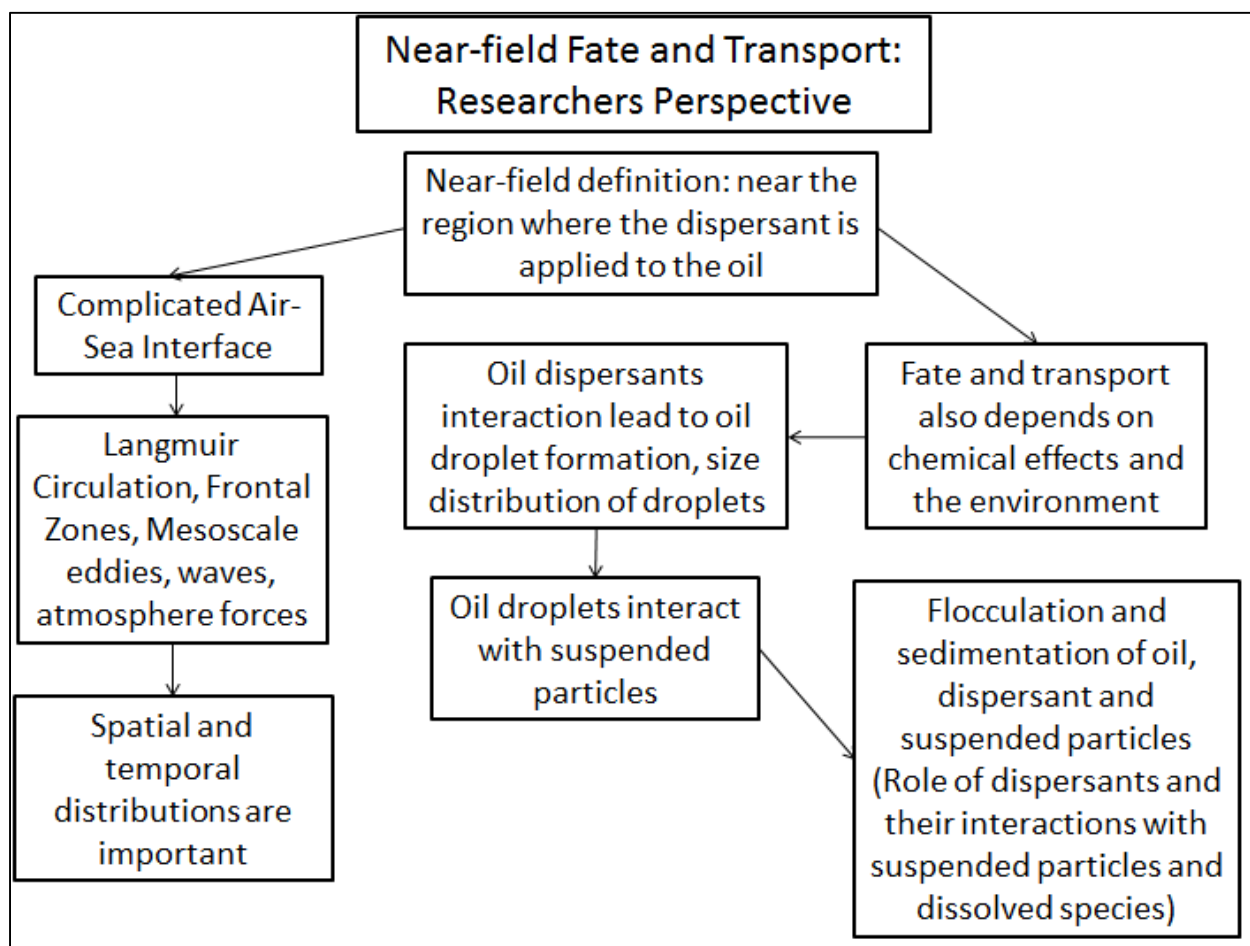


Figure 3: Researchers' Perspective Near-field Fate and Transport Diagram

Researchers noted that it is important for them to understand how response actions are actually conducted in the field. Forecasting and observational data to model or validate flocculation phenomenon is beneficial. For subsurface near-field processes, high temperature and pressure experiments are important; this would be coupled with a need for more information on conditions *in situ* and high resolution images. Other information needs include: biodegradation at high pressure conditions near-field, methane bubbles (e.g., velocity, amount, interaction with dispersants), modulus, trapping depth and density profiles, and modeling of all the aforementioned processes. Practitioners can assist research efforts by: sharing field observations and links to videos, reviewing how well dispersant application worked in situ, and additional data and observations from past spills (from response decision-making).

The fundamental linchpin for near-field fate and transport of DDO is to understand dispersant interactions with multiphase fluids and flow, and then monitor those interactions for translation

from laboratory research to the field. This transition would be easier if the process of scaling up was detailed and careful. Modeling presents a potential bridge from lab studies to *in situ* response. Critical steps including droplet size distribution, and flocculation and sedimentation may be addressed on a time scale of about 3-5 years with increased funding, and 20-50 years for understanding and modeling ocean flows, velocities and turbulence structures.

b. Far-field Fate and Transport

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Far-field fate and transport focuses on DDO further away from the source, downgradient (horizontal movement after initial mixing), where the environmental conditions, such as wind-driven currents, take over. Far-field fate and transport includes the spatial and temporal aspects of DDO which undergoes physical, chemical, and biological degradation as it moves downgradient and weathers.

The practitioners' decision to use dispersants focusing on far-field fate and transport is detailed in Fig. 4, while the researchers' perspective is shown in Fig. 5. The practitioners' objective is to protect the public and the environment with the end result being a net benefit; tradeoffs are weighed heavily. A response practitioner's decision to apply dispersants begins with analysis to determine if the oil can be dispersed, where it will go after being dispersed, what the downstream concentrations and resources at risk will be, will it affect receptors, and is the dispersed oil worse than the surface oil; weighing the tradeoffs.

Timelines for decision-making in response are typically less than 24 hours. Surface spills must be addressed, if at all possible, within 2-3 hours, while subsurface spills have up to 24 hours. There is no time during that timeframe to collect new data; the response is dependent on prior incidents, experience and pre-planning.

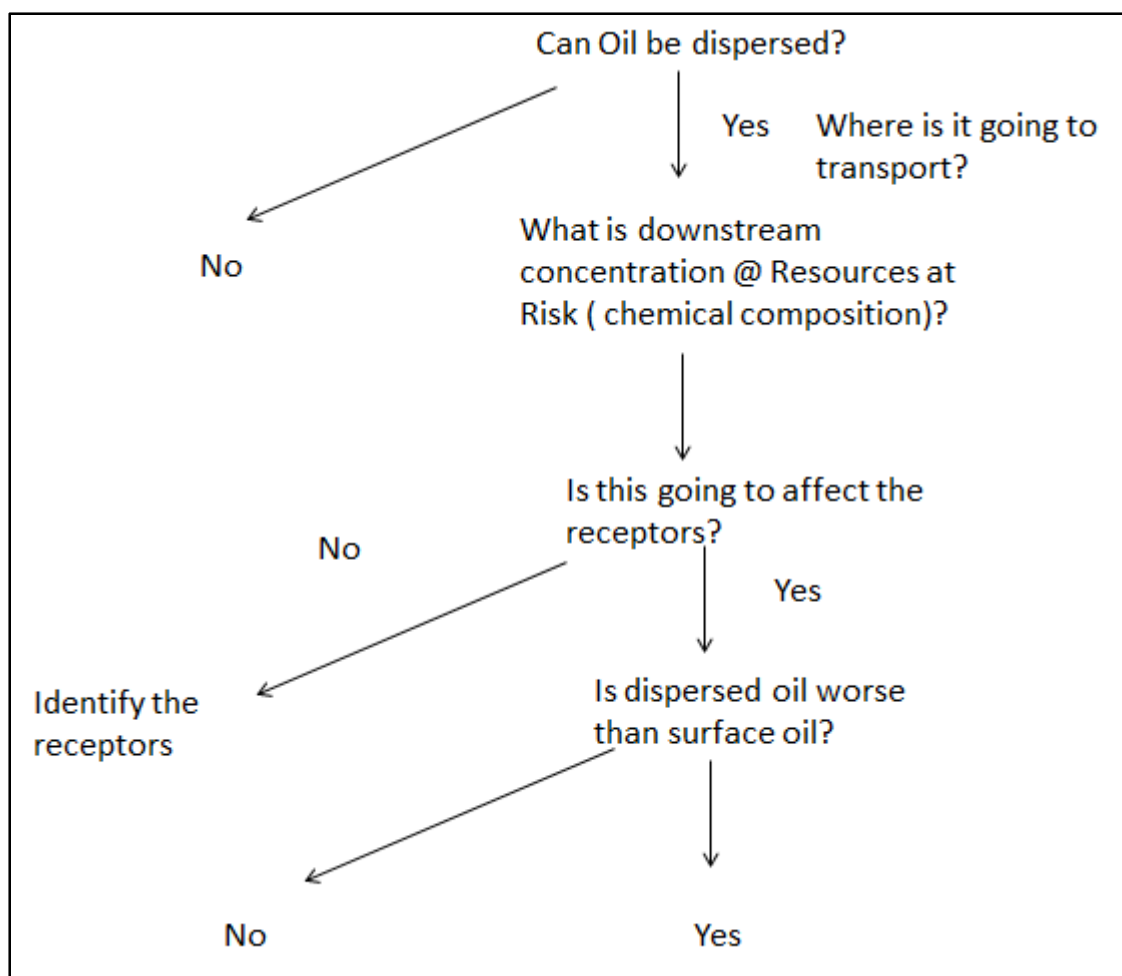


Figure 4: Response Practitioners' Far-field Fate and Transport Decision Diagram

Crucial steps for determining acceptability of dispersants for far-field fate and transport are minimizing human health risk during response, identifying the exposure pathways after an incident, adhering to regulations (e.g., Endangered Species Act), identifying protected areas (e.g., marine sanctuaries, seasonal concerns), and enhancing 3-D modeling (e.g., currents and weather).

Information from researchers to help practitioners address issues with far-field fate and transport include: research on mimicking a surface slick and tracking the DDO (e.g., where is it going, how fast, and at what concentrations, toxicity), transformation of chemical composition of the DDO over time with byproduct effects; methods to enhance surface particle transport and movement, and model validation.

The researchers (Fig. 5) noted that they need sufficient answers and information to conduct future research and address practitioners' needs prior to the next spill. Information to be obtained includes: concentrations of DDO in the far-field; background concentrations; samples of component mixtures as they are applied off the boat to compare to far-field concentrations; composition with and without dispersants; the range of representative environmental systems (e.g., microbial communities, depth, pressure, temperature, nutrient loading); likely zones of

impact; dispersant technologies and risks; definition of likely zones of impact; pre-emptive sampling protocols to be enacted during a spill; resolution on issues with sample storage, transportation, etc.; and access to samples and large scale experiments (e.g., wave tanks).

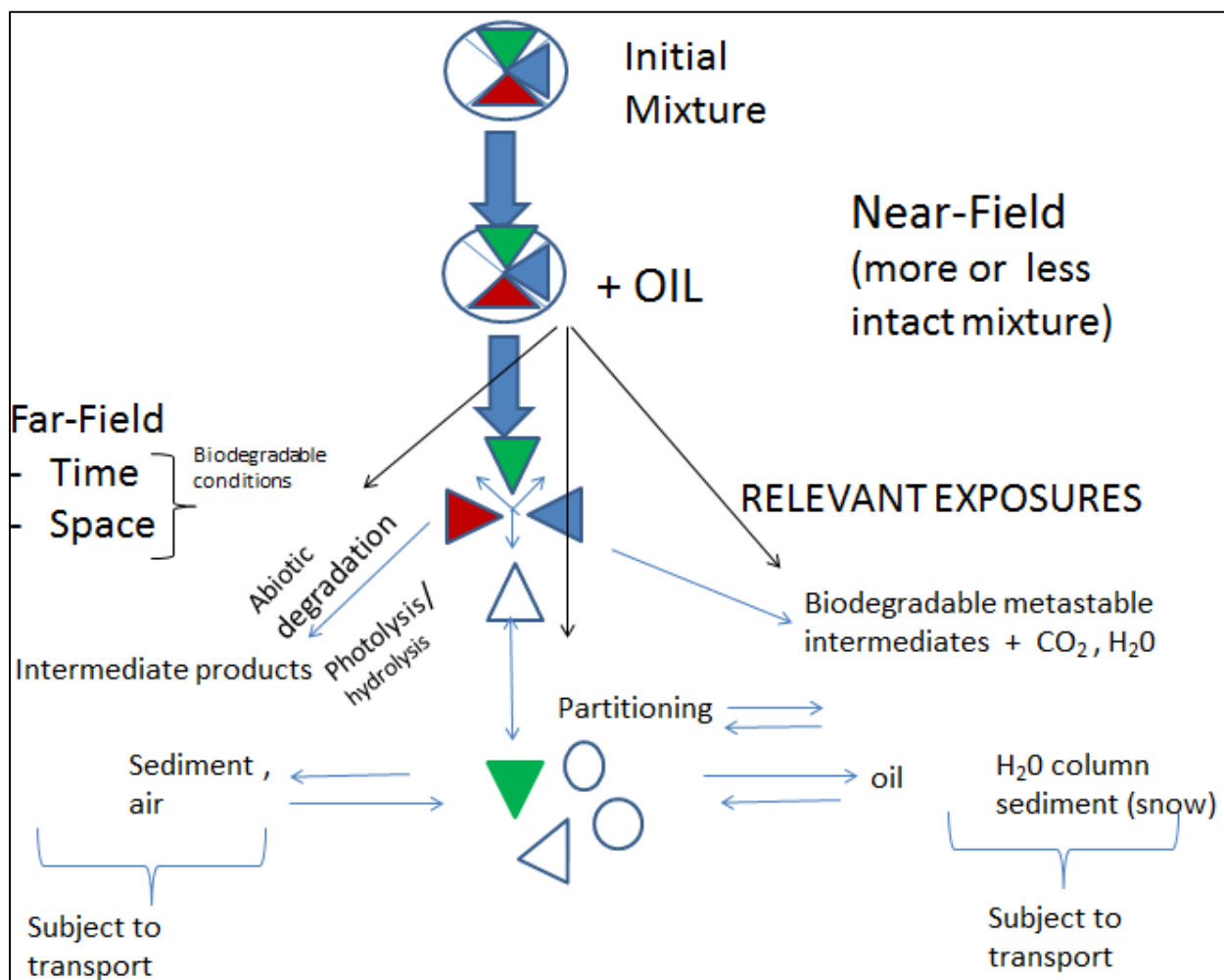


Figure 5: Researchers' Perspective Far-field Fate and Transport Diagram

To improve the use of dispersants in future spills, both practitioners and researchers on far-field fate and transport concluded that there needs to be more public outreach and a detailed list of needs and uncertainties related to DDO. For public outreach, there must be collaboration between academics, practitioners and industry. During a spill event, the trade-off issues should be explained to the public with actual risks and benefits disclosed adequately. A list of current data/knowledge and needs for future response should be created so everyone is “on the same page”.

A major need for far-field fate and transport is to understand how DDO changes in composition over time. The challenge to this is the abundance of data still waiting to be processed, while current knowledge is not ready to be synthesized. All of the existing data (from multiple sources) need to be compiled into one source for synthesis.

c. Biological Effects

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The Biological Effects group focused on DDO and their impacts to biological species (e.g., toxicity) and ecosystems.

Responders want to make timely and effective decisions (Fig. 6) for response, while assessing injury and damage to natural resources (Natural Resource Damage Assessment [NRDA]) for litigation and settlement purposes. Each branch of the diagram acknowledges trade-offs relating to Net Environmental Benefit Analyses (NEBA). Response decision-making depends on the ecosystem, oil properties and response technologies with the goal of minimizing and measuring impacts. These influence the restoration processes and costs associated with them. Ecosystem considerations include: the environment and resources at risk; and their abundance and distribution, life stages, habitat, and sensitive areas. Dispersant application depends on the oil (type, volume), location, dispersion efficacy, trajectory and concentration, and droplet size. Once these issues are resolved between the parties responsible for response and NRDA, cooperative sampling for both aspects of the spill may commence.

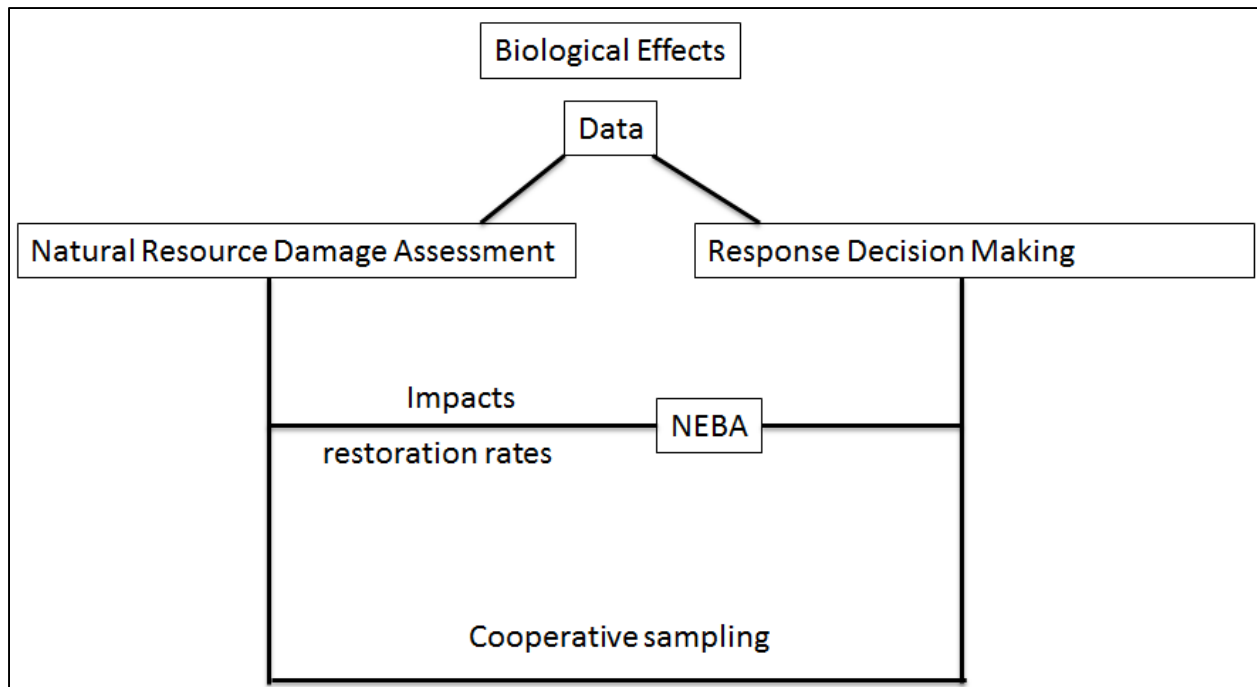


Figure 6: Response Practitioners' Biological Effects Decision Diagram

The response practitioners' concluded that helpful information from researchers would include: toxicity effects of different types of dispersants, population modeling, biomarker degradation, balances with respect to gross effects, data collection during a spill (e.g., type of oil, concentration, hydrocarbons in the water column), and at-risk species.

The researcher's perspective of how they may be involved before, during and after a spill is diagrammed in Fig. 7. The time frames in the diagram are preparation and response. Preparation includes acquisition of data and development of tools beneficial to responders prior to a spill. Response entails support for decision-making during a spill and assisting with measuring impacts and recovery. Areas of research for preparation include: toxicity tests, trajectory modeling, dilution, and dispersant efficacy. These should be evaluated with respect to ecosystem services, food web models, vulnerable species, recovery rates, and response impacts.

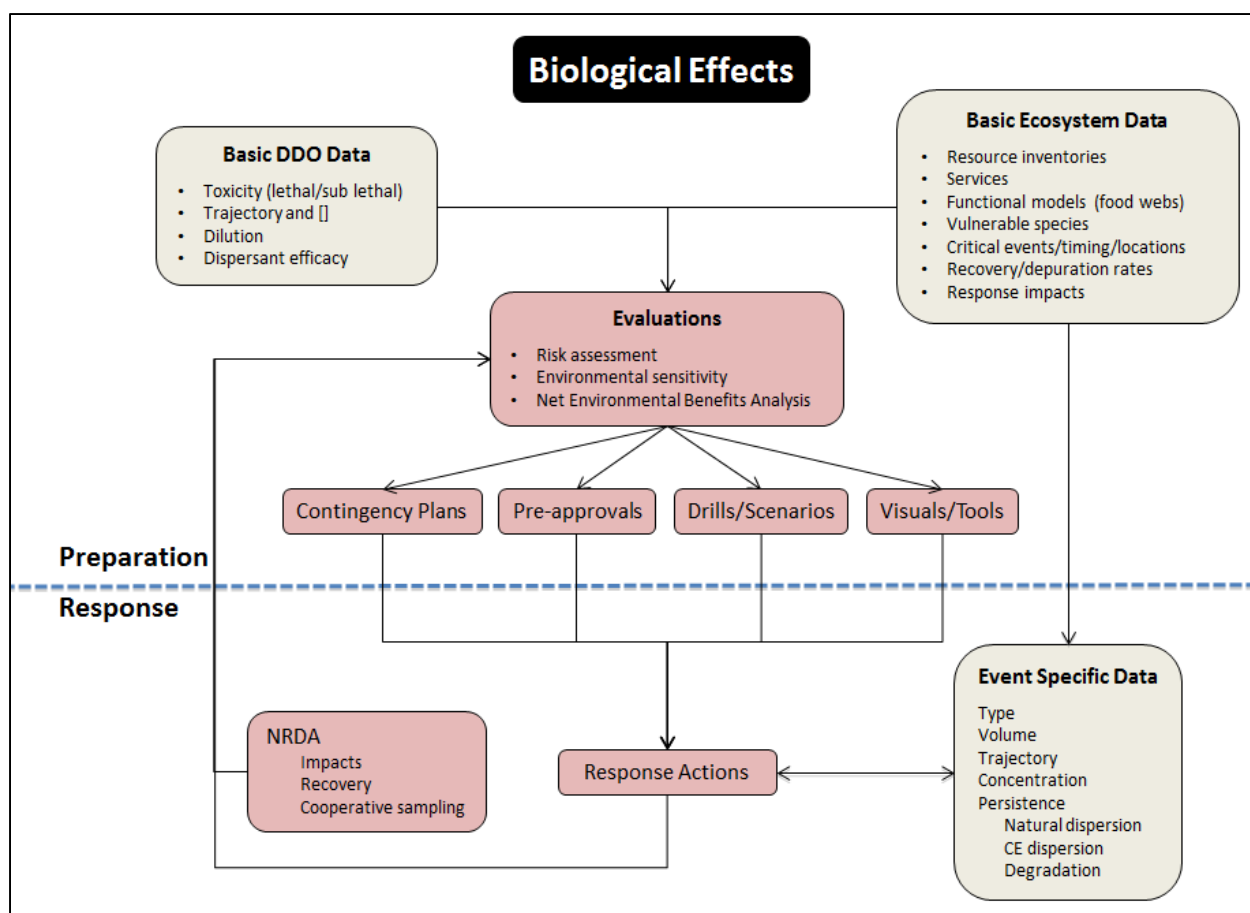


Figure 7: Researchers' Perspective Biological Effects Diagram. Grey boxes contain data or information while pink boxes are actions.

Improving the application of dispersants includes: studies of realistic exposure concentrations and durations; improved use of metadata; translation of laboratory research to response processes; more frequent communications within the Gulf of Mexico Research Initiative (GoMRI) and between researchers and responders; and educating the public. Roles of the National Response Team (NRT), Regional Response Team (RRT), and Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) must be identified to assure research and communications are relevant. For public education, the research community should be incorporated into drills and discussions. This includes training researchers on the Incident Command System (ICS) and participation with the RRT in drills.

Impediments to collaboration include: lack of investments for interaction; lack of mechanisms requiring interactions; few centralized information sources; and different merit mechanisms/goals. The challenges include: improvement of the definition and scientific rigor of the Net Environmental Benefit Analysis (NEBA) and development of a consistent approach to Ecological Risk Assessments (ERA).

d. Efficacy and Effectiveness

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Efficacy and effectiveness of DDO focuses on successful application and evaluation of DDO. Efficacy relates to how well dispersants work in ideal conditions (e.g., lab, controlled setting), while effectiveness describes how well dispersants work in an applied setting during a spill.

Fig. 8 diagrams the responders' perspective on application of dispersants. The decision to use dispersants is based on the net environmental benefit. This demonstrates how dispersant application scores over other response options such as natural dispersion and mechanical oil recovery. Applying dispersants is dependent on location (e.g., surface, subsurface), oil type, available dispersants, the forms of dispersants (e.g., solid, liquid) and susceptibility of the oil to dispersants. The next important step is to monitor the spill and the dispersed oil. Once dispersants are applied, the effectiveness needs to be evaluated for the DDO to determine if environmental impacts were minimized. Typically, the decision to apply dispersants should be made within seven hours of the spill to be sure the oil is not very weathered, as dispersants work best on non-weathered oil.

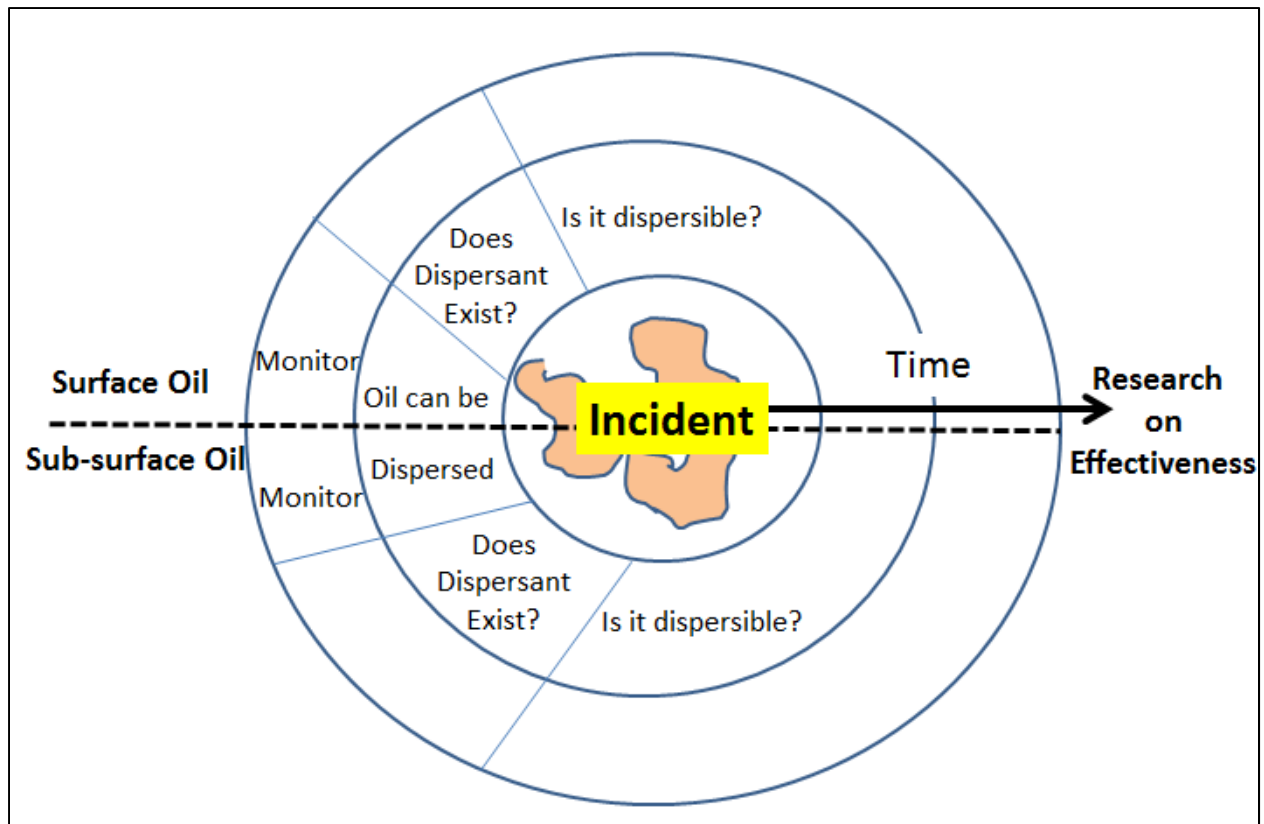


Figure 8: Response Practitioners' Efficacy and Effectiveness Decision Diagram

Response practitioners need information from researchers regarding how to evaluate effectiveness and how to measure effects on the environment using surrogates for effectiveness. Significant linchpins for determining dispersant efficacy and effectiveness include: whether oil disperses, and if the oil can be targeted in the timeframe where it works the best. The timeline for determining dispersant efficacy and effectiveness should be 48 to 72 hours.

The researchers' perspective diagram (Fig. 9) shows three disciplines of research: environmental, physical/chemical, and engineering/application. Future opportunities for research include: expanding the range of oil types being tested (e.g., oil sands, diluted bitumen). Researchers need information from practitioners including: composition of dispersants (e.g., Corexit); impacts of one oil removal technique on another (e.g., mechanical removal vs. dispersant application); and bridges between basic science and understanding of oil spill response.

Conceptual Model/Research Needs

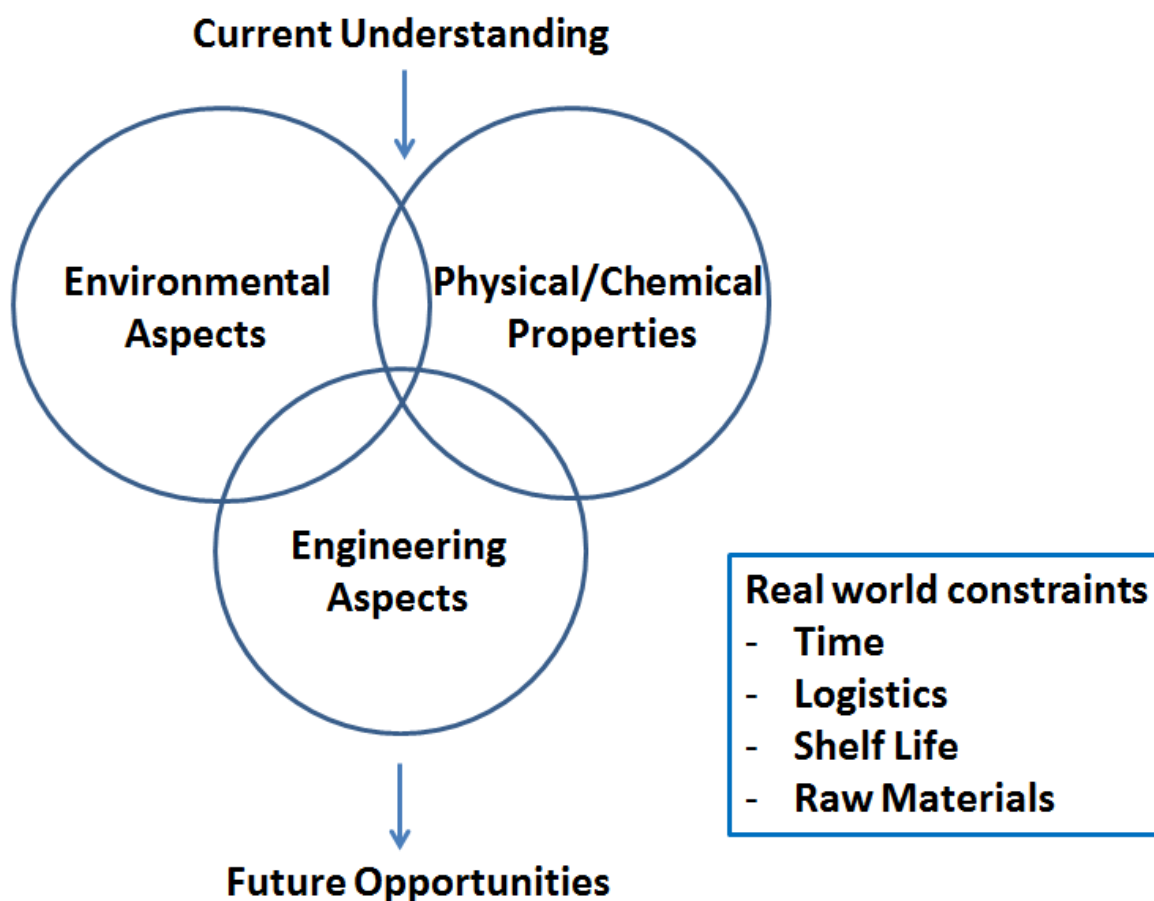


Figure 9: Efficacy and Effectiveness Research Needs Model

Significant linchpins for improving dispersant efficacy and effectiveness include: laboratory experiments that are more representative of *in situ* conditions; better communications between responders and researchers; greater oil spill training or drills; and analysis of dispersants under different conditions (e.g., freshwater, a range of temperatures). The timeline for this research is 2-3 years for funding; 2-4 years for publications and presentations; and 20-25 years for scaling to field application.

An overlap of needs for researchers and practitioners is the search for “better” technologies (e.g., lower toxicity, longer shelf life, greater effectiveness, greater simplicity, and greater ease of testing). Other areas of overlap include: the need to publish in a wide array of journals (e.g., high impact, prestige, trade); establishment of opportunities for students within industry (i.e., internships); and sustainable interactions between researchers and practitioners.

V. Summary and Future Directions

Common themes across breakout groups at the meeting included: enhancing and continuing communication between researchers and responders regarding DDO; increasing public outreach and education; and improving comprehensive and transparent transition of research from laboratory to field application. Modeling is a tool that could act as a potential bridge between laboratory research and field application. All of the scientific information (lab studies and response measures) should be centralized, so it is available to all users.

Research needs to emphasize: the composition of DDO, the changes in DDO over time, and the efficacy of dispersants on a range of oils in a range of environments and conditions. Previous, existing, and future research needs to be compiled, synthesized, and published in an array of journals. NEBAs and ERAs need to be sufficiently defined and their scientific rigor needs improvement. Response and research communities would benefit from NEBA and ERA standardization, and minimization of inconsistent practices.

Benefits to ongoing collaboration and communication between practitioners and researchers include enhancing the knowledge of fate and transport of DDO before, during and after an oil spill. Before a spill more observations of changes, efficacy testing and scientific data are needed. During a spill, researchers should be able to answer questions to assist dispersant application and tailor their studies based on need and risk. These considerations regarding research should be incorporated into preparation, planning, response, and evaluation of response post-spill. This will help mitigate any disparities in translation of findings from laboratory research to field application.

VI. Appendices

Appendix A: Workshop Participant List

Oil Spill Dispersant Research Workshop

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Baton Rouge, LA

March 12-13, 2013

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Oil Spill Dispersant Research Workshop

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Appendix B: Workshop Agenda

Oil Spill Dispersant Research Workshop

Lod Cook Center, LSU
Baton Rouge, LA

March 12-13, 2013

AGENDA

TUESDAY, MAR 12

- | | |
|----------|---|
| 8:30 AM | Registration & Continental Breakfast |
| 9:00 AM | Welcome/Background and Workshop Goals
Nancy E. Kinner, <i>Center for Spills in the Environment</i> |
| 9:15 AM | Opening Remarks
Thomas Coolbaugh, <i>ExxonMobil Research & Engineering</i>
David Westerholm, <i>NOAA ORR</i>
Bob Pond, <i>U.S. Coast Guard</i>
Chuck Wilson, <i>GOMRI</i> |
| 9:30 AM | Participant Introductions |
| 10:10 AM | Dispersants - How They Are Used in Response and How They Were Used in Deepwater Horizon
Bob Pond, <i>USCG</i> |
| 10:35 AM | Break |
| 10:50 AM | Dispersants - How They Work
Tom Coolbaugh, <i>ExxonMobil</i> |
| 11:05 AM | R&D Dispersants Initiatives |
| 11:40 AM | Panel on Response Related Dispersant Issues |
| 12:05 PM | Lunch |
| 1:00 PM | Panel on Research Related Dispersant Issues |
| 1:30 PM | Breakout Groups, Session I |
| 3:30 PM | Plenary Session for Group Reports |
| 4:45 PM | Adjourn |
| 6:00 PM | Group Dinner (Location: Juban's Restaurant) |



Center for Spills in the Environment

www.crrc.unh.edu/workshops

WEDNESDAY, MAR 13

8:30 AM	Continental Breakfast
9:00 AM	Recap & Overview Nancy Kinner
9:15 AM	Breakout Groups, Session II
11:30 AM	Lunch
12:30 PM	Breakout Groups, Session III
2:30 PM	Break
2:45 PM	Plenary Session for Group Reports
4:00 PM	Synthesis & Next Steps Nancy Kinner
5:00 PM	Adjourn



Appendix C: Breakout Group Questions

a. Breakout Session 1: Response Practitioners' Perspective

i. Near-Field Fate and Transport

1. Create a diagram to show the process practitioners use to determine the near-field fate and transport of dispersants and whether it is acceptable?
2. Are there significant parts of the process that are “linchpins” on a critical path (i.e., crucial steps) for determining dispersant near-field fate and transport and whether it is adequate?
3. What the timeline for determining whether dispersants have adequate near-field fate and transport to be considered useful tools in a spill response?
4. What information must be obtained from researchers to help address components of the practitioners' perspective on dispersant near-field fate and transport?

ii. Far-Field Fate and Transport

1. Create a diagram to show the process practitioners use to determine the far-field fate and transport of dispersants and whether it is acceptable?
2. Are there significant parts of the process that are “linchpins” on a critical path (i.e., crucial steps) for determining dispersant far-field fate and transport and whether it is acceptable?
3. What is the timeline for determining whether dispersants have adequate far-field fate and transport to be considered useful tools in a spill response?
4. What information must be obtained from researchers to help practitioners address issues they have with respect to dispersant far-field fate and transport?

iii. Biological Effects

1. Create a diagram of the process practitioners use to determine the biological effects of dispersants and the tradeoffs that must be made?
2. Are there significant parts of this perspective that are “linchpins” on a critical path (i.e., crucial steps) for determining dispersant biological effects?
3. What the timeline for determining whether dispersants have adequate biological effects to be considered useful tools in a spill response?
4. What information must be obtained from researchers to help address components of the practitioner's perspective on dispersant biological effects?

iv. Efficacy and Effectiveness

1. Create a diagram that explains the process practitioners use to determine the efficacy and effectiveness of dispersants and whether their use is acceptable at a spill?
2. Are there significant parts of the process that are “linchpins” on a critical path (i.e., crucial steps) for determining dispersant efficacy and effectiveness and whether dispersant use is acceptable?
3. What is the timeline for determining whether dispersants have adequate efficacy and effectiveness to be considered useful tools in a spill response?
4. What information must be obtained from researchers to help practitioners make decisions on dispersant efficacy and effectiveness and whether dispersant use is acceptable for a spill?

b. Breakout Session 2: Researchers' Perspective and Overlap

i. Near-Field Fate and Transport

1. What is the conceptual model that scientists/engineers have of the basic and applied research needed to understand and improve the near-field fate and transport of dispersants?
2. Are there significant parts of the model that are “linchpins” on a critical path (i.e., crucial steps) for improving dispersant near-field fate and transport?
3. What is the time line for researchers in the study of dispersant near-field fate and transport? Is there an orderly sequence of steps and if so, how long will each one take?
4. What information must be obtained from practitioners to help researchers address components of the research conceptual model on dispersant near-field fate and transport?
5. What are the areas of overlap with respect to researchers’ and practitioners’ perspectives of near field fate and transport?

ii. Far-Field Fate and Transport

1. What is the conceptual model that scientists/engineers have of the basic and applied research needed to understand and improve the far-field fate and transport of dispersants?
2. Are there significant parts of the model that are “linchpins” on a critical path (i.e., crucial steps) for improving dispersant far-field fate and transport?

3. What is the time line for researchers in the study of dispersant far-field fate and transport? Is there an orderly sequence of steps and if so, how long will each one take?
4. What information must be obtained from practitioners to help researchers address components of the research conceptual model on dispersant far-field fate and transport?
5. What are the areas of overlap with respect to researchers' and practitioners' perspectives of far field fate and transport?

iii. Biological Effects

1. What is the conceptual model that scientists/engineers have of the basic and applied research needed to understand and improve the biological effects of dispersants?
2. Are there significant parts of the model that are "linchpins" on a critical path (i.e., crucial steps) for improving dispersant biological effects?
3. What is the time line for researchers in the study of dispersant biological effects? Is there an orderly sequence of steps and if so, how long will each one take?
4. What information must be obtained from practitioners to help researchers address components of the research conceptual model on dispersant biological effects?
5. What are the areas of overlap with respect to researchers' and practitioners' perspectives?

iv. Efficacy and Effectiveness

1. What is the conceptual model that scientists/engineers have of the basic and applied research needed to understand and improve the efficacy and effectiveness of dispersants?
2. Are there significant parts of the model that are "linchpins" on a critical path (i.e., crucial steps) for improving dispersant efficacy and effectiveness?
3. What is the time line for researchers in the study of dispersant efficacy and effectiveness? Is there an orderly sequence of steps and if so, how long will each one take?
4. What information must be obtained from practitioners to help researchers address components of the research conceptual model on dispersant efficacy and effectiveness?

5. What are the areas of overlap of the two perspectives (researchers and practitioners) of dispersant efficacy and effectiveness?

c. Breakout Session 3: Moving Forward

i. Near-Field Fate and Transport

1. How can what we have learned about researchers' and practitioner's perspectives improve the application of dispersants on future oil spills?
2. How do we use the relationships identified impact/change dispersants research?
3. How can practitioners use this understanding to improve oil spill preparation and response?
4. How do all stakeholders use a better understanding of the perspectives areas of overlap to improve interactions among themselves and the other groups (researchers, practitioners and public/NGO's)?
5. What mechanisms exist or could be created to continue interaction among all stakeholders involved with oil and dispersed oil to exchange of information and improve the application of new research findings?
6. Are there topics in these conceptual models that are not being addressed by research or other mechanisms?

ii. Far-Field Fate and Transport

1. How can what we have learned about the two perspectives on far field fate and transport that will improve the use of dispersants on future oil spills?
2. How do we use the relationships identified impact/change dispersants research?
3. How can practitioners use the perspectives to improve oil spill preparation and response?
4. How do all stakeholders use a better understanding of the different perspectives areas of overlap to improve interactions among themselves and the other groups (researchers, practitioners and public/NGO's)?
5. What mechanisms exist or could be created to continue interaction among all stakeholders involved with dispersants and dispersed oil to exchange of information and improve the application of new research findings?
6. Are there topics in these perspectives that are not being addressed by research or other mechanisms?

iii. Biological Effects

1. How can what we have learned about the researchers' and practitioners' perspectives that can improve the application of dispersants on future oil spills?
2. How do we use the relationships identified impact/change dispersants research?
3. How can practitioners use this understanding to improve oil spill preparation and response?
4. How do all stakeholders use a better understanding of the perspectives areas of overlap to improve interactions among themselves and the other groups (researchers, practitioners and public/NGO's)?
5. What mechanisms exist or could be created to continue interaction among all stakeholders involved with oil and dispersed oil to exchange of information and improve the application of new research findings?
6. Are there topics in these perspectives that are not being addressed by research or other mechanisms?

iv. Efficacy and Effectiveness

1. How can what we have learned about the two views improve the application of dispersants on future oil spills?
2. How do we use the relationships identified impact/change dispersants research?
3. How can practitioners use this information to improve oil spill preparation and response?
4. How do all stakeholders use a better understanding of the areas of overlap to improve interactions among themselves and the other groups (researchers, practitioners and public/NGO's)?
5. What mechanisms exist or could be created to continue interaction among all stakeholders involved with oil and dispersed oil to exchange of information and improve the application of new research findings?
6. Are there key points that are not being addressed by research or other mechanisms?

Appendix D: Breakout Group Diagrams and Notes

Near-Field Group Notes:

Breakout Session I

March 12, 2013

Response Practitioners' Perspective

- Surface Spill – Presumption of using dispersants? Impact of dispersant use, type of oil, efficacy of dispersant for that type of oil, physical properties of the oil. Whether you can get them there, resource tradeoffs.
- NEBA is not as important as sub-surface because Sub Surface plumes already have energy. 2 Rules of thumb for surface applications – *top 10m*
- Plume heights are 1.5 times the wave height. Another possible rule is wave conditions.
- Gulf winds are at an average of 5 meters per second. You need 4.2 m/s (incipient wave breaking is the key) to break a wave, therefore enough turbulence is present
- Rule of thumb for thickness?
 - Breaking occurs only at the margins where the oil is thin. Percent area for breaking is quite small.
- Color to the oil?
 - Oil has to be thick enough and has to have a color (brown) to it for application of dispersants. DOR changes. The aim to maximize the amount of oil. Preferred DOR – 1:90 – 1:100. 1:20 (depending on how much was spilled) is kind of good for the surface. What is the effective DOR? Effective numbers may be low.
- Amount of oil- how it's estimated? Like a crop dusting exercise. Assumptions – oil thickness
- Nomenclature issue – Definition of Dispersed. If the droplet size is *70 um* it goes down. Turbulent mixing keeps 70 um drops in the mixture. Sub surface, the turbulent energy goes down. Mix layer depth – used as a determining factor.
- The threshold (droplet size) is energy and oil dependent. Needs revision via research (the 70 um size).
- Q: Energy and turbulence in Gulf of Mexico different from Alaska? Flatness inhibits dispersion effects. You need some energy.
- Turbulence to get the big oil drops to break in smaller drops and then how much turbulence is required for keeping it dispersed.
- Two sources of turbulence, Waves break and push stuff down and Wind Shear. Should be evaluated separately as they are different processes.
- In practice the injection distance changes, the droplet size changes, so the process is complicated.
- Time steps are in the order of hours for studies. Land and sea breeze effects can be considered.
- Waves get too high- prevents application to oil. There has to be a range of waves.
- Note: Oil was dispersed definitely. Even if it's calm, oil should not come at the surface.
- Mix layers change every season? Mix layer depth is difficult to obtain. If shallow, concerns arise.
- Usually mix layer depth is 30-50 m. highest concentrations found at the surface and lowest at the depth. River plumes are to be worried about. High concentrations at sub

surface are the real issue to be worried about. Efficacy of dispersants in river plumes is questionable.

- How to deal with other Oceanographic fronts? Try to get to the oil thickness where dispersion will be most favorable. Mass Balance point of view? Route of dispersant discharge – skimmers v/s planes.
- Oil spill of the 1st Gulf war- Issue was surface oil transporting along the coast and being taken into sea water intakes. Gulf of Arabia.
- Any significant oceanographic features to make you not want to use dispersants?
- Dispersants have been used 20 times in last 30 years for spills no oil has been involved in. All surface spills.
- Processes used by practitioners? Droplet size depends on oil weathering, Mixing, energy, mixing conditions and DOR.
- Texas used dispersants a couple of times. So did LA.
- Effects of presence of environmental resources on the decision of the use of dispersants?
- Q: Depth of water- if Resources are not planktonic. Sediment deposition?
- 10 m or 3 miles depending on area
- Subsurface release near-field fate and transport:
- Well blowouts only. The size of the hole, release rate, the gas to oil ratio (GOR) and the oil density. All these factors determine the jet that eventually tells us about the plume.
- Stuff getting out of the hole (well blowout) and into the environment – 1st part.
- 2nd part – Release part. Stratification, structure of the currents and their variability. For most blowouts, the currents are not strong.
- Plume dynamics- size and density distribution of oil droplets and gas bubbles and dissolved components (critical). . 3-D space distribution of the oil droplets. Spatial scale, vertical structure and a horizontal scale.
- Trapping height (where the plume stops rising – loses buoyancy), thickness of the intrusion layer (goes horizontally) and overshoot (Peeling region).
- Far-field definition – when the environment takes over.
- Tracking the combination of oil and gas is important.
- Aspects of hydrate formations in near-field? What is essential to know about them?
- How to estimate the oil coming to the surface? Oil droplet size distribution is a key estimating factor

Plenary Session 1: Notes

- Surface application of dispersants
 - Applying surface application of dispersants under calm conditions. Did this come up?
 - Yes, general assumption that energy is needed for dispersant application to work and be effective.
 - As in wastewater treatment, is there a threshold concentration that after we reach it or are lower that we would be ok with the concentration?
 - Monitoring turbulence and dispersants will be discussed by the efficacy.
- Subsurface application
 - Exceeding initial physical injection, occurs near the plume
 - No regulatory number for oil like there is for wastewater. But maybe in the future.

- What are the effects of the oil being released?
- # rules of thumb –
 - 1. Definition of dispersed oil – size of droplets 70 μm or smaller that stay in the water column.
 - 2. Need some turbulence for the dispersants to work in the first place.
 - 3. Most of the dispersed oil can be found in the dispersed layer.
- Q: applying dispersants on calm conditions? There needs to be some energy. Too much energy is bad on the other hand. 4-5 m/s speeds needed.
- Q: Initial mixing zone, no need to care about the concentrations. No answer.
- Near-field sub surface application when there is a sub-surface release.
- Talked about only well blowouts. Release characteristics. Environment, stratification, currents and their variability, depth ...
- At what point the plume stops. Plume dynamics. Trapping height, thickness of the intrusion layer, overshoot. Oil and gas particle size distribution is a key factor.
- Hydrate formations?
- Q: Analogy zones of initial dilution, outside initial physical injection.
 - A: No regulatory number that you get to.
- Q: A way to talk about concentrations? Zone transition between near and far-field.
 - A: Figure out the area.

Breakout Session 2 and 3
March 13, 2013
Researchers' Perspective

Participants : Tamay Ozgokmen, JT Ewing, David Hollander, Aubrey Heath, Nancy Kinner, Jaspreet Arora, Malcolm Spaulding, KT Valsaraj, Rebecca Green, Debbie Payton, Ali Khelifa, Chris

What is the conceptual model that scientists/engineers have of the basic and applied research needed to understand and improve the near-field fate and transport of dispersants?

- *Surface*: Langmuir circulations are used by waves. Fronts are formed by lateral density gradient. The frontal structure is more prominent in the winter time. You have a lot of filaments, convergences etc.
 - Increase your spatial resolution- there is a problem
 - A lot of convergence and divergence- Accumulation along fronts. The distribution of oil is not homogeneous. Typically very high velocities associated. These are the higher order structures.
 - If wind speeds > 10m/s Langmuir circulations start to form. In the summer, there are not too many mix layers. Even when the mix layer was around 30 m in the Mississippi river, there were errors.
- Near-field definition for surface release: near the surface, not near the source. All the parameters being talked about have spatial field variations.
- Near the surface means-Near of dispersant application. Near-field is before the process gets out of your control/plan. Dispersants may not be applied to some frontal zones.
 - Maximizing the use of dispersants is difficult because of the oil distribution. You never have a homogeneous distribution. You have to consider ocean processes, waves and other possible processes.
 - Langmuir circulation- Paper by Jerry- documented an analysis method
 - A sedimentary record of material affects the transport of particles. Formation of flocculants? Ecotoxicological aspects of this? What are the roles of the oil, dispersant, their mixture etc. with the various particles.
 - Remediation processes are dependent on these oil-particle interactions. Do you need dispersants at oil in some cases? Some cyanobacteria were detected up in the surface. The sedimentation increased by a factor of 2. Also the interactions with Algae? Role of dispersants and particle interactions on the sedimentation process is to be studied. . Do the dispersants have any moderating or contributing role? Terrestrial inputs need to be considered too. Ongoing experiments show linkage to mineral composites. Particles with lithogenic material. Significant amount of flocculation and sedimentation. You see petrogenic and pyrogenic PAHs. 20 fold increase in organic carbon inputs and 300 fold increase in PAHs.
 - Experimental scales: up to 70-80 miles north east. 200-1800 m water depth.
 - Dispersant components were not analyzed. Redox chemical aspects of the sediments were studied. Connection between different types of clay minerals was studied.

- Time scales – 3 month long window for the sedimentation process. The spatial and depth related characterizations are being made. You also get an idea of the fluxes. Average sedimentation was measured to be 3-4 cm/ year. This can also be dated and the corresponding flocculation can also be calculated. Not sure about the role of dispersants.
- Marine Geologists have been studying the sedimentation rates for decades. A bridging phenomenon. Application of dispersants. Oil sediment flocks are very similar to the natural flocks.

What's needed in the future?

- A lot of work on the above was done in Alaska
- Most of the fate of transport is because of chemical effects and the environment. The environmental winds lead to an inhomogeneous distribution of oil. Different factors depend on the time scales.
- In terms of the dispersant response you try to go the thin oil slicks. Near-field is some distance away from the source before it hits a transition.

Are there significant parts of the model that are “linchpins” on a critical path (i.e., crucial steps) for improving dispersant near-field fate and transport?

- Understanding droplet size distribution, understanding processes of flocculation and sedimentation, understanding and modeling velocity and turbulence structure (especially upper 3 m of the water column), wave current interaction near the sea surface,

What is the time line for researchers in the study of dispersant near-field fate and transport? Is there an orderly sequence of steps and if so, how long will each one take?

- 20-50 years for ocean flows. 3-5 years for the flocculation and sedimentation studies.

What information must be obtained from practitioners to help researchers address components of the research conceptual model on dispersant near-field fate and transport?

- An important insight into how things are actually in the field. Iterative procedures would help. Forecasting movements of fronts. Observational data to confirm or validate flocculation phenomenon. Dialogue with practitioners regarding their experience with spills that can help in research.
- *Sub surface near-field processes Q1.*
- High pressure, high temperature experiments. Up to 150 bars. Particle size (oil droplets and the bubbles) distribution and particle velocities are quite difficult to measure in the same environment. More info needed on conditions. High resolution images needed. Bubbles rise very fast and interfere with the oil droplets and introduce turbulence.
- Biodegradation at high pressure conditions in the near-field phenomenon.
- Two different droplet sizes, >1 mm optical measurements for them. High resolution camera in high pressure conditions.
- Single methane bubbles – in range of 1 mm. Studying velocity of the bubbles at diff pressure conditions. At 4 degree Celsius and 150 bar. Rising velocity decreases because of the hydrates.
- Shear Module- Next step. To study the bubble under shear stress (introduce velocity gradient between a stationary plate and a rotating plate) Ambient conditions and under

pressure. Looking at individual bubbles in the laboratory. Want to simulate the shear stress in the plumes.

- Scaling laws? Info from blow out videos. What info u need from practitioners?
- High resolution PIV analysis is ongoing and will be available in the future. Eddy simulations by Tamay are available.
- **Data from SINTEF run experiments in their big tank is critical to many people's work.**
- Gas bubbles, how far are they driving the oil jets?
 - Images which are higher than 20m over the blowout are not helpful, but there is gas present.
- CDOG simulations estimate the trapping depth. When the gas goes in solution, the buoyancy force dies out and then horizontal migration takes place. Amount of gas going in solution depends on bubble size and other factors.
- Difficult to obtain mass transfer coefficients for gas bubbles.
- At what height does the methane disappear? When the plumes get trapped, all the methane is in solution. The overall number is more important which will help you determine the height where trapping occurs.
- API phase 2 activities are going to happen soon on high pressure, low temp conditions. These are very expensive experiments with custom built facility.
- Experiments with dispersants are scheduled for next year. Biodegradation under pressure experiments are being carried out. It takes some days. So this gets initiated in the near-field and goes into the far-field. Right now the experiments are without dispersants.
- Mixed case with dispersants can be looked at.
- The Modeling of all the above processes is essential. There are different modeling approaches. There are lots of complicated factors that need to be corrected.
 - At the sea bed, the currents are well behaved as compared to the surface. Therefore, the factors need to be less complicated.
 - Methods that can take models to the ocean scale have to be developed.
 - The transitioning from one model to another in terms of scale is essential.
 - Feedback loop? There is a scale discrepancy of 3 orders of magnitude in the ocean and pipe models.
- 3 sources of flow
 - Jet, oil and bubbles, hydrate.
 - Gas is a greater driving force because of its low density.
- The environment in a plume in shallow water is a very complicated system. In a shallow water setup, the rapid rise of gas can cause safety issues when it comes to burning up stuff.
- Top of the plume is in the mixed layer? Complex density profile alters the trapping behavior. Much stronger currents are found closer to the surface.
- Different geometries have to be accounted for in models. Because the extraction rate is less than the release rate (top heads), the plume initially goes down and then comes up. Configuration of the new devices is important to know. Effects of mixing dispersants at different times or their premixing has to be taken into account.
- Use of a diffuser, need to consider new technology which adds a diffuser on pipes in addition to applying dispersants.

- Details about the dispersant application. What is the least amount of dispersant that can be used effectively? The DOR? The site of application? The velocity of injection? How will bubbles interact with the dispersants– Key areas of research? New tools needed for measurements and computation to answer these research questions. What kind of collection techniques can be used for high pressure conditions? Tools used in the lab should be used in the deep waters.

Linchpins?

- The fundamental one is to understand the application of the dispersant interactions with multi-phase fluids and flow and monitoring of those interactions to help translate from the lab to the field. Scale/Translation can be easier if we understand how the process of scale up works. Modeling represents a potential bridge.

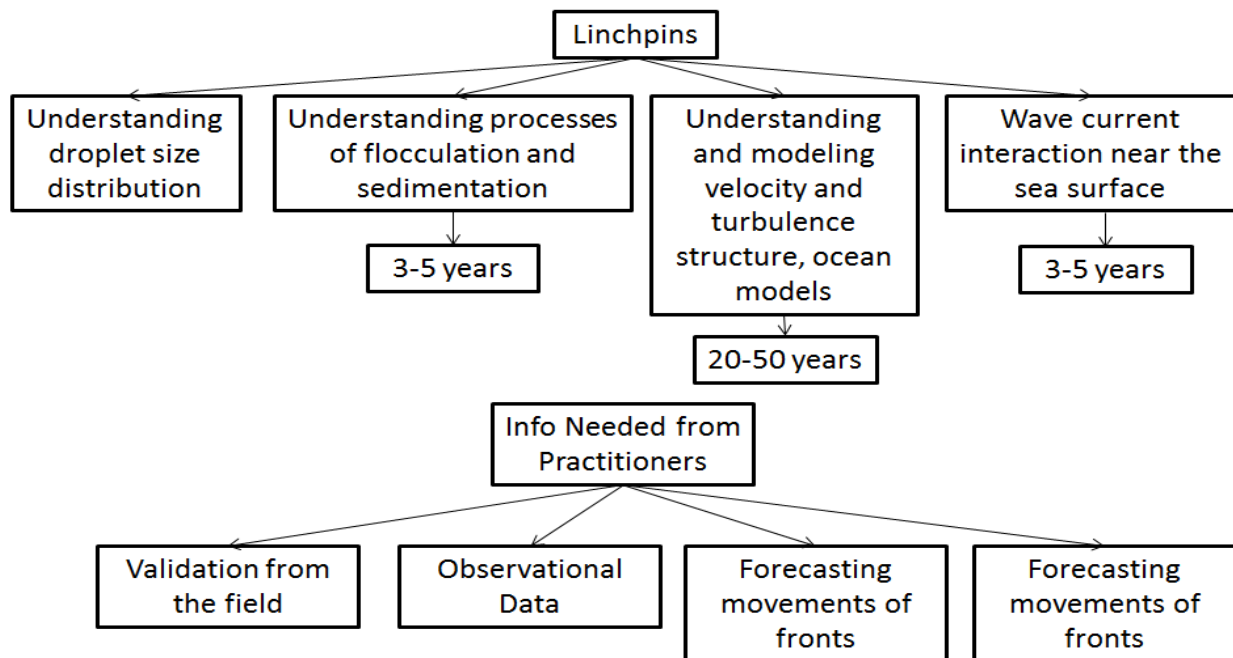


Figure 10: Linchpins for Researchers and Information Needed From Practitioners

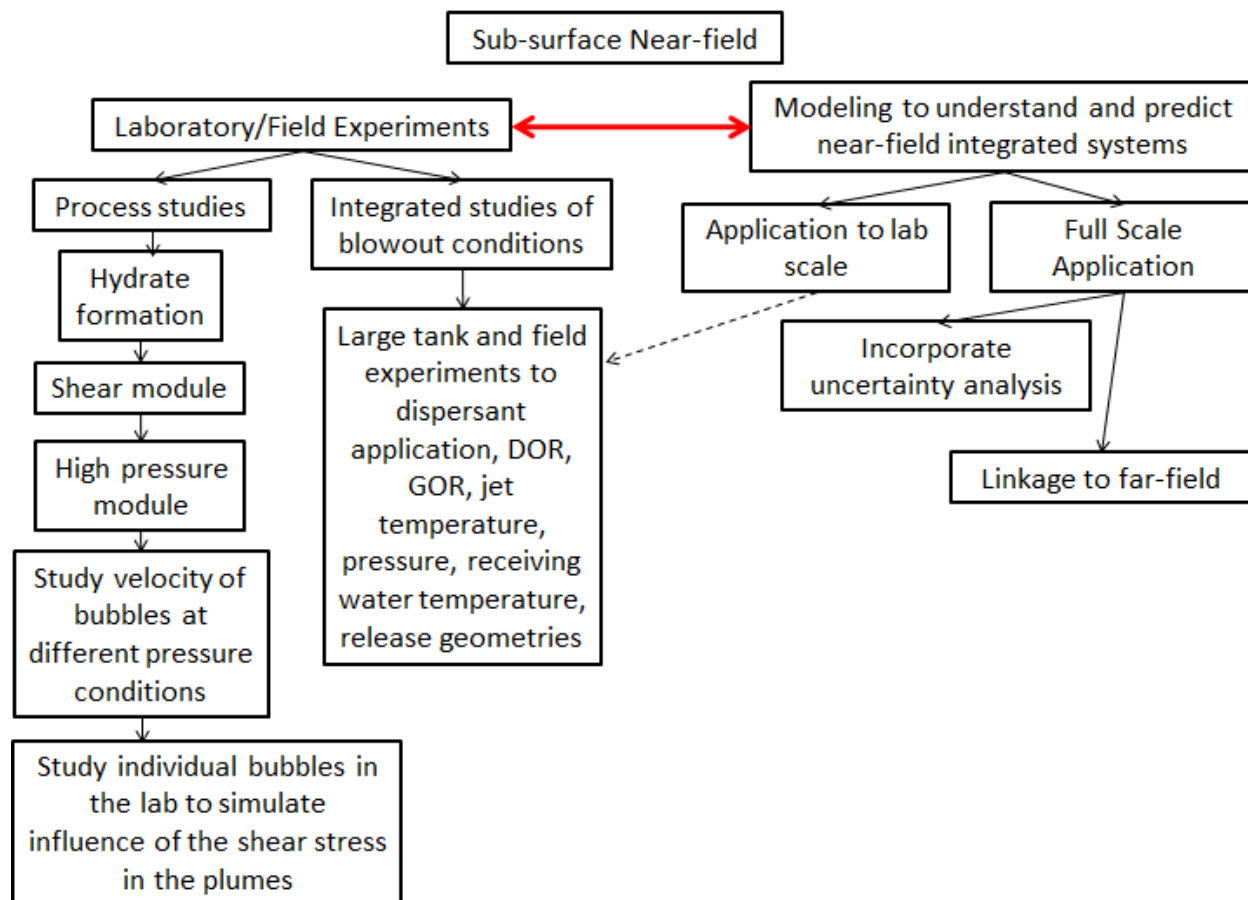


Figure 11: Near-field Sub-surface Overlap

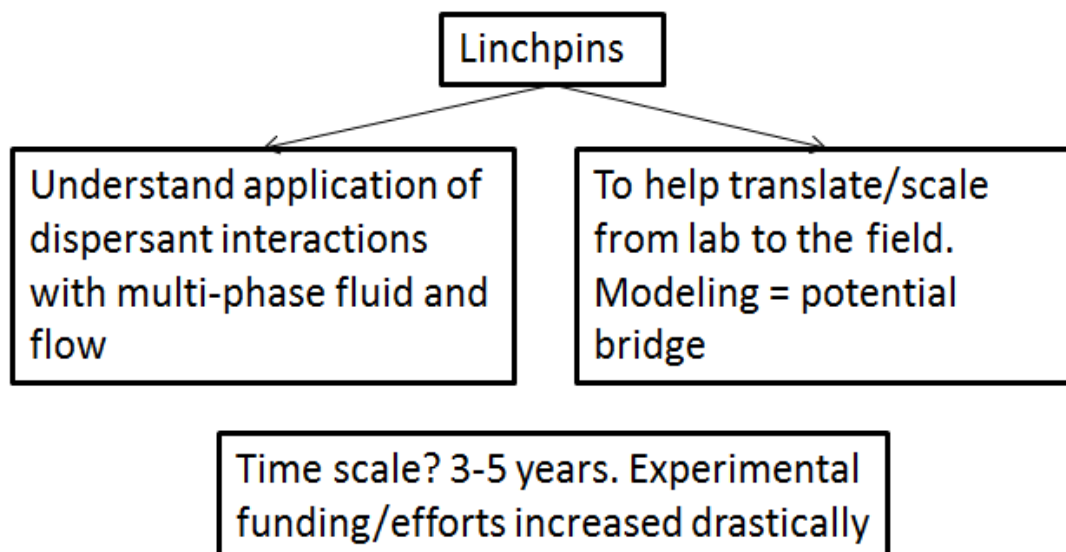


Figure 12: Linchpins to Overlap

- *Time scales?* 3-5 years. Experimental funding and efforts have been increased drastically.
- *Info from practitioners:* field observations, linkage to videos. Asking how things worked, how well they worked. Data from the past spills. Revisiting the observations of them and asking what led them to make those decisions.
- Data in the deep needed to document effects of the dispersants. Asking what was their objective?

Plenary Session 2: Notes

Surface application of dispersants on the near-field

Q: Under calm conditions vs. turbulent conditions

A: need some energy, calm does not work, too much energy complicates, ~2m

Q: Mixing zones no need for concentration... dispersion application?

A: no comment

Q: turbulence near-field

A: movement uncertainty variability – did not discuss

Monitoring covered by effectiveness group

Note: This question was asked over the phone and was unclear to the note taker.

Near-field subsurface application of dispersants when there is a subsurface release

Q: Analogy with exceeding initial physical ejection

A: near plume

no regulatory number

Q: range of concentration – high at source of release – what is too high with respect to distribution

A: near-field vs. far-field – not trying to control release just to evaluate effects – concentrations of concerns – cannot predetermine

Far-Field Group Notes:

Breakout Session I

March 12, 2013

Response Practitioners' Perspective

Are there significant parts of the process that are “linchpins” on a critical path (i.e., crucial steps) for determining dispersant far-field fate and transport and whether it is acceptable?

- Human health during response (minimize risk, some risk is acceptable in the protection of human health),
- exposure pathways after incident
- regulations Endangered Species Act (ESA)
 - special protected areas
 - marine sanctuaries and other
 - seasonal considerations
- better 3-D modeling (currents and weather--> driver of ultimate fate)

What is the timeline for determining whether dispersants have adequate far-field fate and transport to be considered useful tools in a spill response?

What information must be obtained from researchers to help practitioners address issues they have with respect to dispersant far-field fate and transport?

- Far-field vs. near-field:
 - situational/temporal differences of each incident
 - makes hard to define
 - depends on
 - local/region oceanography
 - scale/footprint
- our purposes = short duration (temporal limitation)
 - geographical limitations will be dependent local/region oceanography
 - scale
- far-field could be effects far from the region of application
- question presented deals with transport of dispersed oil
- surface slick scenario that has been dispersed (practitioners):
 - Where is it going to go? When is it going to get there? And at what concentrations relevant to at risk receptors?
 - Transformations in chemical composition over time
 - potential effects of transformation products
 - surface particle movement/transport--> better ways to capture
 - How good are our models? Can we trust them? How do we validate/cross check models?
- Special Monitoring of Applied Response Technologies (SMART)
 - 3 tiers
 - 1. visual orbs--> I see a change
 - 2. efficacy testing
 - 3. more scientific data

- flexible to answer questions needed during the response
 - tailored based on need and risk
 - incorporated into future response
 - Water column samples etc.
- detection of oil 1/10 ppm = LOD → not sufficient for far-field monitoring (too dispersed within 48ish hours)
 - depth of surface mixing →
- what receptors are down stream and at risk(dispersants vs. the do nothing option)
 - Regional specific (e.g. habitats, species, etc.)
 - time frame of exposure vs. environmental presence of parent compounds and transformation products
 - more polar trans prod-->persistence and effect (changes in)
 - ESA (endangered species act) consultation and other regulations--> need to be performed
 - pre-approval vs. after action
 - difficulty of getting consultations within time frame of response
 - ROT-6 and 4 NIMPHS form filled out within a reasonable time frame with prior verbal communications
 - coast guard--> determination of threat to an ESA species during response, must complete an after action evaluation/consultation
 - formalization of process
 - species should be identified in regional plan
 - often species driving decisions, habitat/etc. may be just as important in supporting that species
 - recognition of risks associated with any response (including do nothing)
 - dispersants shorten the life time of oil in the environment
 - oil will be in the environment longer
 - Tampa bay spill (1993?)
 - critical volume for dispersant use?--> no magic number, situation dependent
- current 3-D modeling
 - data gaps
 - not enough data to constrain the model or validate (data not available)
 - temp, salinity--> ultimately drives sub surface currents
 - how good do you need the answer--> acceptable level of uncertainty
 - information that practitioners have to base decisions on is extremely limited
 - Models are more conservative than actual fate in the environment--> good enough?
 - What do we want to know in the future that we can't answer today based on current models/data
 - models are limited in how far into the future they can predict a response
 - dynamic ocean environment (e.g. currents)
 - weather
- health and safety--> seafood
 - public perception plays a prominent role

- special protected areas
 - marine sanctuaries and other
 - seasonal considerations
- Time lines--> how much time do we have to make a decision?
 - Max = 24 hrs.
 - decisions regarding surface spills must be dealt with within 2-3 hours
 - Time frame may be extended to 24 hrs. for subsurface releases
 - no time to collect data--> emergency response relies on past incidents/experience and pre-planning
 - understanding gained from current response can only be incorporated into the response to future events
 - minimum regret
 - assume situation is worse than it is and respond accordingly
 - go big early--> can turn off the response, much more difficult to mobilize as time since incident increases
- difficulty in applying dispersant to correct area and at ideal concentrations

Plenary Session 1: Notes

- Far-field is difficult...need better models that can predict for a longer timeline.
- How did the diagram reflect uncertainty? The diagram did not. Uncertainty of where oil will go, what's at risk. Modeling these uncertainties is difficult. Minimum threat approach. The more accuracy (the fewer unknowns) that be a better model.
- May not have enough data to use probability to create a model for an oil spill.
- Definition of near field and far-field. Temporal perspective. Time after couple of weeks etc. Protecting public and environment- Practitioner.
- Net result should be a benefit. Upsides and downsides of decisions taken in account rigorously,
- Where will oil go? Can it be dispersed, concentration distribution of oil? Are the receptors going to be effected? Is the dispersed oil worse than surface oil? How much timeline do we have to make decisions – surface (1-2 hours), sub surface (maybe a few days). Learn from the past!
 - Addition: Basic science- tracers that can be dispersed in the environment- can be observed and tracked. Which are biologically safe? Need to improve modeling.
- Q: Timeline of decisions. Will effects of oil on fishes etc. in a temporal manner be considered?
- Q: How the diagram addresses uncertainty?
- 3-D current – not sure about. Probability, enough data?

Breakout Session 2 and 3
March 13, 2013
Researchers' Perspective

Are there significant parts of the model that are “linchpins” on a critical path (i.e., crucial steps) for improving dispersant far-field fate and transport?

- Authentic materials of what was applied during response (needed to track changes, validate).

What information must be obtained from practitioners to help researchers address components of the research conceptual model on dispersant far-field fate and transport?

- Relevant exposure times
- chemical composition and persistence of parent compounds and transformation products
- dispersant vs. dispersant oil mixtures
 - toxicity (relevant exposure ratios for lab experiments)
- forensic links (finger printing)
 - where did the dispersant come from
 - far-field effects--> how do you discriminate dispersant from the response from dispersant from other (near shore) sources
- consumer use dispersants of concern
 - persistence
 - alternative dispersant for future use
 - ex = reduced solvent ratio of current dispersants--> result = less toxic and more efficient
- tracers/surrogates (one day meeting in WA)
 - as a method for increasing understanding of transport modeling/real time surface transport
 - designed to biodegrade
 - remote sensing
 - non-toxic
 - depth mixing
 - dilution rates in open ocean--> fluorescence (current use)
- background concentrations dispersant and hydrocarbons in the absence of dispersant
 - sample known point sources
- form 209 (coast guard)
 - mass balance of oil attenuation and dispersants
 - better models will help increase accuracy
- differences in environmentally relevant dispersant action vs. lab (in regards to toxicity)
- Near vs. far-field
 - near: immediate zone of mixing-->high concentrations
 - acute toxicity concerns
 - composition more closely resembles Corexit
 - heterogeneous/patchy
 - far-field: composition after dilution (e.g. lower concentrations)
 - homogeneous
 - steady state

- temporal and spatial fingerprint
 - materials likely to be used--> what is stock piled (component constituents)
 - method development and validation takes time
 - ability to do some of this prior to the need generated during a response helps speed the process
 - precise ratio of components defines surfactant action/efficacy
 - variability of ratio--> testing only involves performance requirements prior to application
 - actual compound composition varies from lot to lot
 - capturing component mixtures as they are applied off the boat (500 mL)
 - helps define uncertainty around down field changes to component mixture over time
 -
 - in advance samples of all the products that could possibly be used
 - do preliminary research upfront, rather than reactionary
 - samples of surface slicks with and without Corexit
- challenges of in spill response sampling
 - not practical for during spill response
 - must study under more controlled response during preplanning (to manage variability)
 - Only under controlled conditions will generate enough scientific rigors for data collected to be meaningful.
 - Challenges become larger in the field, reserving materials during preplanning may be more easily achieved
- Over what time frame should we be collecting samples
 - need to define this for dispersants (lab)
- shelf life of dispersant
 - dispersants are made in large quantities and stored until it is needed
 - stock piles get randomly tested overtime for performance
- up front willing cooperative relationships between involved parties
 - reverse engineering of products, takes time and slows down generation of data being requested
 - 2-3 yrs. after response, still in discovery phase of research due to above limitations
- need to answer some of these questions prior to next spill to define exactly what we need to study
 - ex: degradation times of key components
- complications of complex mixtures of dispersants
 - difficult, takes time to develop methods
 - relies on collaboration between academics and industry and access to samples
- environmental complications
 - complicated dynamic system
 - Need to range find across representative systems indifferent “compartments” to be able to better define (microbial communities, depth/pressure/temp, nutrient loading, etc.)
 - time scale of partitioning

- likely zones of impact (need to better define)
- SMART
 - initial ($t=0$) sample of dispersant is not collected
- alternative, less persistent dispersants
 - practitioners only see a need for this if there are clearly defined unacceptable risk to Corexit
 - this question needs to be answered first, to provide incentive/need for alternatives development
 - Alternatives require a lot of validation and testing which is prohibitively expensive unless there is a clear need.
 - Potential drivers
 - eliminate potential persistence and plausibility of toxic effects
 - there are studies that suggest deleterious consequences at environment relevant concentrations
- time line
 - pre-planning phase collection of back ground levels
 - near shore, wastewater treatment plant (WWTP) effluent
 - likely point sources
 - these samples are critical to validation
 - involvement of capable large scale laboratories
- What size dispersant application would trigger a high level of monitoring/sampling?
 - Most events are on a much smaller scale than DWH
 - creating methods and tools to have in place prior to response to be able to answer the question of far-field fate
- need methods in place ahead of time
 - so we know how to collect samples and in what quantity so that a minimum number of samples can be analyzed properly
 - issues of sample storage, transport etc. need to be known before samples need to be collected
 - when should we be looking/collecting
- dispersants are not used in fresh water
- Metabolic markers of fish exposure to dispersant not currently studied?
 - Potential for bioaccumulation of dispersants or dispersant/oil mixtures
 - change in route of exposure
- needs for collecting data during a response
 - clear instructions and training--> to be able to generate the samples needed
 - job aids
 - need to contract additional groups targeted with collecting needed samples--> financial issue
 - possibility for charging portions of academic groups with sample collection--> financial cost transferred from regulatory agencies
 - may have window of opportunity to put some of these procedures in place given changing regulations/methods in response to DWH
- need for more/better utilized meetings of scientists and practitioners during response to better address needs and concerns
 - road blocks to this include

- amount of work required for a response given time available
 - science directed by public perception
- coordination between groups involved (academics/responders/agencies)
 - better cooperation
 - Memorandum of Understanding (MOU; coast guard and region 7)
 - Cross training (lingo/process/etc.)
 - allows better understanding of how to better support efforts between groups
 - pre-planning efforts
- conceptual diagram
 - near-field components are considered to be mixed and resemble neat dispersant
 - far-field individual components are subject to separation and degradation and partitioning processes that can change the chemical make up
 - generation of meta stable intermediates
 - Oil/dispersant mixtures are subject to a concomitant separate pathway subjected to the same processes.
- Comments on conceptual model
 - identifying sources of dispersants
 - need finger print that absolutely identify source similar to that for hydrocarbons
 - fingerprinting is currently an interest of the academic community--> method development takes time

What are the key questions practitioners need answered?

- short term vs. long term dispersant use
 - long term use is where sample collection/science can occur
 - practitioners need small list of key pieces that can be accomplished
 - can't deal with long wish list
- what are the key pieces of data needed to be collected in real time during a response and who is going to pay for it
 - partitioning of dispersant between oil droplets and aqueous phase
 - need for better understanding of dispersant behavior in environment to direct future sample collection during a response
 - access of academic community to samples and large scale experiments (WAVE TANKS, ETC)

Summary Questions

How can what we have learned about the two perspectives on far-field fate and transport that will improve the use of dispersants on future oil spills?

- More public outreach in collaboration between academics practitioners and industry.
- Use knowns about past use of dispersants to convey actual risks and benefits to public rather than leave the framing of the issue to the media.
 - Honest brokering of what we do know relative to dispersants do and impact
 - credibility of academia vs. agency
 - expertise in oil differs from dispersants, need attention to both

- sufficient funding and focus to plan for monitoring of next event
- create check list/flowchart of current data/knowledge and future needs/procedures to be used in future response
 - National Response Teams/Regional Response Teams (NRT/RRTs)
 - Get everyone on the same page (inter agency etc.)
- inclusion of academics in regional response team meetings
- Use of mechanisms such as the National Response Center (NRC) to develop a finished product defining consensus based understandings of current knowledge of practitioners, industry, and academic research.
- Define what we know and uncertainties
- Is the net benefit assumption of dispersant use true? Need to answer this
- Need a better understanding of how dispersant and dispersant oil mixtures change in composition over time.
- Challenges
 - still waiting for a lot of the data to be processed so that we can understand what we have learned
 - not ready to synthesize current knowledge
 - Collecting data from multiple sources into one source so that synthesis can occur.

How do we use the relationships identified impact/change dispersants research?

- Current academic research is directed at addressing current data gaps identified by practitioners and regulators
- should this research be directed at specific components likely to be used in future response or should this research be broadened to a wide scope of potential compounds
 - switching component mixtures for alternatives may increase unknowns
- Need to better define how what we know about efficacy and impacts of dispersants effect the net benefit assumption? Do we still think there is a net benefit to dispersant use
- Oil Spill Response Organization (OSRO)
 - in response to a spill, stockpiled dispersant identified in the response plan (company specific) are what will be used
 - RRI (response resource inventory)
 - lists stockpiled dispersants for use in response

How can practitioners use the perspectives to improve oil spill preparation and response? How do all stakeholders use a better understanding of the different perspectives areas of overlap to improve interactions among themselves and the other groups (researchers, practitioners and public/NGO's)?

- Full story won't be out until NRDA information is released
- increase response time of modeling
 - transport, resources at risk
 - Part of preplanning should include potential transport and (resources at risk???) RAR (of surface and subsea)
 - subsea dispersant use should be included in response plans
- need better understanding and modeling of subsurface oil/oil-dispersant dispersion to create better 3- d models
 - data gaps need to be filled to drive models

- historical data could be used to develop a 3D TAP
- must use community approach/cooperative effort--> problem is too big for an individual agency/group
- NTL
 - define how oil spill response plans (OSRPs) are laid out
 - in future area contingency plans will be publicly available online
 - include modeling component of ACP IRPs
 - area contingency plan
 - federal plan for emergency response
 - what is important from federal perspective
 - IRP: Industry is responsible to have its own response plan
- regional contingency plans need to involve all of the above
 - consistency between area, regional, and national contingency plans (ACPs RCPs NCP)
- ACPs generally deal with near shore environmental
 - off shore effects should be included-->RCPs might be best suited for this
- public perception of dispersants is a major issue
 - fish closures have a large financial impact on an important industry
 - use of dispersants on small scale spills may hang on public perception
 - communication to public of actual vs. perceived risk is an important component

What mechanisms exist or could be created to continue interaction among all stakeholders involved with dispersants and dispersed oil to exchange of information and improve the application of new research findings?

- Need to promote an understanding amongst all stakeholders that oil spills are bad and that any response has inherent risks and impacts, but the response chosen is geared to minimize impact
 - manage expectations of what is possible in terms of minimizing impacts through a response action
 - response actions are not silver bullets
 - need to convey honest info
- incident command system
 - joint information system is responsible for synthesizing response and conveying it to media
- academic community may best serve in role of answering questions about understanding and risk for the media
 - more trusted
 - may be best served through formation of panel of experts from academic community to convey consensus based understandings and uncertainties
 - pre-planning could involve identification of potential participants which could be brought into JIC and other agency mechanisms for communicating with the media
 - creating of a panel of academic experts may also reduce public perception issues related to
- road blocks to agency and industry publishing
- passing the gauntlet of internal oversight

- establish firewalls between industry/agency and academics to preserve public trust of academics
 - have corporate money pass through 3rd party (GOMRI, NAS)

Plenary Session 2: Notes

Comment: Far-field is very difficult - timeframe small, quick decision required, all impacts must be considered – operational models must be practical

Use of models for preplanning is useful. I.e. assessment workshops – but cannot be specific

Q: How is uncertainty addressed?

A: Not. But, practitioner must address uncertainty of where oil will go or risk – would rather take worst case potential – assumptions of threat zone – decisions based on that – less unknowns would clarify decision-making

Q: Model to predict impacts of oil

A: Surface oil has been done before, difficult. 3D current, no statistical information available

Disaster probability like hurricane services – but difficult with oil spill, not enough data – presenting probability is difficult for the decision maker. Who will decide what probability is a trigger point?

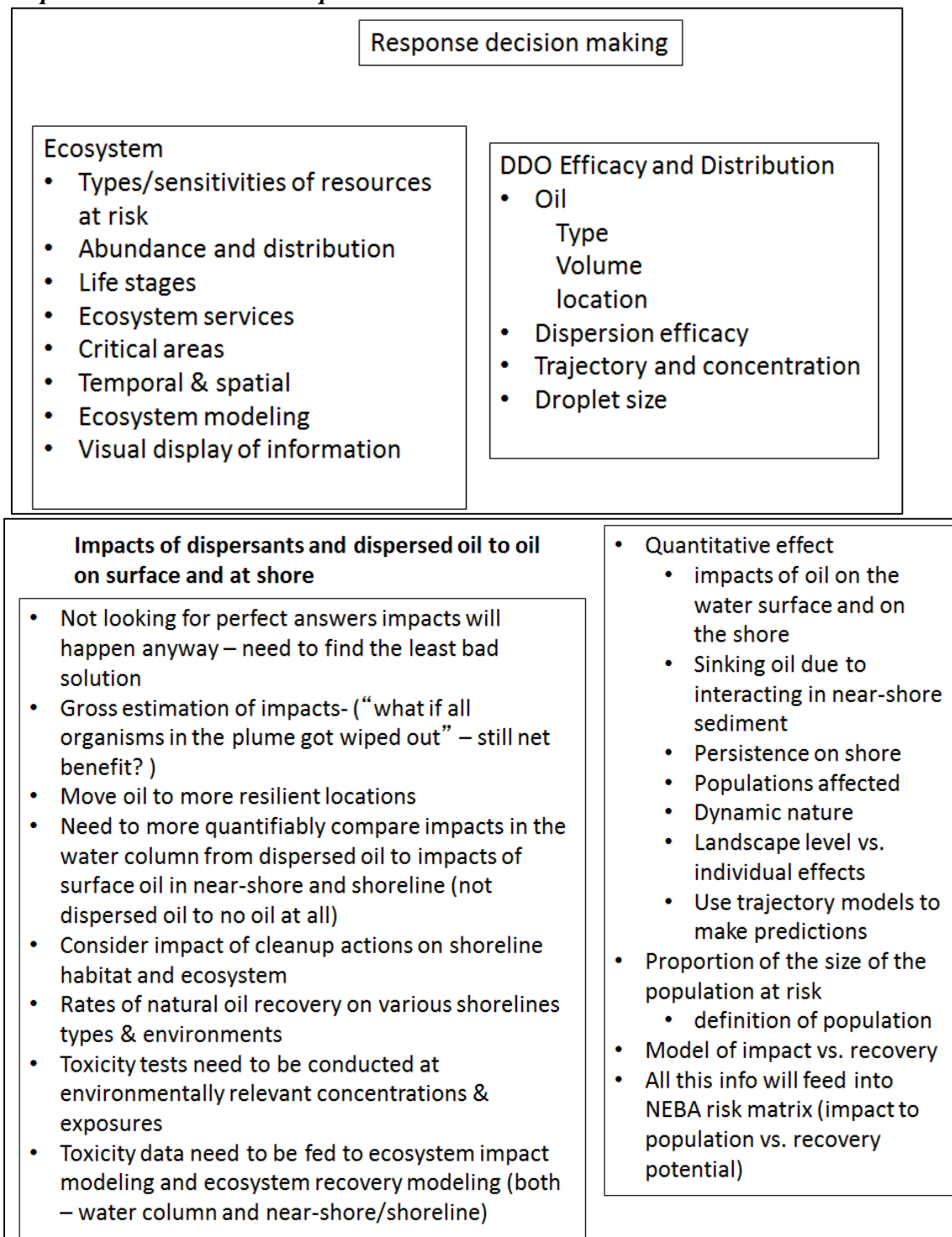
Comment: Environmental analysis approach for possible impact, uncertainties must be addressed

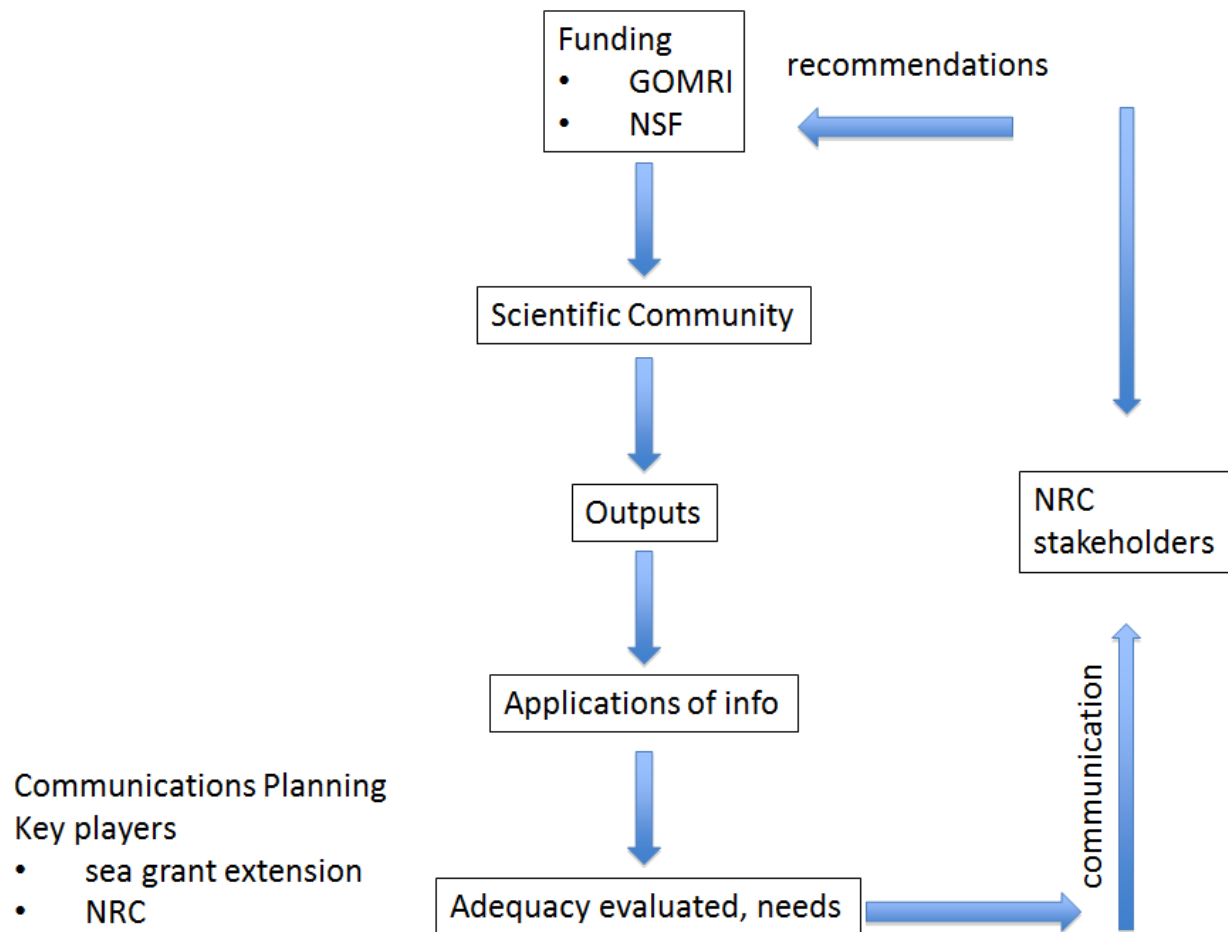
Biological Effects Group Notes:

Breakout Session I

March 12, 2013

Response Practitioners' Perspective





What information must be obtained from researchers to help address components of the practitioners' perspective on dispersant biological effects?

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- Light blue boxes indicate data types required. Pink boxes are processes, activities and products conducted before or after a spill. DDO is dispersant and dispersed oil; data of interest includes comparison of chemically-dispersed and physically-dispersed oil.
- The Assumptions used for modeling are either not fixed or not properly defined
- Population Modeling has to be established pre oil spill so as to know to have the information handy for the decision makers
- Toxicity Effects of different types of dispersants (gel types, or additional chemicals) has to be determined so as to apply them appropriately according to the situation.
- Biomarkers degradation – fading effect of dispersed oil over time has not been studies so don't know what is the fate of the oil overtime is?
- Balancing gross effect – decisions based on the population loss. The actual field condition is difficult to bring to mimic in the lab. In the midst of response this info takes long time to process or does not predict the accurate solutions hence prove useless

- Collecting data during response has to be available ASAP. There has to be rapid turnaround for the response based on the available data from the spill site.
- The type of data to be collected includes Concentration, type of oil and the type of hydrocarbon in water column during the spill.
- What species are at great risk? Risk Matrix has to be determined before the spill actually happens.
- Actual exposure to species or microbial community varies when comparing the pre study based on concentrations used in the lab. Experimental limits hinders this
- Tests at low concentrations have to be designed in the lab so as to mimic the field conditions.
- Sensitivity of marshes, visualization and compression of pre results dictates decision-making in the field.
- Decision process of preapprovals eluted in the idea of dilution has to be firmed and recognized
- Tradeoff using the dispersants in the oil spill: oil not on the surface rather in the plume or subsea, dilution concentration, or the toxicological info has to be available to reach the decision in a time bound condition
- What are the critical elements of the decision process in that timeframe? A conceptual model will be helpful in determining that.
- Ignored Population areas on the map? Some areas that have high population area could have been ignored altogether. Community affected by the dispersants.
- Protection of certain species over other ones in the ecosystem. Protect species that the public really care about or the species that support the entire ecosystem. Basically, prioritizing species that are more affected by the dispersed oil versus that are less dictated by the spill.
- Some species in the ecosystem have a fast restoration rates and so are less affected by the spill. Calculation of percent population affected and what is the recovery rate to the spill. Risk Assessment matrix is the key method to determine this parameter
- Discrete species are present in that particular water column and how to model it.
- “Natural resource damage assessment”
- Impact of different degree of spill on shoreline (lightly oil and not heavy oil). What is the Net effect on the environment?
- Magnitude of impact of degradation on the shoreline might help to understand the net outcome and if marginal oil on beach versus some oil that involve cleanup is the way to go during the response. It might turn out that less environmental damage could happen if left the beach as it is.
- What is the gross effect that goes in the NEBA and that would provide a quantitative ranking tool in the decision-making process in the case of oil spill?
- The cleanup restoration technique could in fact damage the habitat instead. Long term effect of the invasive cleanup is not known.
- Difference in modeling of dispersed oil versus undispersed oil and what is the impact difference in going either path.
- Timeline during response: monitoring, sampling that loops back into the preplanning phase.
- Dispersant operations drills are not in place yet.

Critical Points in the Process

Data inputs (light gray boxes) occur and are critical during both preparation and post-spill phases, but the difficulty of bringing high-quality data increases after a spill occurs.

Both response and NRDA actions need to feed data back to prepare for future events.

There must be rapid and timely feedback between the response actions and the data inputs that affect it while the response action is occurring.

Timeline

The group agreed on the overwhelming importance of preparation in order to be ready with all pre-approvals, skills, tools, and other needs that will affect decisions made during a spill. So focus on preparation is critical.

Research on effects of dispersants under different spill and response scenarios is most critical in the interim between spill incidents. While research may also occur during an incident, it is not timed appropriately to enhance the effectiveness of the response. Practitioners need not only research results, but also interpretations in the context of response scenarios, incorporation of findings into response tools, and communication of these findings between responders, stakeholders, and to the general public.

Information Needs from Researchers

Ecosystem models need be improved, with better information on links between resource types, and provide higher confidence in predictions of consequences of various response options. It would be very helpful in a response to better understand the tradeoffs of protecting species that may be of high public interest over those that play critical ecosystem roles, as well as the relative likelihood that protection efforts would be effective. Better understanding recovery rates would also facilitate response decisions.

Sensitivity indices, risk analyses, and benefits analyses need to be improved with higher quality data and active involvement of the science community. Prior to an actual event, there needs to be a clear understanding of the ecosystem types and resources at risk, baseline data on abundance and distribution of key species, knowledge of life stages at risk and critical areas, temporal and spatial dynamics of ecosystems, and assessments of resistance levels and recovery potential. Furthermore, the risks and benefit of all aspects of use/non-use decisions need to be considered – e.g., the effects on air, surface water, and subsurface in different scenarios, the effects of mechanical vs. chemical treatment, the tradeoffs of cleaning vs. leaving some oil on beaches and marshes. Effective, interactive visual tools displaying this information need to be prepared for use in a response.

There is a need for greater understanding of the relative risks of DDO impacts in the water column compared to the ocean surface and near-shore or shoreline areas. Also, more research is needed on the relative impacts of chemical vs. mechanical cleanup methods, and the rates of natural degradation of oil in various ecosystem types and environments.

Toxicity information for different dispersant types should be made more easily available and more understandable, so it can be used in a timely manner by responders, stakeholders, and the media. Particularly important is the need for data that reflects real world changes in concentrations caused by dispersion and dilution, changes in chemicals over time that may affect toxicity, expected dispersion efficacy based on oil types, volume, location, and trajectory.

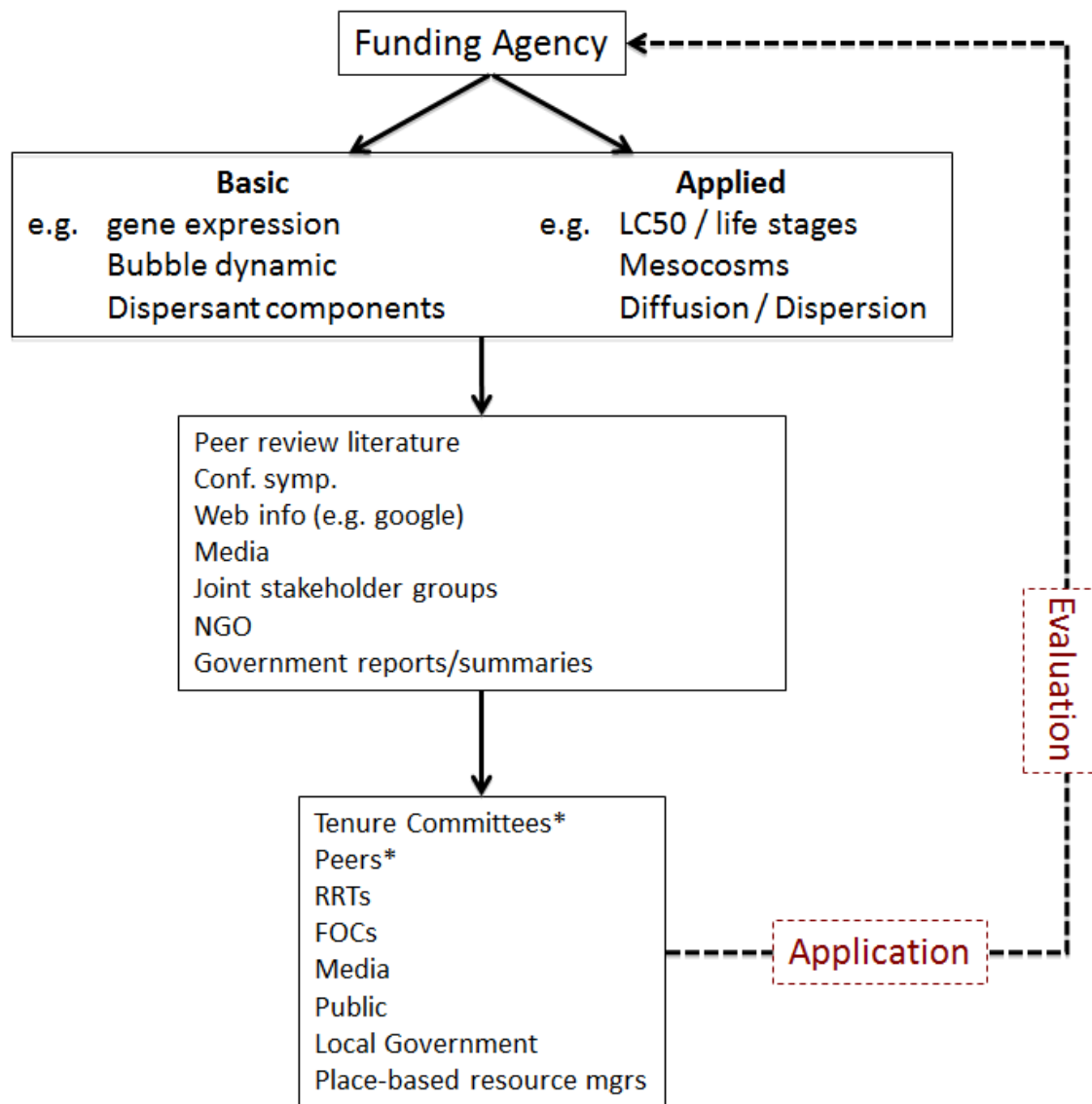
Better understanding of the mechanisms and consequences of sinking oil as it approaches the near-shore environment (e.g., interactions with suspended sediment and plankton) will help responders mitigate damage, and better predict and assess injury to water column and benthic communities. We also need to know more about how the addition of dispersants (surface and sub-surface) affects the tendency of oil to attach to sediments and plankton, thus altering vertical movement and patterns of deposition.

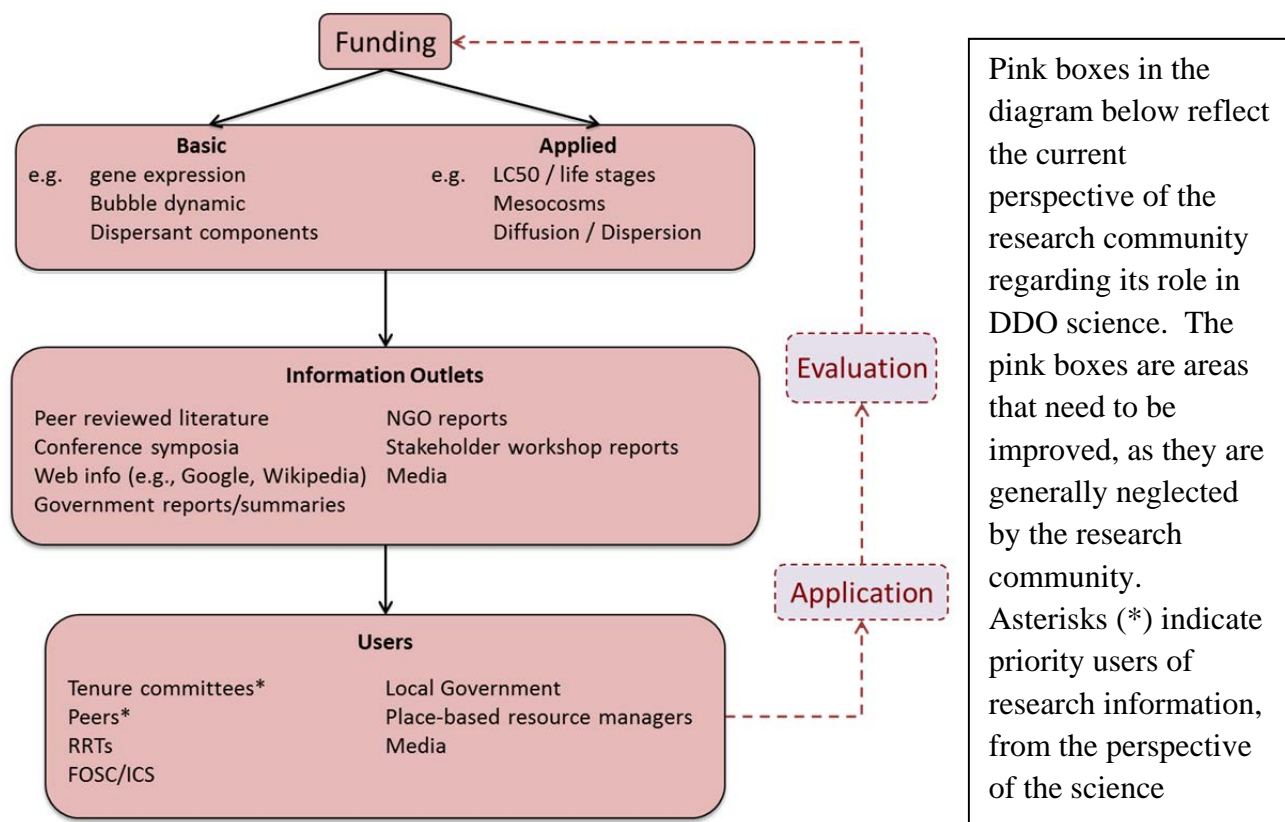
Plenary Session 1: Notes

- Timelines?
 - Preplanning, event activities, post plan. But critical phase is time before an event occurs.
 - All time available in between events is the timeline to generate the data.
 - Some things can't have preplanning. Such as volume of oil, duration of spill.
- How do you determine exposure when you have a moving water column and a moving organism? What kind of timeline is used?
 - Not addressed in group. Level of detail is not what is needed. Need ranges, less specific.
- Same model used in planning stage is same model used in actual event. This just shortens the time needed to make the model.
- Determine biological effects practically to large organisms.
 - Importance of modeling.
- Many states are using GIS, etc. as a modeling tool to start answering questions in a scenario based format.
- Geographic information systems. In FL, have a rel. complex GIS, can use any boundary, and have it generate a report. Valuable tool for them. Drawback, mapping all types of info is massive, and less money has been put up for pre-planning. So if more funds were available, this could be a more powerful tool.
- Doing a lot upfront is important. A lot of info- feedback- risk assessment. Impact assessments-

- The essence is quick planning with adequate data. Adequate visual tools, sensitivity analysis.
- Ecosystem – types, land, life stages, ecosystem services, critical, temporal and spatial, ecosystem modeling, visuals – NEED FOR DATA. Efficacy and distribution – oil (type, volume, location). Dispersion efficacy, trajectory and concentration, droplet size.
- Quantitative effects
- Toxicity of dispersed oil to surface oil, field conditions data needed, impact of cleanup,
- Q: what kind of timeline to generate all that data?
 - Answer: All time between events. Pre planning is important.
- Q: Moving of organisms in oil, exposure times of organisms to oil, what is used experimentally.
 - Answer : Relative impacts : LC50s
- Q: any practical way where you can assess biological effects on say polar bears etc. ahead of time.
 - Answer. Modeling needed.
- What tools are being made for remote locations? GIS spatial tools, preplanning scenarios. Desktop tools, web based tools. Overlapping confirmations on various time scales
- Reiterate on geo info systems -tool Florida GIS, report of resources at risk.

Breakout Session 2 and 3
March 13, 2013
Researchers' Perspective





Critical Points in the Process

The group considered funding to be the dominant driver of the research enterprise. Whether the ensuing research is categorized as “basic” or “applied” is not as important as delivering information that is understandable and useful to the user community. There are numerous sources and venues that serve as means for dissemination of scientific findings. This is a critical decision point for researchers, as it affects both professional merit (e.g., promotion, tenure and awards) and the application of their findings. The usual preference therefore, whenever possible, is to submit findings to the peer review process and publishing in scientific journals. This affects, and arguably limits, the timeliness and level of dissemination to many response planners and practitioners.

The group acknowledged the difficulty in acquiring all the relevant information needed to prepare for and respond in actual incidents, as well as the difficulty in interpreting it. This also negatively influences the unity of messaging about impacts, and the confusion in the media and in public opinion about DDO issues.

Timeline

New knowledge is often slow to be incorporated in spill preparation and response. This is partly because the research community is not always aggressive in directing it to the response community. Because merit and career advancement are dictated mostly by publication record,

the primary objective is to publish results in peer reviewed literature. Once this is accomplished, it becomes the responsibility of responders to find and interpret scientific information. This could, of course, be facilitated by including the science community more in spill preparation and planning, response, and evaluation (post-response). With that, needs for future research could also be identified, then conveyed to funding entities, thus improving the connection between the science produced and its application by user communities.

Information Needs from Researchers

The research community needs to better appreciate the processes used in spill response, the information used to make decisions, and the current challenges facing responders. Participation in training (e.g., ICS familiarization, drills, scenario planning), response, and post-spill “hotwashes” would be extremely useful. And feedback from responders to funding sources could lead to improved alignment of needs and research products.

How can what we have learned about the researchers and practitioners perspectives that can improve the application of dispersants on future oil spills?

The research community needs to communicate more with practitioners in order to better understand issues of concern and levels of concern that trigger various response options.

Practitioners need information from the science community better translated so it can be meaningful for planning and response. Both sides should feel responsible for enhancing communication and gaining a better understanding for the needs of the other.

The long gaps between research and decision-making need to be reduced, as decisions during a response often must be made in a time frame from minutes to hours.

It is critical that the research community continue to try to overcome the challenges to replicate real-world conditions when conducting experiments on DDO issues (dynamic concentrations, exposure durations, and chemical environments).

Greater standardization (e.g., toxicity testing protocols) may be needed to improve the applicability of research findings to real-world problems.

Scientific information should be centralized in a way that makes it available to the user community. Access to metadata should also be enhanced to facilitate continued progress on science. Practitioners, on the other hand, should ensure that data collected throughout the history of responses (often in government reports or held by industry), is made available to the research community.

- “Real world” exposure
 - Duration of exposure
 - Centralized info
- Concentrations
- Improved use of metadata
- Better understanding of levels of concern
- Improve translation of info for RRTS, etc.

- Need arrow to go both ways from users and research communities on needs
- Simple understanding across the board. Responsibility of researchers to understand and make improvement:
 - Ex: dispersant chemistry, not harmful
- Researcher communication needs to better understand relevance level of past work and application to today's challenges
- Outreach to science journals
 - Re: experienced reviews that are available.
- GOMRI Interaction
- Funding for communications
- Wikipedia Corrections
- ID roles of NRT and RRT & ICCOPR in assuring research are relevant? And communications are relevant?
- Educating public, off-event messaging
- More standardization for testing protocols
- Extremely long gaps between the research and the decision-making: research really long and decision-making is really small.
- Preplanning and getting data to extrapolate for your scenario but then there is no data that suit your situation
- Even past attempts to ID data needs are lagging or not being addressed. Need strong and more frequent communications
- Some researchers do step up to assist (but still jealous of data)
- Editorial
- Ecological risks assess workshops.
- Needs identified in NRC 2005 dispersant reports still priorities. Research that still needs to be done for applied context (new reports needed)
- National Science of Academy: NRC report on spill response with additional outreach

How do we use the relationships identified impact/change dispersants research?

Greater interactions between researchers and practitioners will result in an increased focus on response-relevant applied research. It will also allow a higher level of specificity to be written into funding guidance and selection criteria.

GOMRI could serve an important role in facilitating communication and interaction between researchers and practitioners. Then, as a major funder of oil spill research, GOMRI can be very specific in solicitations with regard to desired research.

Funding for communications and outreach should be written into grants, and requirements could be added to ensure training in practical applications (e.g., ICS training).

Communication, interpretation and messaging of science needs to occur between events to a much greater extent than it does now.

- Improve translation of info for RRTS, etc.
- Researcher communication needs to better understand relevance level of past work and application to today's challenges

- Outreach to science journals
 - Re: experienced reviews that are available.
- **GOMRI Interaction**
- Funding for communications
- Wikipedia Corrections
- ID roles of NRT and RRT & ICCOPR in assuring research are relevant? And communications are relevant?
- Educating public, off-event messaging
- Direct research focus on applied science

How can practitioners use this understanding to improve oil spill preparation and response?

There have been numerous past efforts to identify and document data and information needs (e.g., NRC dispersant reports), but a large number have not yet been addressed. There would seem to be little need to conduct additional such efforts at this point. The focus should be to continue to encourage funders to clearly communicate and support directed research.

Future funding for spill research should consider avenues for communication to responders and media outlets. This will necessitate dedicated budgets, an often overlooked aspect of research projects, but one that could dramatically increase the utility and impact.

As leaders for planning and execution of response, the National Response Team (NRT), Regional Response Teams (RRTs) and Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) should become even more involved with engaging the talents of the research community to improve spill response and communications. A higher level of involvement of Sea Grant, through both research contacts and extension programs, could facilitate this process.

Practitioners should reach out to science journals to encourage publications that are relevant to DDO, and participate as reviewers, when possible.

- Real world exposure
 - Duration of exposure
 - **Centralized info**
- Concentrations
- Improved use of metadata
- Better understanding of levels of concern
- Need arrow to go both ways from users and research communities on needs
- Simple understanding across the board. Responsibility of researchers to understand and make improvement
 - Ex: dispersant chemistry, not harmful
- Researcher communication needs to better understand relevance level of past work and application to today's challenge
- Outreach to science journals
 - Re: experienced reviews that are available.
- GOMRI Interaction
- Funding for communications

- Wikipedia Corrections
- ID roles of NRT and RRT & ICCOPR in assuring research are relevant? And communications are relevant?
- Educating public, off-event messaging
 - Including research community members into the drill, and discussions. Training the researchers on ICS for funded researchers. And participation with RRT and the drills.

How do all stakeholders use a better understanding of the perspectives areas of overlap to improve interactions among themselves and the other groups (researchers, practitioners and public/NGO's)?

There is clearly a need for improved translation and outreach of scientific information for use by Regional Response Teams and other users.

It would be valuable for all parties to increase communication across scientific and response disciplines. For example, collaborations between toxicologists and food inspection specialists, between ecosystem and trajectory modelers, and between cell biologists and dispersant chemists would help address quite a few of the existing information needs. Toxicology data, for example, need to be fed into ecosystem impact and recovery models, both for the water column, near-shore, and shoreline. Similarly, interactions between NGOs with specific interests (e.g., wildlife rescue, restoration), other responders, and scientists, would improve efficiencies throughout the application of the latest and most relevant scientific knowledge.

Effort should be made to review, correct, and update internet-based information on Wikipedia. This is one way to generally start to improve the information available on DDO and related issues.

- Improve translation of info for RRTS, etc.
- More frequent opportunities for communications (e.g. Sanx citizen Adv. Communities)
- to information users (media)
- Researcher communication needs to better understand relevance level of past work and application to today's challenges
- Outreach to science journals
 - Re: experienced reviews that are available.
- GOMRI Interaction
- Funding for communications
- Wikipedia Corrections
- ID roles of NRT and RRT & ICCOPR in assuring research are relevant? And communications are relevant?
- Educating public, off-event messaging

What mechanisms exist or could be created to continue interaction among all stakeholders involved with oil and dispersed oil to exchange of information and improve the application of new research findings?

One example of an effectively model of communication between the science and response communities was conducted by the Gulf of the Farallones National Marine Sanctuary. The sanctuary established a Citizens Advisory Committee to help it learn about spill response options, prepare for spills, and make decisions during incidents. Members of the committee represented a number of stakeholder groups. One activity of the committee was to invite specialists on a regular basis to give presentations and discuss spill issues, including dispersant use. The purpose was to enable the committee to make spill response recommendations to the sanctuary.

- Improve translation of info for RRTS, etc.
- Communication across specialties
 - E.g.: toxicologist with food source
- More frequent opportunities for communications (e.g. Sanx citizen Adv. Communities)
 - to information users (media)
- Simple understanding across the board. Responsibility of researchers to understand and make improvement
 - Ex: dispersant chemistry, not harmful
- Communication Planning
- Researcher communication needs to better understand relevance level of past work and application to today's challenges
- Outreach to science journals
 - Re: experienced reviews that are available.
- GOMRI Interaction
- Funding for communications
- Wikipedia Corrections
- ID roles of NRT and RRT & ICCOPR in assuring research are relevant? And communications are relevant?
- Educating public, off-event messaging
- More standardization for testing protocols

Are there topics in these perspectives that are not being addressed by research or other mechanisms?

Scientists can help communicate their findings through participation in planning (e.g., risk assessment workshops), response, and evaluations, through editorials in journals, coordinating topical sessions at scientific meetings.

There is a need to improve both the definition and scientific rigor of Net Environmental Benefits Analysis (NEBA) and Ecological Risk Assessments (ERA). Both terms are used in different

ways by different people, leading to inconsistent protocols. And both would benefit from standardization as well as greater engagement of the science community during development.

- More frequent opportunities for communications (e.g. Sanx citizen Adv. Communities)
 - to information users (media)
- Communication Planning
- Researcher communication needs to better understand relevance level of past work and application to today's challenges
- Outreach to science journals
 - Re: experienced reviews that are available.
- GOMRI Interaction
- Funding for communications
- Wikipedia Corrections
- ID roles of NRT and RRT & ICCOPR in assuring research are relevant? And communications are relevant?
- Educating public, off-event messaging
- More standardization for testing protocols
- Toxicity data need to be fed to ecosystem impact modeling and ecosystem recovery modeling (both – water column and near-shore/shoreline)

Needs:

- 1&3 “real world” exposure
 - Concentrations
 - Durations of exposure
- 3 Centralized info
- 4 Improved use of metadata
- 1,3,4,5 Better understanding of levels of concern
- 1,2,4,5 Improve translation of info for RRTs, etc.
- 5 Communication across scientific specialties
 - E.g. toxicologists with food science
- 4,5,6 More frequent opportunities for communication to inform users (& media)
 - e.g. Sanx Citizen Adv. Comm.
- 1,3 Need arrow to go both ways from users <-> res. comm. on needs (individual training)
- 5,6 Communication Planning
- 1,3,5 Simple understandable messaging
 - e.g. dispersant chemistry, not harmful
- 1-6 Research community needs to better understand relevance & level to past work and application to today's challenges
 - Outreach to science journals
 - Re: experienced reviews that are available
 - GOMRI interaction
 - Funding for communications
 - Wikipedia corrections

Identify roles of NRT & RRT & ICCOPR in assuring research and communications are relevant?

- Educating public, off-event messaging
- 4 Consider dispersant use as a tool like any other response option within the practitioner community
- 1,5,6 More standardization for testing protocols
- 3 Involve academic community with NEBA

Timeline: 1

- Too long compared to decision needs (points to importance of pre-planning)
 - Research timeline long
 - Decision-making timeline short
- Even past attempts to identify data needs are lagging or not being addressed. Need stronger and more frequent communications.
- Some researchers do step up to assist (but still jealous of data)
 - Editorials
- Ecological risk assessment. workshops
- Needs identified in NRC 2005 dispersant report still priorities (new report needed?)
- NRC report on spill response with additional outreach

What's stopping us? The Biggest Challenges:

- Lack of investments for interaction (communication, feedback, training)
- Lack of mechanisms for requiring interaction (e.g. tied to grants, etc.)
- Few (obscure?) centralized info sources
- Different merit mechanisms/goals
- Lack of clarity in many solicitations
- Improve the definition and scientific rigor of NEBA
- Consistent approach to ecological risk assessments

Plenary Session 2: Notes

Timeline for practitioners?

A: Preplanning, so whole time period before an event so info is available prior to event.
Timeline to generate data is all time available between events.

Q: Preplanning is limited. Don't know specifics: ecosystem affected type of oil, etc.

Concentration exposures never understand moving water column and moving organisms. What concentration to use? What time span? When don't know exposure time and other parameters?

A: 2 starting exposures: entrained organisms (higher concentrations at first then decline) & fixed features such as reefs

A: Only gross effects needed. No need for specifics. Those can be addressed on the fly. Class and populated considered later. Direction of sub-lethal affects or nomic info is generating data that may be good for injury assessment.

Assessment different from response

Planning model also used during event but with stages preset. Less time needed to explain process.

Q: Practical way to determine effects to large marine organisms, i.e. whales, polar bears, cannot be in lab? Can we do this in advance?

A: That's why modeling is important.

Q: What products, tools, resources being developed for locations without ERAs, workshops?

A: Most states and agencies use GIS and other spatial tools for preplanning scenarios and data. Desktop tools, web-based, overlap tools for these scenarios.

Materials for communications and generalities found in morning session.

Geographic info systems, Florida GIS, use any boundaries. Valuable tools to keep at hand. Drawback: mapping info for wide area is massive, not enough money, need support.

Efficacy and Effectiveness Group Notes:

Breakout Session I

March 12, 2013

Response Practitioners' Perspective

- Diverge from current diagram that everyone work on or enhance them? We already know the process needs to go through get the diagram. Effectiveness is the most important, and need to be validated, how? Experimental tests (e.g., if it disperses). Also look at different temperature regimes that can be used.
- Effectiveness: Also it depends on the situation (type of oil), also what is the most important part, if oil is dispersed or if environmental affects? This change depending on the people looking at this issue.
- Coastguard definition effectiveness: minimize environmental impact on species, not if it disperse or not. Toxicity, availability, make from raw material when looking for new dispersants.
- There are dispersants made to pass EPA test.
- Need lab scale test that reflect exiting conditions.
- Should be able to apply dispersants within 7 hours, this is a requirement.
- TILL NOW ONLY LIQUID DILIVERD SYSTEMS. When it comes to use of powders (sub-sea), delivery should be slurry method and there might be problems delivering methods.
- Dispersant: Dispersed, will be able to disperse oil, need to be available and also it should be able deliver to area of oil spill, look at effectiveness. (Need to look at these points when looking for new dispersants or the exiting dispersants)
- Finding the thick part of the slick would help too, and then you get the value out from the dispersants used in that area.
- Not only does it disperse, also effects on the environment.
- How measure on the environment?
 - Surrogates? Need years to do this, so don't know for sure the effect.
 - What are more important factors in the environment?
 - Need to be investigated before the spill.
- Need to look at dispersant modeling, identify levels that we are less concerned (field testing)
- Use actual oil in a test environment.
- Oil spill at night what happens offshore (decision-making process) (9.00pm)
 - Form a unified command, coast guards, responders will start looking at the options.
 - Skimming vessels
 - Filling out dispersant checklist, specific gravity, type, dispersible, capability to deliver
 - Pending decision, get ready to apply, get everything to the area of the spill
 - If recommended, then use dispersant
 - (By the time the sun comes up will have a decision)
- Check if the dispersant worked
 - Did it work the way it was supposed to?

- Sea not rough? Then it's easy to apply a target and because it's not calm for long time it won't be a problem (dispersant do not lose effectiveness fast)

Are there significant parts of the process that are “linchpins” on a critical path (i.e., crucial steps) for determining dispersant efficacy and effectiveness and whether dispersant use is acceptable?

- Does it disperse?
- Can we put it on a target on right time frame?

What is the timeline for determining whether dispersants have adequate efficacy and effectiveness to be considered useful tools in a spill response?

- 48 to 72 hours

What information must be obtained from researchers to help practitioners make decisions on dispersant efficacy and effectiveness and whether dispersant use is acceptable for a spill?

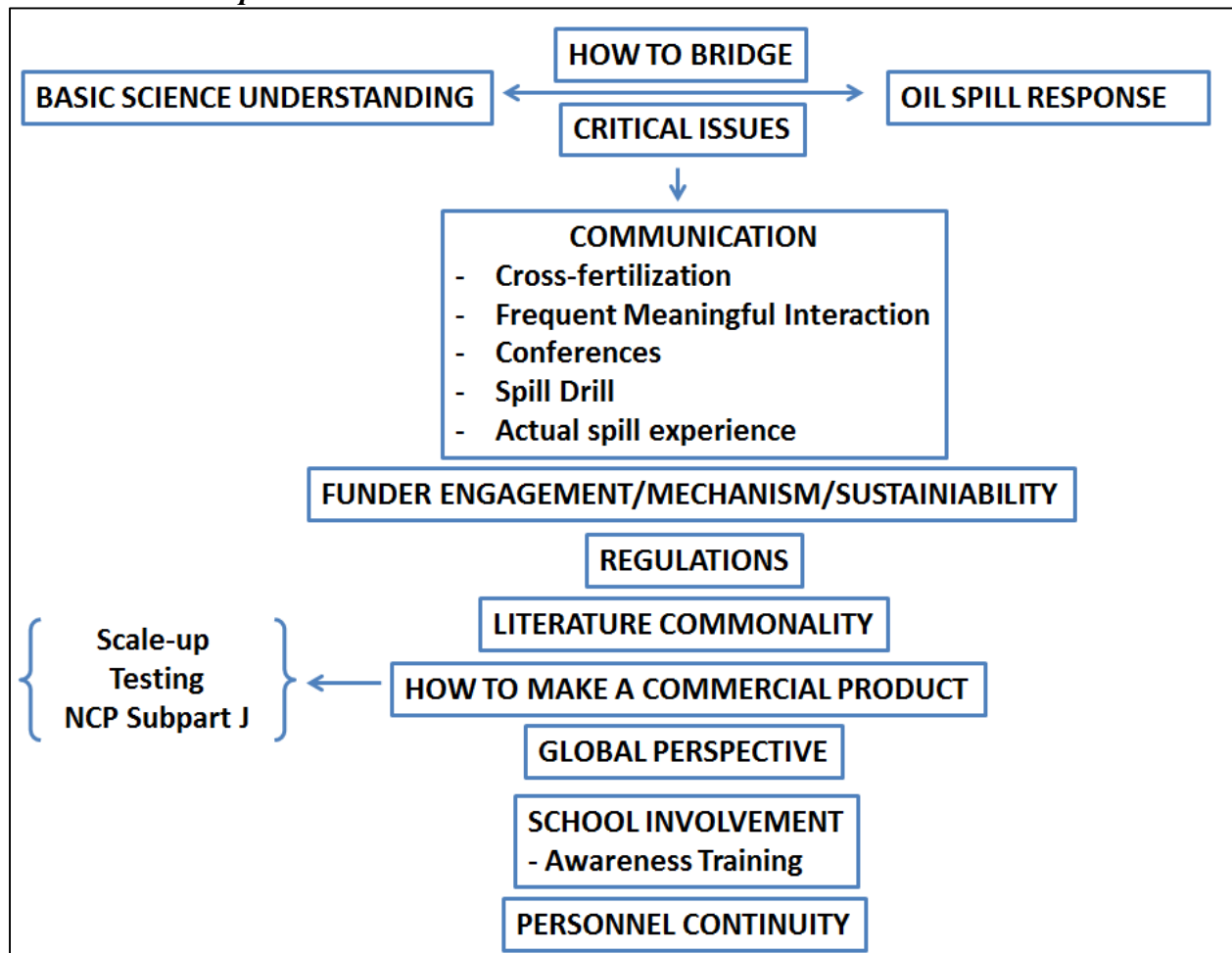
- Environmental affects, use surrogates to check the effectiveness

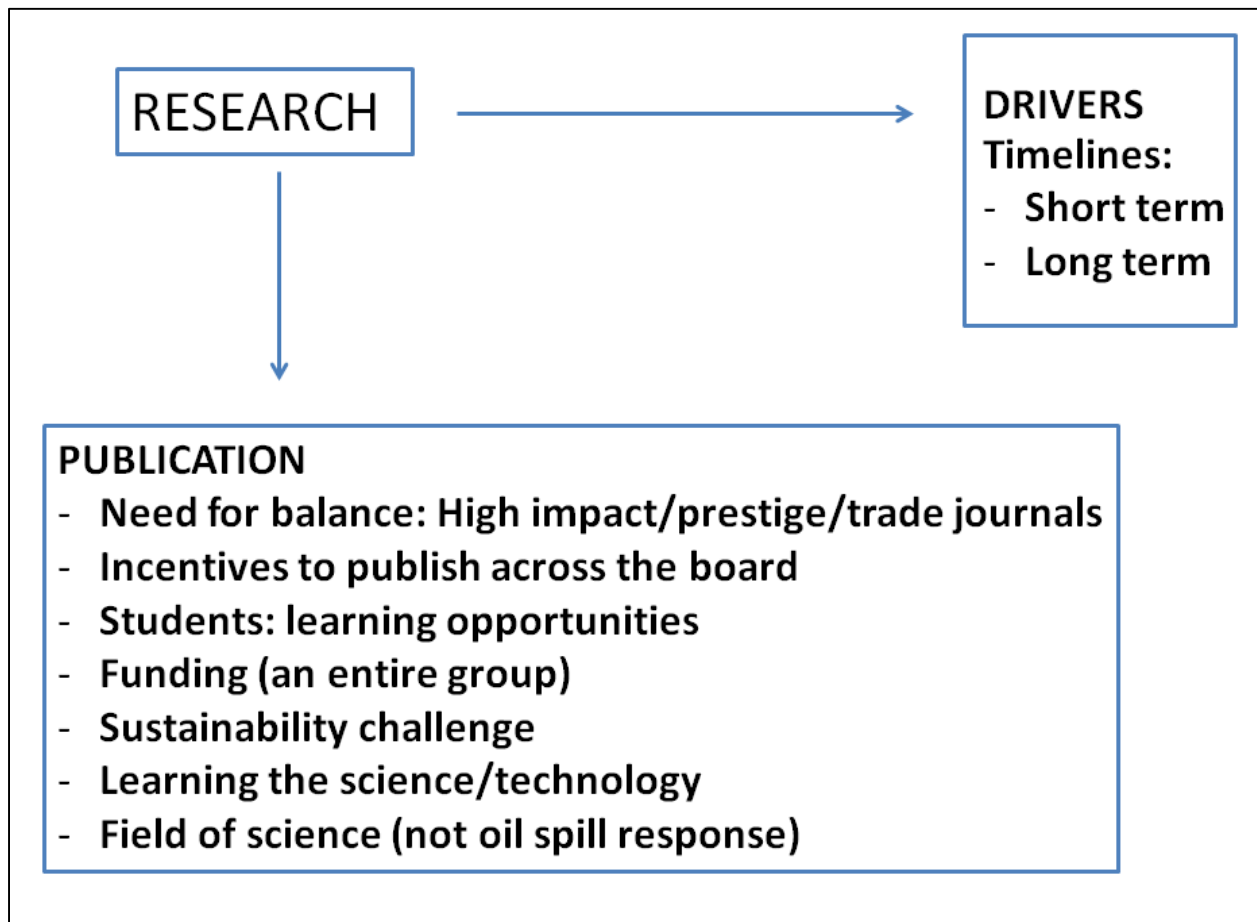
Plenary Session 1: Notes

- Evaluation of efficacy of deep sea applications
 - Challenge. With Macondo well, it was initially basically on the fly. Trying to find the tools to determine the particle size distribution at the release itself. Light scattering. Limitation of trying to determine what's happening in the deep sea in the lab. A real study would be the next step.
- Dispersion checklist was good.
 - Surface application only though.
 - Non-toxic dispersant? Dispersant is less toxic than oil.
- Is injection of dispersant being considered? Placement of injection site is being considered.
- Time window for an oil spill. Different for a subsea release and a surface release.
- Typical dispersant application is very different than a well-blow out (deep sea).
- Control of sub-surface release (DOR vs. subsurface)
- Tom: **Practitioners** perspective: questions similar from the researchers point.
- Q: is the oil dispersible? Can we get the dispersant there? What critical path items have to be gained access to? Forms of dispersion (solids or liquids). Where the most concentrated layer of the slick is?
- Pre-approval zone dispersant use checklist.
- Request SMART -
- Q: how to evaluate efficacy of deep sea dispersion applications?
 - Answer: Challenge. Coil tubing system- oxygen concentration etc. measured. Particle size distribution is needed to know. SONAR, light scattering, what techniques can be used to measure? Field study needed.
- Q: knowledge of oils and their ability to be dispersed depending on their state and location.

- Q: comments: Likes the checklist☺. Looking for non-toxic dispersants. The dispersed oil can be toxic!
- Q: experiments – effects of placement of injection sites. Yes, that is being looked at.
- Q: How you deal with the state of the oil and delivery? There is a diff
- Q: typical and atypical dispersant are diff- surface release and medium releases? Is different from deep water release like in the case of a well blowout.
- Q: DOR? Applicability.
 - Answer – Subsea has 100% encounter rate.

Breakout Session 2 and 3
March 13, 2013
Researchers' Perspective





Research types

- Environmentalist
- Physical and chemical properties
- Engineering side (applications)

Current + future state

- Be more efficient
- Expand range of oil (including oil sands, Dilbit)

Understanding performance, capabilities of current products/application techniques

- Understand why Corexit work, how much of each compound is in Corexit (getting in to fundamentals)
 - There are understanding of how span and tween come to an interface and work.
 - Look at not only the surface tension but also the dynamics of these compounds at the interface.
- Use of Micro bubbles, with dispersants in them. (new techniques) , use of bio polymers
- How can researcher find a way to work with practitioners to come up with these new methods
- Does using one tool takes away other tools (collecting oil)
- Pellets might be useful (powder might have delivering problems) - need to be a fairly heavy pellet to avoid drifting. With an oil soluble skin.

- Dispersants only applied during daytime, expand this time limit (night operations)
- Night operations problems
 - Targeting problem
 - Liquids
 - Solids (granule)
 - Gels
 - Slurry
- Empirical approach
- Scientific research ----- complementary
- Commercialization
 - Design for use
- Sensor enhancement/ identification
 - Use/improve/create
- Testing capabilities
 - Existing equipment
 - Exchange understanding
 - Might solve this with pellet use (with an oil soluble skin but not water soluble skin)
 - Have classes to get a better understanding of the oil spill

Are there significant parts of the model that are “linchpins” on a critical path (i.e., crucial steps) for improving dispersant efficacy and effectiveness?

- Experiments are setup for laboratory ease
 - Does not give the real life environment
 - Need something efficient and practical that represents real life environment
 - Lot of results does not give data which relate to real life situation
 - Boundary conditions are different for experiments in tests
- Bridge basic science understanding and oil spill response (communication)
- Oil spill training, Spill drill. Look at how it works (Give what information is actually used)
- Shelf life
- Fresh water dispersants (issues with drinking water)
- Journal dedicated for oil spill related research

**What is the time line for researchers in the study of dispersant efficacy and effectiveness?
Is there an orderly sequence of steps and if so, how long will each one take?**

- Funding time line – 2 to 3 years
- Depends on objectives
 - Educate people
 - Publications and presentations (shows you have contributed), 2 to 4 years
 - It can be a 20 to 25 year cycle (including scaling up)
 - How applicable and also more realistic models in labs

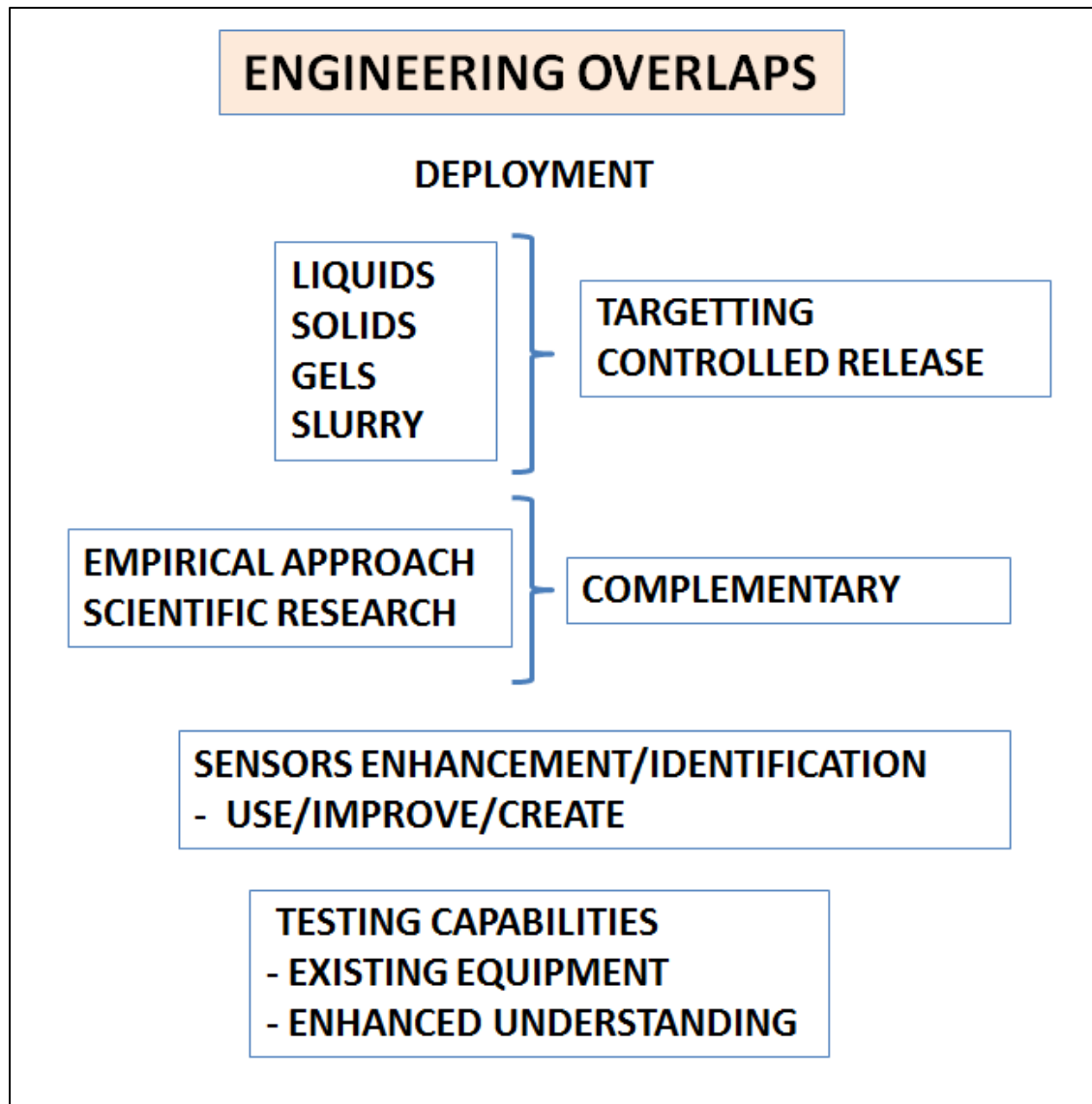
What information must be obtained from practitioners to help researchers address components of the research conceptual model on dispersant efficacy and effectiveness?

- Bridge basic science understanding and oil spill response (communication)
- Oil spill training, Spill drill. Look at how it works (Give what information is actually used)

Overlap of the Researchers' and Practitioners' Perspectives

OVERLAPS RESEARCHERS/PRACTITIONERS

- SUSTAINABLE INTERACTION IN GENERAL INTEREST
- COLLABORATIONS: GOAL FOR EXAMPLE
- BOTH LOOKING FOR "BETTER" TECHNOLOGY
- DEFINITIONS MAY BE DIFFERENT
 - LOW TOX
 - LONG SHELF LIFE
 - HIGH EFFECTIVENESS
 - KEEP SMART SIMPLE
 - "SIMPLE" TESTING
- BOTH STRUGGLING WITH FEAST/FAMINE
 - WOULD LIKE STABILITY



What are the areas of overlap of the two perspectives (researchers and practitioners) of dispersant efficacy and effectiveness?

- Balance need between publishing journals (high impact/prestige/Trade journals)
- Need 2-way understanding between practitioners and researches.
- Opportunities for students (internships) in the industry.
- Sustainable interactions in general interest.
- Collaborations- GOALI example
- Looking for better dispersants (what is better?)
 - Definition different
 - Low toxic
 - Long shelf life
 - High effectiveness
 - Keep smart simple
 - Simple testing
 - Would like stability

- Other items
 - Special dispersants
 - Near especially sensitive areas
 - Arctic response
 - Near source for higher effectiveness
- Other products
 - Marker for thicker part of slick
 - Florescence
 - Reflective
- Safe bio-surfactants
- Cyclodextrins

Summary Questions

How can what we have learned about the two views improve the application of dispersants on future oil spills?

- Is there science that can enhance what dispersants already do?

How do we use the relationships identified impact/change dispersants research?

- Identify the gap between practitioners and researchers and bridge that gap
- Interactions between the research communities (strengthening and continuing)
- Awareness and attendance at conferences (AMOP,IOSC)
- Awareness of websites (EPA, API)

How can practitioners use this information to improve oil spill preparation and response?

- New technology (new dispersants, targeting...)

How do all stakeholders use a better understanding of the areas of overlap to improve interactions among themselves and the other groups (researchers, practitioners and public/NGO's)?

- Academic research creating new Practitioners
- Learn the limitations (practical and research)
- Improve outreach and communication (by having academics assist delivering message)

What mechanisms exist or could be created to continue interaction among all stakeholders involved with oil and dispersed oil to exchange of information and improve the application of new research findings?

- Continuing work shops
- Interactions at conferences
- Help academic side understanding challenges
- Scholarships for students
- Attendance at RRT meetings
- Electronic collaboration (websites: ICCOPR)

Are there key points that are not being addressed by research or other mechanisms?

- Challenge of commercialization
- Field tests

- Spills of opportunity: database of proposed research

OTHER ITEMS

SPECIALTY DISPERSANTS

- NEAR ESPECIALLY SEINSITIVE AREAS
- ARCTIC RESPONSE
- NEAR SOURCE FOR HIHGER EFFECTIVENESS
- SAFE BIOSURFACTANTS
- CYCLODEXTRINS

OTHER PRODUCTS

- MARKER FOR THICK PART OF SLICK
- FLUORESCENCE
- REFLECTIVE

Plenary Session 2: Notes

Q: Detail evaluation of efficacy of deep sea applications.

A: Macondo dispersant treatment on the fly, 11 gal/min. measurements taken after [O2] & microbes, etc. evaluated – light scattering and other tools must be available at great depths – organizations researching this based around limitations in laboratory settings – Norway research set the stage

Oils dispersible in concentrations 1-200, more dispersible when fresh & less viscous

Q: Surface application only not subsurface

Research areas for nontoxic dispersants – even if nontoxic, at first oil, and oil is toxic

Q: Consider injection of dispersant? Efficient mixing at source?

A: Placement of injection considered

A: Dispersible vs. dispersant available. Timing of release <72 hrs. – Subsurface release timing different

Typical vs. atypical dispersant application – surface vs. deep water – different problems

Q: Control of Subsurface vs. surface release

A: Function of target – more accurate at the source – subsea 100% encounter rate

Appendix E: Initial Plenary Session Presentations

Dispersants- How They Are Used in Response and How They Were Used in the Deepwater Horizon

Bob Pond, USCG



Dispersant Use under the National Contingency Plan

Mr Robert G. Pond
US Coast Guard
Marine Environmental Response Policy

Dispersants

- Subpart J of NCP provides guidelines for use of dispersants.
- The decision to use dispersants is focused on net environmental benefit.
- The decision to use dispersants in every incident is vested in the FOSC in consultation with the EPA, DOI, DOC and the state(s).



Dispersants

- The NCP allows for the FOSC to be pre-authorized to make dispersant use decisions under certain circumstances.
- Pre-authorization is based on net environmental benefit determinations of those circumstances made by the EPA, DOC, DOI, and State representatives to the RRT.
- Pre-authorization in place around the US (except Alaska) generally in open water marine environments >3 miles from shore.

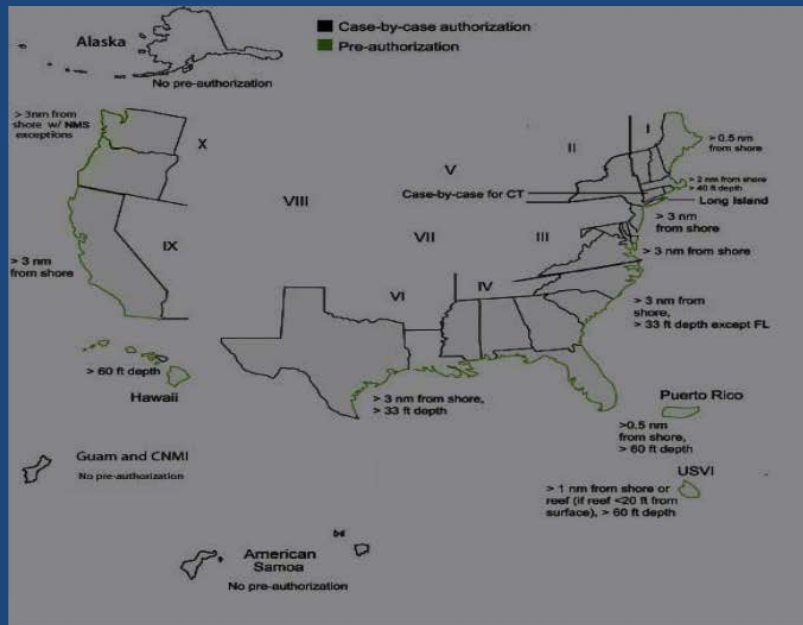


Dispersants

- Why do net environmental benefit analysis of an oil spill - a simple mental model.
 - 100 shares of oil spilled in environment
 - natural processes remove 20-60 shares; balance: 40 to 80 shares
 - mechanical recovery & in-situ burning on water remove 10-25 shares; balance: 15 to 70 shares
 - chemical dispersion remove 30 to 70 shares; balance: 0 to 40 shares stranded on the shoreline with dispersant; 15 to 70 without.



Pre-authorization



Subsea Dispersant Use

- DWH first time dispersants applied in the subsea environment.
- Prompted the development of interim subsea dispersant guidelines by the NRT.
- Provides guidance on application and monitoring of subsea dispersant use; is not regulatory nor does it imply pre-approval.
- Decision to use subsea dispersants still lie with RRT and FOSC during an incident.

Questions?

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Dispersants- How They Work

Tom Coolbaugh, ExxonMobil

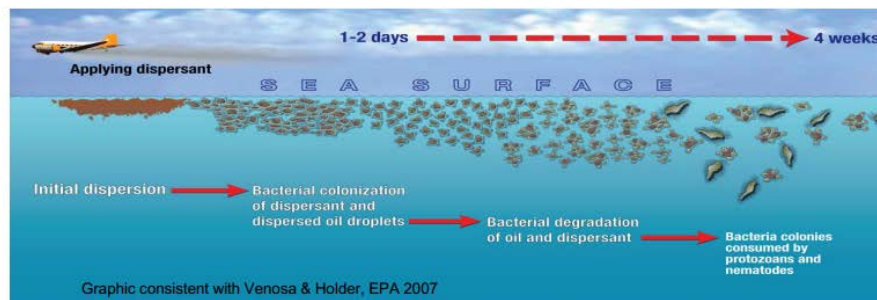
How Dispersants Work

March 12, 2013

1

Dispersants – What are they and what do they do?

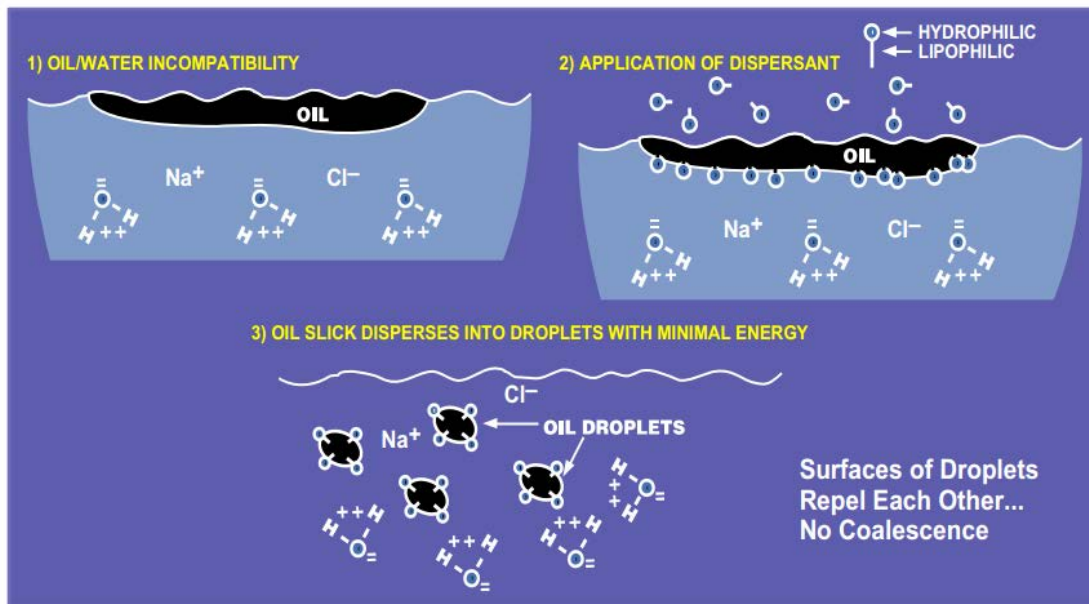
- Dispersants are solutions of surfactants dissolved in a solvent
- Surfactants reduce oil-water interfacial tension – allows slicks to disperse into very small droplets with minimal wave energy
- Dispersed oil rapidly dilutes to concentrations <10 ppm within minutes, <1 ppm within hours, ppb range within a day
- Each dispersed oil droplet is a concentrated food source that is rapidly colonized and degraded by marine bacteria
- Dilution allows biodegradation to occur without nutrient or oxygen limits



2

How Dispersants Work

The Goal: Rapidly Reduce Oil Concentration to Below Impact Levels Rapidly



Environmental Impact of Dispersant Use

- Toxicity of oil > toxicity of the dispersant
 - Dispersants do not make the oil more toxic
- Modern dispersants use ingredients found in household products
 - NALCO website*
 - NOAA & FDA test results for dispersants in Gulf seafood, "There is no question Gulf seafood coming to market is safe from oil or dispersant residue."

(http://www.noaa.gov/stories/2010/20101029_seafood.html)

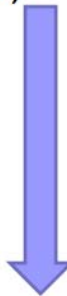
Other Uses of Corexit® 9500 Ingredients (from Nalco website)

Corexit® 9500 Ingredients	Common Day-to-Day Use Examples
Span™ 80 (surfactant)	Skin cream, body shampoo, emulsifier in juice
Tween® 80 (surfactant)	Baby bath, mouth wash, face lotion, emulsifier in food
Tween® 85 (surfactant)	Body/Face lotion, tanning lotions
Aerosol® OT (surfactant)	Wetting agent in cosmetic products, gelatin, beverages
Glycol butyl ether (solvent)	Household cleaning products
Isopar™ M (solvent)	Air freshener, cleaner

*<http://www.nalco.com/applications/corexit-technology.htm>

It is Important to Remember Relative Toxicity

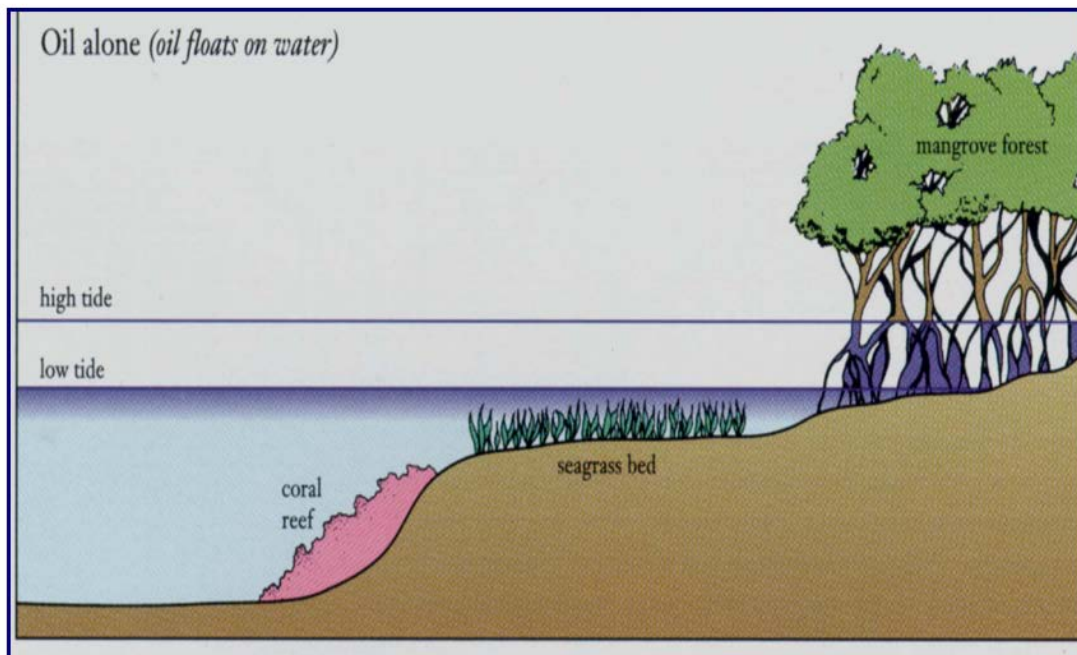
Environment Canada Study

Product	Toxicity (ppm)	
Palmolive Dish Soap	13	 Less toxic
Sunlight Dish Soap	13	
Mr. Clean	30	
Corexit 9527	108	
Corexit 9500	350	

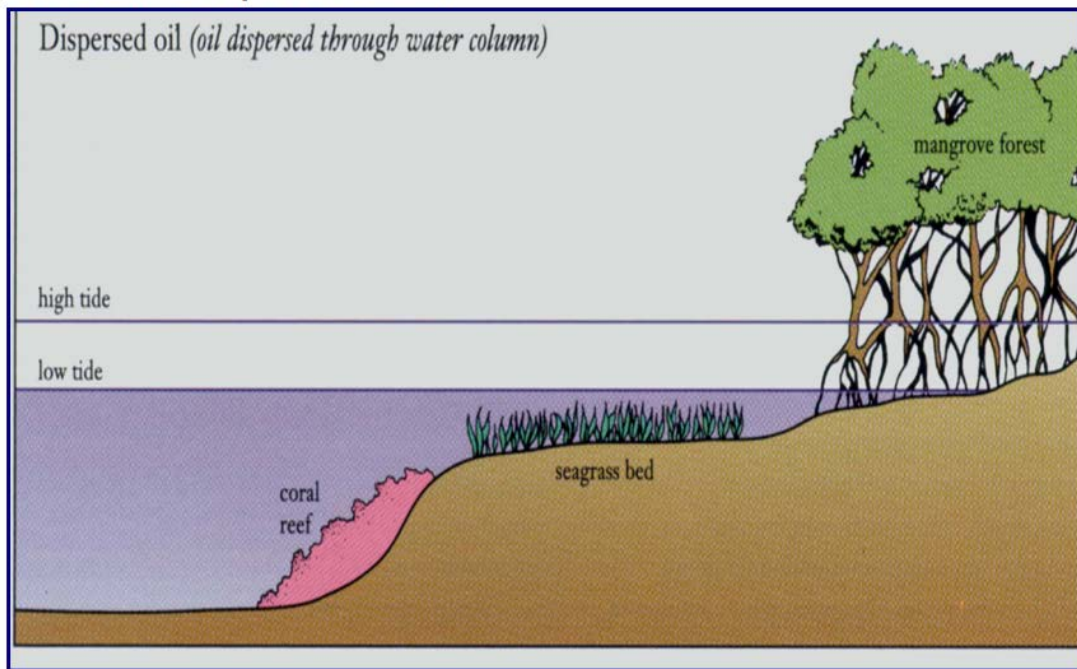
(96 HR Rainbow Trout LC50)

5

NEBA: Floating Oil



NEBA: Dispersed Oil



Dispersants: One of the Tools in the Toolbox



**Mechanical Recovery:
Booms & Skimmers**

**Monitor &
Evaluate**



In-Situ Burning

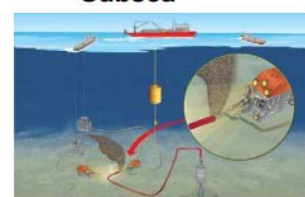
Aerial



**Dispersants
Vessel**



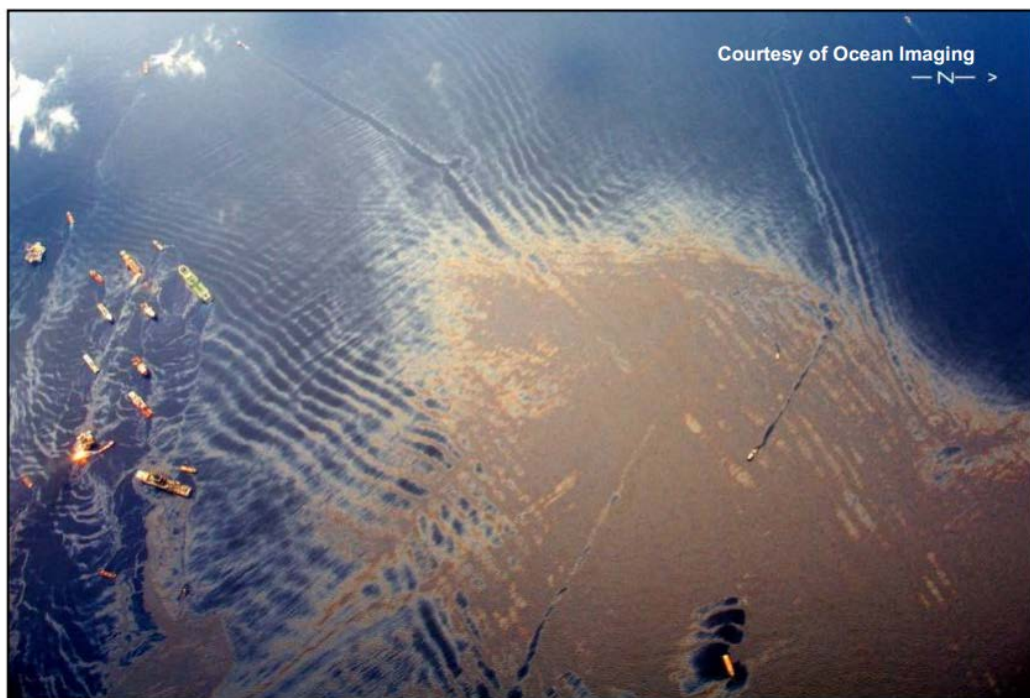
Subsea



**The goal is to design a response strategy based on
*Net Environmental Benefit Analysis (NEBA)***

8

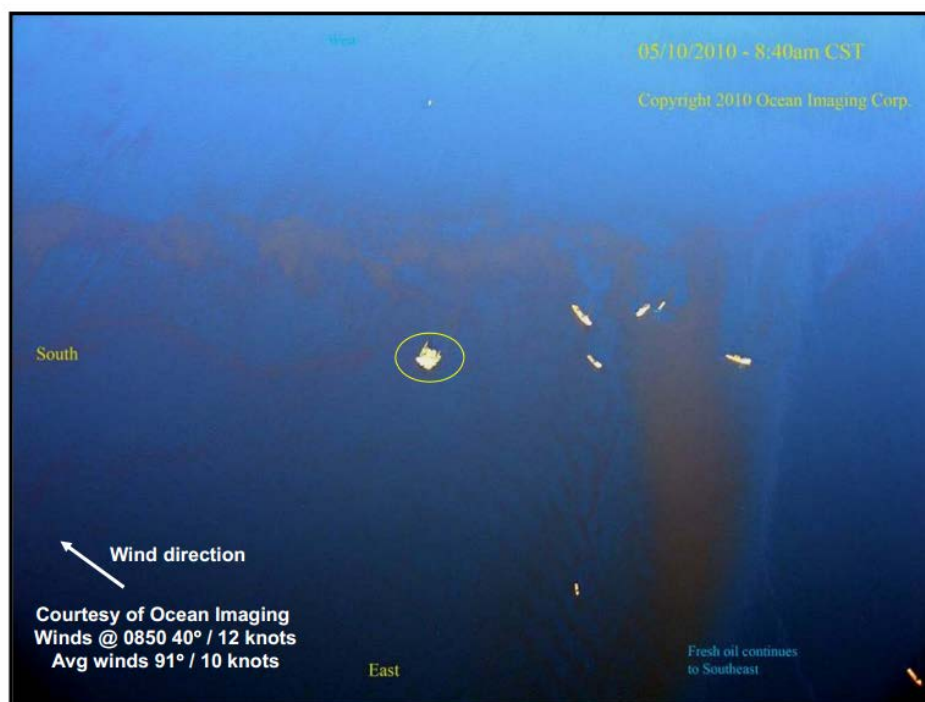
Encounter Rate is Key to Offshore Response



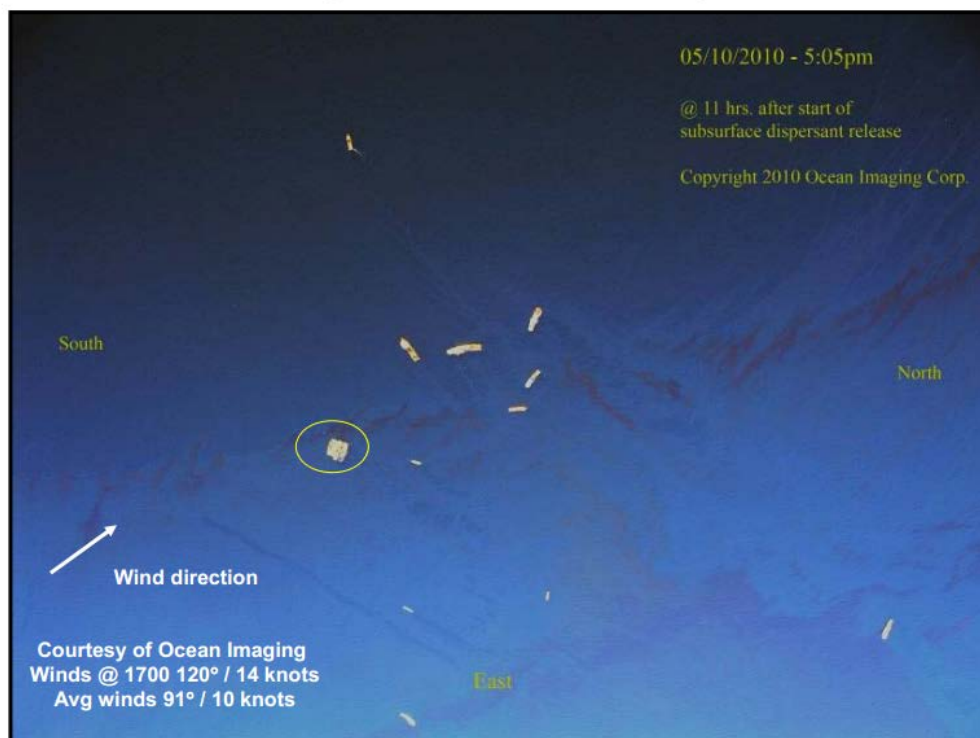
Release Site May 9: Prior to Injection



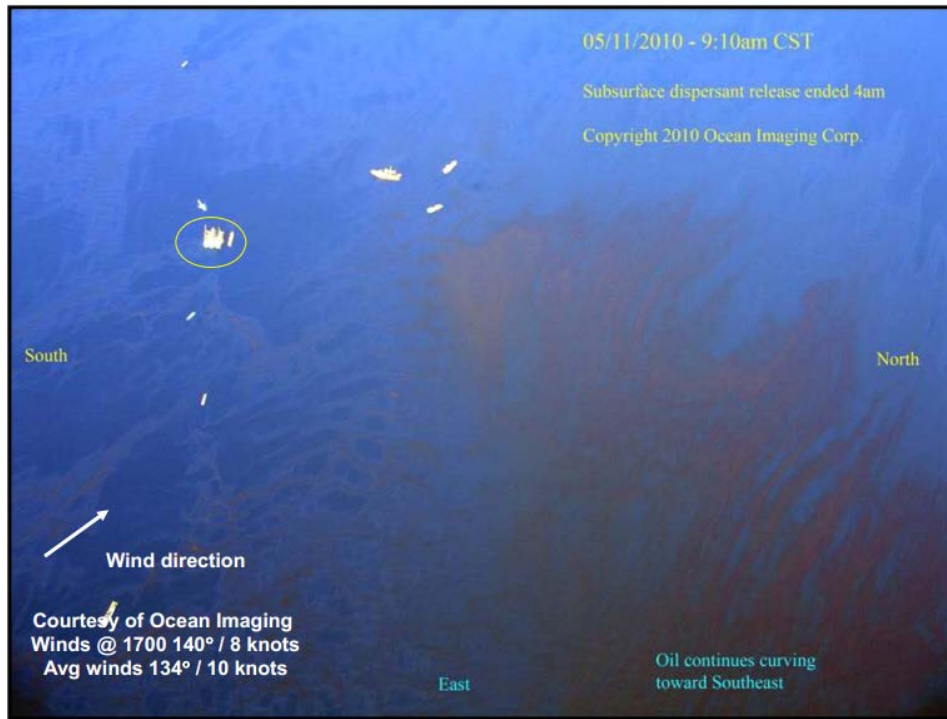
Release Site May 10: 3 hrs of Injection



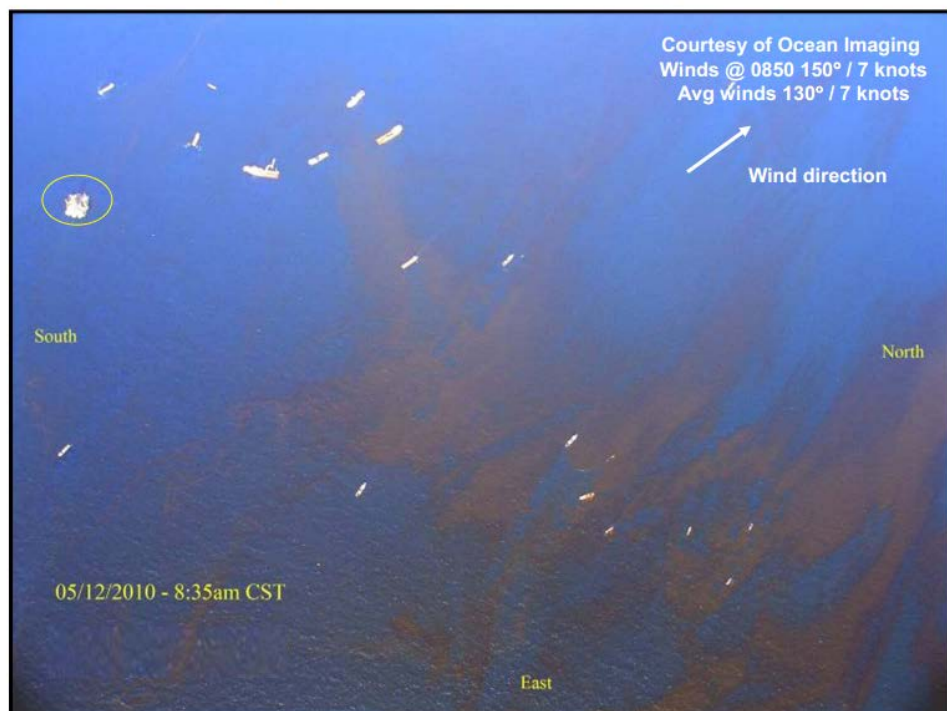
Release Site May 10: 11 hrs of Injection



Release Site May 11: 5 hrs after Injection Ended



Release Site May 12: 28 hrs After Injection Ended



R&D Dispersant Initiatives

Occurrence, Fate, and Transport of Dispersant Chemicals

Jennifer Field and Matt Perkins
Department of Environmental and Molecular Toxicology

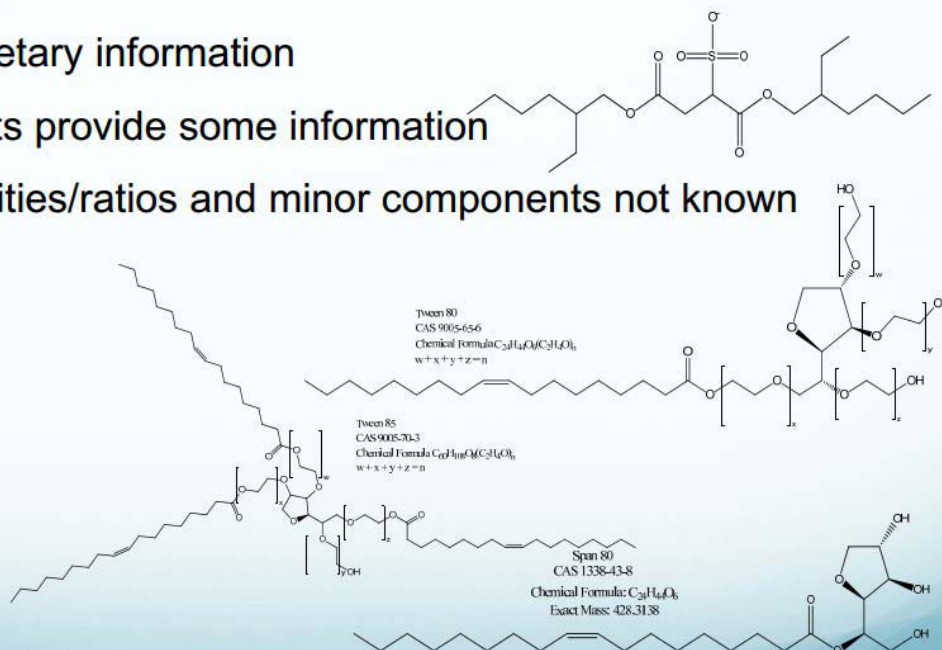
* National Institutes of Environmental Health Sciences Training Grant Fellow

Objectives

- Identify key questions about dispersant chemical occurrence, fate, and transport
- Identify research gaps & active groups
- Recommendations

What chemicals were applied?

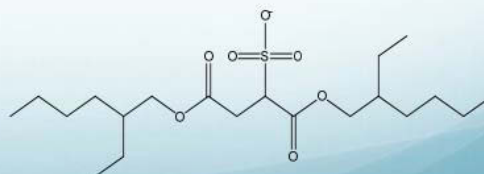
- Proprietary information
- Patents provide some information
- Quantities/ratios and minor components not known



Not shown: Petroleum distillates, propylene glycol, 2-butoxyethanol

How are the chemicals measured?

- Lack of information/methods delayed onset of monitoring efforts
- Gas chromatography/mass spectrometry (GC-MS/MS) methods available for volatile/semi-volatiles
 - ✓ Petroleum distillates, propylene glycol, 2-butoxyethanol
- Liquid chromatography/mass spectrometry (LC-MS/MS) methods not available for polar components
 - ✓ Diethylhexyl sulfosuccinate (DOSS)
 - ✓ Span 80
 - ✓ Tween 80
 - ✓ Tween 85



Where are the chemicals now?

- Limited field data available to public
 - ✓ ng/L levels in water column (Kujawinski, Gray, EPA, ECOGIG)
 - ✓ little sediment data
- Data gaps (OSU via ECOGIG)
 - ✓ occurrence in water column, sediment, and marine snow
 - ✓ chemical form(s) present
 - ✓ sedimentation via deposition of marine snow

What environmental processes potentially affected chemical fate?

- Partitioning (no change in mass)
 - ✓ water to sediment (Brownawell, SUNY Stony Brook; Ferguson, Duke; Field, OSU)
 - ✓ water to air (Valsaraj/Ehrenhauser, LSU)
- Transformation Reactions (mass lost/change in chemical form)
 - ✓ photolysis (Linden, Rosario-Ortiz, U. Colorado)
 - ✓ biodegradation (Venossa, EPA; Suflita, U. Oklahoma)
 - mineralization (CO_2 , H_2O , SO_4^-)
 - partial degradation to intermediates (OSU, Brownawell and Ferguson)
 - ✓ hydrolysis rates pH and temperature dependence (OSU)

Methods development challenge

- LC-MS/MS not well suited for screening unknowns
- LC-MS/MS requires *training* the instrument with *standard materials* (so must know structures)
- Confidence in data quality requires stable-isotope labeled standards (takes time and \$ to synthesize)
- Quality control needed to prevent data artifacts (background levels, loss during collection, transport, and storage)

Oil Spill Response Research Program

Bureau of Safety and Environmental
Enforcement

Oil Spill Response Division



Lori Medley
Oil Spill Response
Research Coordinator



• FY 2012 New Awards

OSRR # 1001

*Dispersant Effectiveness, In-Situ Droplet Size
Distribution, and Numerical Modeling to Assess
Subsurface Dispersant Injection as a Deepwater Blowout
Oil Spill Response Option*

PIs: Kenneth Lee and Robyn Conmy, EPA

Objective: This project will address the operational performance of the subsurface injection of dispersants into deepwater blowouts by developing methods focused on oil transport after dispersant injection.



- FY 2012 New Awards

OSRR # 1002

Acoustic Assessment of Subsea Chemical Dispersant Efficacy

PI: Dr. Paul Panetta, ARA

Objective: To develop acoustic techniques to measure the droplet size distribution for subsea release of crude oil and dispersants in the presence of natural gas. It will build off of the results of ARA's previous proof-of-concept study for using ultrasound to assess dispersant efficacy by measuring oil droplet sizes.



Also, see recently completed OSRR # 697.



- FY 2012 New Awards

OSRR #1003

Subsea Chemical Dispersant Research

PI: Randy Belore SL, Ross

Objective: The objective of the project is to advance the state of the art and knowledge in chemical dispersant use when injected into a subsea oil, or oil and gas release. The PI will investigate the role of natural gas in the gas-dispersant-oil system and evaluate measurement methods to quantify the oil drop and gas bubble plumes resulting from a treated or untreated subsea release.



- FY 2012 New Awards

OSRR # 1006

Development of Real Time Monitoring Protocol for Assessing Volatile Organic Compound Impacts on Response and Cleanup Workers Safety During Surface and Subsurface Dispersant Operations



PI: Dr. Ed Overton, Scott Miles , LSU

Objective: The objective of the proposed research is to develop real-time and passive monitoring protocols to effectively determine the impact of dispersant use and VOC release, in both surface and subsurface applications, on oil spill response worker safety.



- FY 2012 New Awards

OSRR #1009

Evaluation of Oil Fluorescence Characteristics to Improve Forensic Response Tools

PI: Kenneth Lee and Robyn Conmy, EPA

Objective: The overall objective is to translate oil fluorescence R&D into operational tools for spill response. Created will be an index listing optimum wavelengths to be measured depending on oil type and DOR. This will be used for selecting sensors and establishing Best Practices for rapid decision making during spill response.



• FY 2012 New Awards

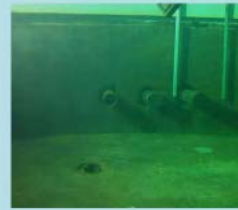
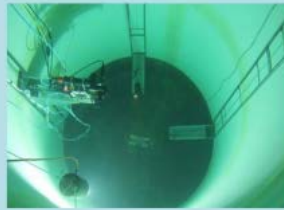
OSRR #1011

Evaluation of Feasibility of Conducting Subsea Dispersant Research at Ohmsett

PI: Randy Belore, SL Ross



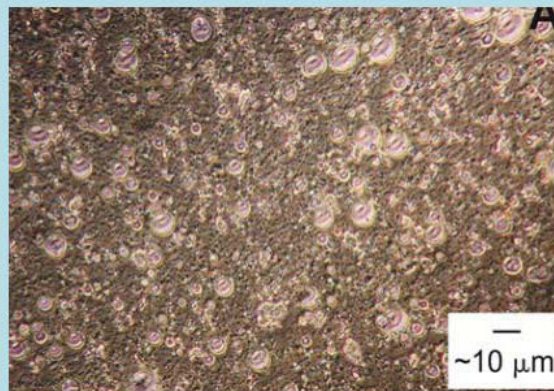
Objective: The objective of the study is to identify and provide rough cost estimates for the upgrades that would be required at the Ohmsett test facility to enable it to be used by researchers to study the process of direct injection of dispersants in subsea oil and gas well blowouts.



Recently Completed OSRR #681

Laboratory-Scale Investigation of a Method for Enhancing the Effectiveness of Oil Dispersants in Destabilizing Water-in-Oil Emulsions

PI: Dr. Joel Hayworth, Auburn University



The research investigated the feasibility of enhancing the de-emulsifying properties of commercially available oil dispersants by modifying the composition and fraction of polar constituents in the oil phase of water-in-oil emulsions and increasing the pH of the emulsion aqueous phase.



Lori Medley

Oil Spill Response Research Coordinator

Bureau of Safety and Environmental Enforcement,
Department of the Interior

381 Elden Street MS-HE3327

Herndon, VA 20170

(703) 787-1915

Fax: (703) 787-1555

[http://www.bsee.gov/Research-and-Training/Oil-Spill-Response-Research-\(OSRR\).aspx](http://www.bsee.gov/Research-and-Training/Oil-Spill-Response-Research-(OSRR).aspx)

Industry Sponsored Dispersant Research Initiatives

March 12, 2013
Baton Rouge, Louisiana

OGP JIP – Arctic Response Technologies

BP
Chevron
ConocoPhillips
ENI
ExxonMobil
NOC
Shell
Statoil
Total

Project is managed through International Association of Oil and
Gas Producers(OGP)

<http://www.arcticresponsetechnology.org/>

Dispersant Testing Under Realistic Conditions

- State of knowledge review
- Basin testing to evaluate dispersants in ice:
- Evaluation of dispersant injection for well control events
- Bench-top testing to evaluate dispersant effectiveness after oil or oil-dispersant mixtures have been frozen in or on ice
- Definition of the regulatory and permitting requirements for dispersant use in Arctic countries

3

Fate of Dispersed Oil under Ice

- Literature review to determine availability of suitable modeling data.
- Model selection. Collection of new data needed to run and validate the model; primary need is expected to be field data of natural under-ice turbulence.
- Modeling of surface and subsurface dispersant use scenarios.
- Reporting and submission to peer reviewed journals.

4

API JIP

American Petroleum Institute
Anadarko
BP
Chevron
ExxonMobil
Marine Well Containment Company
Nexen Petroleum
Shell
Statoil
Total
Wild Well Control

In addition to industry membership, Technical Advisory Committee members from various agencies, international organizations, and academia are providing input and input

5

Dispersants Projects

- Dispersant Research Forum
- Dispersant fact sheets
- Dispersant survey workshop held July, 2012
- High level “scan and glance” dispersant information
- Pacific Northwest and Eastern VA shores stakeholder conferences held in 2012
- Net Environmental Benefit Analysis (NEBA) communications package
- OHMSETT Open House July 9, 10, 11, 2013
- Dispersant Research Review Panel
- Surface Dispersants Operational Manual

6

Subsea Dispersants

- Effectiveness
- Fate and Effects
- Modeling
- Monitoring
- Communications

7

Effectiveness Project Team

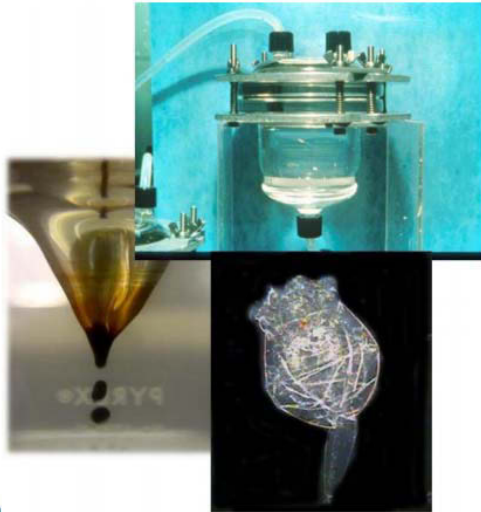
Preliminary testing in Sintef tower

1. Dispersant was effective at reducing droplet size even with low DOR's (1:100)
2. Injection wands were effective
3. Removing solvent IMPROVES dispersant effectiveness
4. Injecting dispersant over 5 pipe diameters above discharge point was effective



Fate and Effects Project Team

Focus: Evaluate the biodegradation and toxicity of dispersants & dispersed oil on deepwater communities



- Summarize previous research on dispersed oil biodegradation and toxicity
- Identify relevant deepwater test organisms and develop appropriate testing protocols
- Conduct biodegradation and toxicity tests on water samples and species representative of depth

9

Modeling Project Team

Focus: Enhance existing numerical tools to model dispersed oil plumes resulting from subsea injection

- Contracted with experts from MIT/TAMU/ NJIT to
 - Evaluate existing droplet submodels and validate against lab & field studies
 - Hold a workshop to review results to discuss inclusion of our preferred droplet submodel into integrated model (e.g. ASA, NOAA, etc.)
 - Evaluate integrated oil fate & transport models commonly used by the Industry

10

Communications Project Team

Focus: Develop tools to communicate the results of subsea dispersant injection research externally

- Education fact sheets have been developed
- Each project has a Technical Advisory Team to foster transparency
- Project Newsletters
- Conduct workshops including a NEBA workshop at the end of the project

OGP/IPIECA JIP

BP	Petrobras
Chevron	Marathon Oil
ExxonMobil	Nexen
Shell	ENI
Statoil	GDF Suez
Total	Wintershall
BG Group	Inpex
ConocoPhillips	Hess Carin
	RWE

<http://oilspillresponseproject.org/>

Dispersants Projects

- OGP–IPIECA Dispersant Good Practice Guide
- Communication materials on Net Environmental Benefit Analysis (NEBA)
- Efficacy of subsea dispersants injection
- Dispersant logistics & supply
- Dispersant Effectiveness and Post-Spill Monitoring

Kill•Spill Project Overview



Integrated Biotechnological Solutions for Combating Marine Oil Spills
(Grant Agreement Number 312139)

Nicolas Kalogerakis (Tech U Crete)
nicolas.kalogerakis@enveng.tuc.gr



This project is supported by the European Commission under the Food, Agriculture and Fisheries and Biotechnology theme for the 7th Framework Programme for Research and Technological Development



Topic Addressed

KBBE.2012.3.5-01

Innovative biotechnologies for tackling oil spill disasters (The Ocean of Tomorrow)

Kill•Spill project:

Total cost: 12,483,643.40 €

EU contribution: 8,996,599.00 €

with 27.38% to SMEs



Integrated Biotechnological Solutions for Combating Marine Oil Spills (Grant Agreement Nr 312139)



Project Partners

KILL SPILL TEAM
1 TECHNICAL UNIVERSITY OF CRETE (TUC) - Greece
2 FACHHOCHSCHULE NORDWESTSCHWEIZ (FHNW) - Switzerland
3 ALMA MATER STUDIORUM-UNIVERSITA DI BOLOGNA (UNIBO) - Italy
4 UNIVERSITY OF NEWCASTLE UPON TYNE (UNEW) - UK
5 The Geological Survey of Denmark and Greenland (GEUS) - Denmark
6 UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA (UNIRM) - Italy
7 AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (CSIC) - Spain
8 UNIVERSITY OF ULSTER (Ulster) - UK
9 CONSIGLIO NAZIONALE DELLE RICERCHE (CNR) - Italy
10 UNIVERSITA DEGLI STUDI DI MILANO (UMIL) - Italy
11 UNIVERSITEIT GENT (Ugent) - Belgium
12 VYSOKA SKOLA CHEMICKO-TECHNOLOGICKA V PRAZE (ICTP) - Czech Rep.
13 Københavns Universitet (UCPH) - Denmark
14 BANGOR UNIVERSITY (Bangor) - UK
15 HELMHOLTZ ZENTRUM MUENCHEN DEUTSCHES FORSCHUNGSZENTRUM FUER GESUNDHEIT UND UMWELT GMBH (HMGU) - Germany
16 MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM (MBA) - UK
17 UNIVERSITE CATHOLIQUE DE LOUVAIN (UCL) - Belgium

KILL SPILL TEAM
18 NATIONAL UNIVERSITY OF IRELAND, GALWAY (NUIG) - Ireland
19 BIOBASED EUROPE LIMITED (BBE) - UK
20 BIOREM ENGINEERING BVBA (BIOREM) - Belgium
21 GORTON CONSULTANCY LTD (GCL) - UK
22 CREATIVE RESEARCH SOLUTIONS BVBA (CRS) - Belgium
23 ENVIRONMENTAL PROTECTION ENGINEERING SA (EPE) - Greece
24 MADEP SA (MADEP) - Switzerland
25 HEIQ MATERIALS AG (HeiQ) - Switzerland
26 MARITIM MILJO BEREDSKAP AS (MMB) - Norway
27 INSTITUT ZA FIZIKALNO BIOLOGIJO D.O.O. (IFB) - Slovenia
28 EcoTechSystems Srl (ECOTS) - Italy
29 UK SPILL LIMITED (UKSpill) - UK
30 VERMICON AKTIENGESELLSCHAFT (VER) - Germany
31 ACTYGEA SRL (ACTY) - Italy
32 OMYA DEVELOPMENT AG (OMYA) - Switzerland
33 STATE UNIVERSITY OF NEW YORK AT BUFFALO (UB) - USA

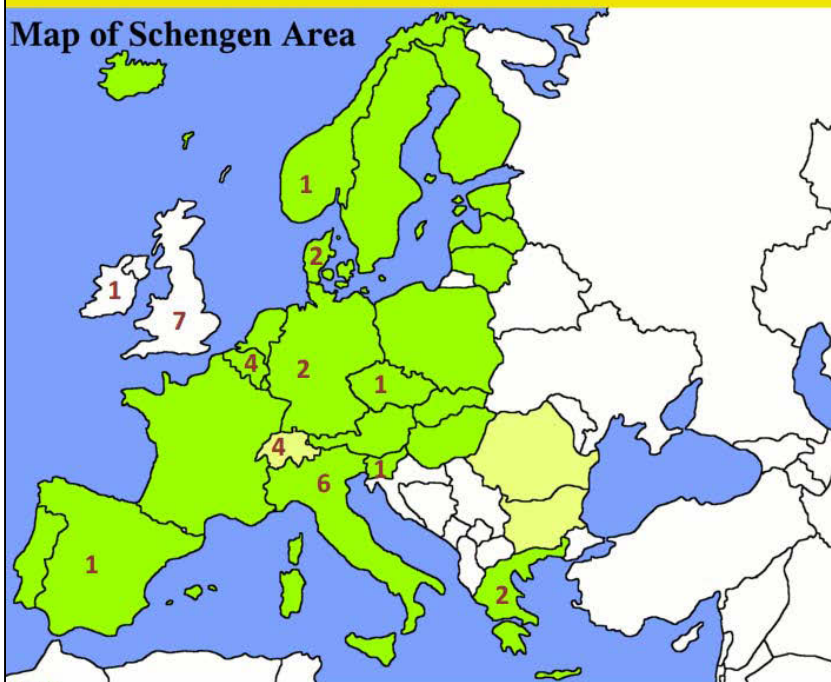


Integrated Biotechnological Solutions for Combating Marine Oil Spills (Grant Agreement Nr 312139)



Geographical Distribution

Map of Schengen Area



Country	No.
Greece	2
Switzerland	4
Italy	6 (+1)
UK	7
Denmark	2
Spain	1 (+2)
Belgium	4
Czech Rep	1
Germany	2
Ireland	1
Norway	1
Slovenia	1
USA	1
Total	33 (+3)

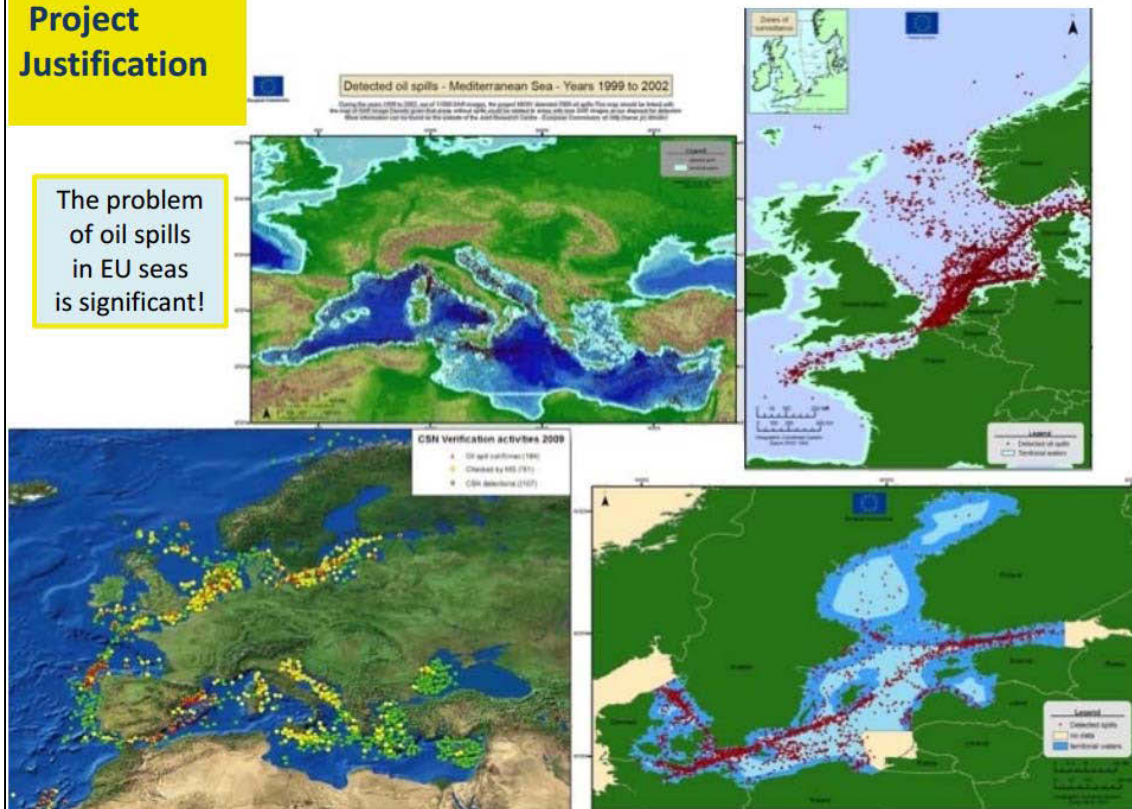


Integrated Biotechnological Solutions for Combating Marine Oil Spills (Grant Agreement Nr 312139)



Project Justification

The problem of oil spills in EU seas is significant!



Project Focus / Objectives

1. Review State-of-the-Art & identify technology gaps
2. Develop biosensors to monitor hydrocarbon degraders & hydrocarbon degradation
3. Develop novel bio-based dispersants
4. Develop novel bioremediation agents
5. Develop solutions for sediments
6. Develop multifunctional bioremediation agents
7. Test their toxicity



Integrated Biotechnological Solutions for Combating Marine Oil Spills (Grant Agreement Nr 312139)



Technologies (products) to be Delivered

No.	Technology	Application
1	"Kill●Spill Biosensor" (Biosensors for HC-monitoring)	On-site monitoring of oil degradation
2	"Kill●Spill FISH-Kit" (Cultivation-independent microbial diagnostic kits)	CARD-FISH diagnostic kit for on-site monitoring of microbial communities
3	"Kill●Spill FCM-Kit" (Cultivation-independent microbial diagnostic kits)	FISH + FCM diagnostic kit for on-site monitoring of microbial communities
4	"Kill●Spill Chip" (Microarray chip)	On-site monitoring of microbial communities
5	CHEMSIC	Monitoring of oil degradation
6	Polymer-based non-woven fabrics	Sorbent material (shoreline and near-shore)
7	Mineral-based powders	Sorbent material, accelerated bioremediation (oxic and anoxic environments)
8	Oxygen-releasing dispersants (OXYGEL™)	Dispersant, accelerated bioremediation (oxic and anoxic environments)
9	Porous granular sorbent (AEROBEADS™)	Sorbent (floating oil), accelerated bioremediation (oxic and anoxic environments)
10	Plant-based biosurfactant blends (SC1000™, SUPERSOLV™, EASYSOLV™)	Emulsification and mobilization of oil, sand washing, accelerated bioremediation
11	Microbial biosurfactants and emulsifiers	Emulsification and mobilization of oil, sand washing, accelerated bioremediation
12	Formulated HC-degrading MOs and consortia	In-situ bioaugmentation (incl. ABA), further technology development
13	High-pressure reactor	Lab-scale testing environment for deep-sea cases
14	Microdroplet reactor	Improvement/isolation of degrading MOs

Technologies (products) to be Delivered

No.	Technology	Application
15	Low cost biostimulant formulations	Accelerated bioremediation, further technology development
16	"Kill●Spill ElectrO ₂ " (Electrode-based oxygen supply)	In-situ sediment cleanup
17	"Kill●Spill snorkel" (Microbial electrochemical snorkel)	In-situ sediment cleanup
18	"Kill●Spill Robot" (Bio-electro-chemical roaming system)	In-situ sediment cleanup
19	Infauna accelerated degradation	In-situ sediment cleanup
20	"Kill●Spill Sed-Cleaner" (Modular system for enhanced biodegradation)	In-situ bioaugmentation and biostimulation for sediments
21	Sequestering sorbents	Sorbent material for oil sequestration in sediments
22	"Kill●Spill Deep-sea" (Multi-functional bioremediation agents)	Enhanced bioremediation of HC-"clouds" formed in deep-sea oil releases
23	"Kill●Spill Mesoporous" (Mesoporous silica (nano)particles)	Enhanced bioremediation though bioaugmentation and biostimulation on silica
24	"Kill●Spill SlowRelease" (Slow release microparticles)	Enhanced bioremediation though bioaugmentation and slow-release fertilizers in lipophilic carriers
25	"Kill●Spill All-in-One" ("All-in-One" multifunctional carrier)	First response measure for enhanced bioremediation and oil dispersion
26	"Kill●Spill MineralSorb" (Multifunctional sorbent materials)	Mineral based Sinking and agent (Oil transferred to sediments) and enhanced bioremediation
27	"Kill●Spill Bio-carriers" (Porous bio-carriers)	Biomaterials for immobilization of HC degraders and biostimulants for sea water & sediments
28	"Kill●Spill Bio-boom" (Improved biodegrading booms)	Oil barriers (booms) and with enhanced sorbent & bioremediation capabilities.

Field Testing of Technologies

- Field tests of developed technologies during 3rd & 4th year:

1. At CNR-IAMC pilot testing facilities
 2. In Aegean Sea (EPE)
 3. In North Sea/Norwegian Sea (MMB)
 4. At Sea DIAMOND wreck (EPE)
 5. In Disko Bay / Greenland (GEUS)
- and at
6. TUC land-farming mesocosms
 7. At ship wreck (CNR-IAMC)

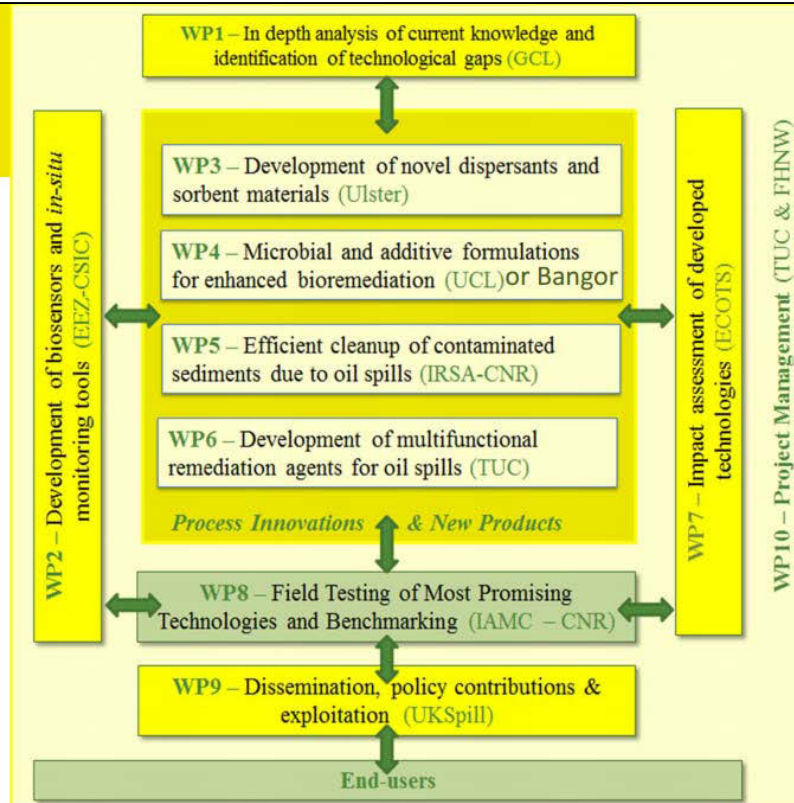


Integrated Biotechnological Solutions for Combating Marine Oil Spills (Grant Agreement Nr 312139)



WPs & WP Leaders

- Project duration: 48 months
- Mid term REVIEW: month 30



Integrated Biotechnological Solutions for Combating Marine Oil Spills (Grant Agreement Nr 312139)





Thank you for your attention

We have the opportunity to Kill the Spill by delivering some very high impact technological solutions...

www.killspill.eu



A faint outline map of California is visible in the background of the slide.

Dispersant Use In California Waters

Ellen Faurot-Daniels

ART Lead

California Department of Fish and Wildlife
Office of Spill Prevention and Response

ellen.faurot-daniels@wildlife.ca.gov

831-649-2888

Presentation Objectives

- Role Review: Regional Response Team (RRT) IX and relationship of Unified Command and RRT during a spill
- Dispersant use zones in California
 - Net Environmental Benefit Analysis (NEBA)
 - NEBA in Pre-approval Zones vs. RRT Incident-Specific Approval Zones
- General layout of the California Dispersant Plan (CDP)
- How the CDP used during drills and spills
- Past and present work in research and response planning

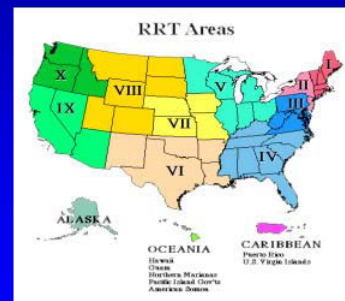
Federal Planning and Response

National Response Team:

- National planning & coordination (NCP)

Regional Response Team (RRT IX):

- Regional contingency planning, coordination of preparedness and response, including use of ART.
- Membership: Federal and state agencies
- Standing and Incident-Specific RRTs.
- Subcommittees (including ART) where most of plan update work begins



Region IX ART Approach

- 2002-2004: Multi-level/team approach to revise the dispersant policy
 - Expert panels for trustees & RRT agencies (OSPR participated in all of them)
 - Area Committee evaluations for each zone of operation
- New dispersant use zones reviewed and adopted by RRT
- California Dispersant Plan part of RCP
- OSPR drafted ESA Sec. 7 Biological Assessment on behalf of RRT
- 2009-Present: CDP update work, including BA

RRT Assignment to the Area Committees for Dispersant-Use Policy

- Each California marine Area Committee asked to recommend dispersant use zones within their Area of Responsibility, 3 - 200 nm from shore.

RRT policy zone choices:

- Dispersants are Pre-approved
- Dispersants are Pre-approved, with consultation
- Incident-Specific RRT Approval Required



- Area Committees used a modified ERA/NEBA model for the ecological trade off determination
- To adequately develop NEBA trade-off considerations, included impacts of any response option, to all marine waters and shorelines, -0 to 200 nm offshore, all water depths and habitats. This NEBA information retained in CDP.
- Zone recommendations forwarded by Area Committees to RRT for their review and approval

Process Used by each Area Committee/Dispersant Subcommittee

- Developed a risk matrix
- Ranked species/habitat based on relative risk
- Designated Dispersant Use Zones and areas of special concern (Sanctuaries, etc).

NEBA Matrix Design

RECOVERY

1. Irreversible 2. Reversible

MAGNITUDE

A. Severe

B. Trivial

1A	2A
1B	2B

Los Angeles Matrix (North and South Area Committees)

Zones	Terrestrial	Water Surface	Intertidal			
Habitats	Upland and Supratidal		Marsh	Mud Flats	Sandy Beach	Rip Rap/Sea Walls/Pilings
Subhabitats						
Natural Recovery	B1	B1	D3/C1	C2	A1	C1/C2
Mechanical Rec. (30%)	B1	B1	D3/C1	C2	A1	C1/C2
Dispersants (75%)	D2	C1	E3/D2	D3	C2	D1
ISB (30%)	B1	B1	D3/C1	C2	A1	C1
W/shoreline protections	B2	B1	E3/D1	D3	Not Appropriate	C2/4E
Shoreline Cleanup	B2/C3	Not Applicable	A1	C1	D3/C4	C2

Comparative Risk Assessment Analysis Methodology

- The NEBA process provided the basis for comparing and prioritizing risk.
- If assume that every response alternative presents some level of risk, then this approach can provide the basis for choosing among alternatives.
- Risk assessment goal: Determine if a given response option offers a *relative environmental improvement*, when compared to no response.

California Dispersant Use Zones

Pre-Approval Zone

All areas 3 – 200 nm off the coast, except:

- Within a National Marine Sanctuary
- Within 3 miles of the US-Mexico border

Incident-Specific RRT Approval Required Zone

- Marine waters within 3 nm of the coast (including offshore islands)
- Waters within a National Marine Sanctuary
- Waters within three miles of the border with Mexico
- Marine waters one mile from anadromous fish streams during times of emigration and immigration

Post DWH: Subsea use and surface use for >5 days requires RRT approval



Dispersant Use Plan

- Complete guide for evaluating a dispersant use in California
- FOSC checklists and flow charts for all zones (Pre-Approval and RRT Incident-Specific Approval)
- Critical reference material in appendices

Multiple Plan Uses

- Planning and response tool
 - Easy to use flow charts and forms
 - All information needed in body of document
 - Appendices for supplemental information
 - SMART
 - Wildlife Spotting
 - Seafood Safety
 - NEBA summaries
 - Public Communications Plan
 - Oil Characteristics and their general dispersibility
 - Dispersant resources in or available to CA
- Training
 - Drills and exercises, oil spill schools, new staff training
- Stand Alone Document
 - An appendix to the regional contingency plan

Development of Dispersant Monitoring Program

Special Monitoring of Applied Response Technologies (SMART)

- Conducted in real time
- Provides visual or fluorometry information regarding the presence of dispersed oil; does not provide information on concentration or toxicity (although there has been discussion of including this additional monitoring step as a new tier within SMART)

Short and Long-Term Monitoring for Environmental Concentrations

- Draft Dispersed Oil Monitoring Plan (DOMP): Goal is to determine where and when monitoring should take place
- Data can be used for NRDA and seafood safety, as well as validating assumptions made during the NEBA process for dispersant pre-approval

MEXUSPAC and Dispersant Use

- In the event dispersants are to be applied in U.S. waters within 3 mi of the border with Mexico, notification to Mexican Navy will be made.
- Concerns by Mexican Government over dispersant application within 3 mi of MX waters will be considered by RRT IX prior to approval.

Next Steps

Overall: Update California Dispersant Use Plan (to be completed end of 2014?)

- Complete all ESA Section 7 consultations (now in CG and EPA hands); provide links to related Biological Assessments, get Coastal Commission federal consistency decision letter
- Finalize dispersed oil monitoring plan (DOMP), or equivalent
- Integrate dispersant and ISB flowcharts, worksheets and checklists, as appropriate, to de-conflict possible concurrent dispersant, ISB and mechanical removal operations

On-Going Work/Next Steps

Living document:

- Conduct/sponsor additional focused research as possible (sub-lethal effects, new dispersants or dispersant formulations)
- Include new Job Aid, to include full suite of templates for use by NOAA SSC and ART Lead Technical Specialist use
 - Determination of NEB, briefing memos and records of decision for FOSC, briefing memos and records of decision for RRT, added conditions and BMPs, communications with Operations Section, QA/QC of SMART results, etc.
- Clarification within state Drill & Exercise regulations, and in RCP, of who leads ART within Environmental Unit

Next Steps, continued

- Clarifications with IMH and federal drill and exercise regulations of who leads ART within Environmental Unit
- Integrate new research results (especially fate/effects, biological/ecosystem effects, dispersed oil monitoring for toxicity, public communications)
- Update CA OSCA licensing requirements as necessary to bolster toxicity and “additional hazards” considerations of licensed products (OSPR may internally conduct some side-by-side comparisons products within various OSCA classes)
- Update RCP and ACPs as appropriate

Next Steps, continued

- Conduct/facilitate additional, focused NEBAs as necessary (e.g., for other waters, other products, newly listed species or critical habitats), especially if will change ESA Sec. 7 effects determinations
- Continue training and outreach, especially to trustee agencies that might be working as ART Technical Specialists within EU
- Refine conditions and BMPs so that provide maximum protection of potentially impacted species yet also maximize operational efficiencies

Questions?

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