BEAUFORT REGIONAL
ENVIRONMENTAL ASSESSMENT

Workshop on Dispersant Use in the Canadian Beaufort Sea

Canada

October 2011

Beaufort Regional Environmental Assessment (BREA)

Building a strong knowledge base to support regulatory decisions on offshore oil and gas activity

The Beaufort Regional Environmental Assessment (BREA) was announced in August 2010. BREA is a four year, multi-stakeholder initiative that provides an opportunity for Inuvialuit communities, industry, governments, academia and regulators to prepare for oil and gas activity in the Beaufort Sea. BREA was established to develop scientific and socio-economic information to support efficient and effective regulatory decisions for oil and gas exploration and development in the Beaufort Sea.

Évaluation environnementale régionale de Beaufort (EERB)

Élaboration d'une base de connaissances solide en vue d'appuyer les décisions réglementaires concernant les activités pétrolières et gazières extracôtières

L'évaluation environnementale régionale de Beaufort (EERB) a fait l'objet d'une annonce en août 2010. L'EERB est un partenariat de quatre ans, qui permet aux collectivités inuvialuites, à l'industrie, aux gouvernements, au milieu universitaire et aux organismes de réglementation de mieux planifier les activités pétrolières et gazières dans la mer de Beaufort. L'EERB permettra l'avancement des connaissances scientifique et socioéconomique qui guideront un processus décisionnel efficiente et efficace en matière de réglementation portant sur les activités d'exploration et développement dans la mer de Beaufort.

Workshop on Dispersant Use in the Canadian Beaufort Sea

Midnight Sun Complex & Conference Centre
Inuvik, NWT
July 25 to 28, 2011

Sponsored
by
Beaufort Regional Environmental Assessment (BREA)
Aboriginal Affairs and Northern Development Canada
10 Wellington Street
Gatineau, Quebec, Canada
K1A 0H4

and

Canadian Association of Petroleum Producers
2100, 350 – 7th Avenue SW
Calgary, Alberta, Canada
T2P 3N9

by

SL Ross Environmental Research Limited
717 Belfast Road, Suite 200
Ottawa, Ontario, Canada
K1G 0Z4

October 31, 2011

Table of Contents

1 Introduction **2**

3 Presentations **5**

3.1 Setting 5

3.2 Technical Aspects of Dispersants and Effectiveness of Operations 6

3.2.1 The Environmental Risks of Oil Spills and Risks and Benefits of Dispersant Use 7

3.2.2 Dispersant Regulation in Canada and Elsewhere 9

4 Tabletop Exercise **13**

4.1 Introduction 13

4.2 Scenario #1 - Batch Spill From a Tanker 16

4.2.1 Spill Conditions 16

4.2.2 Oil Fate, Behaviour and Movement 16

4.2.3 Spill Impact and Net Environmental Benefit Analysis 17

4.3 Scenarios #2 and #3 – Above-sea (#2) and Sub-sea (#3) Blowout Spills 19

4.3.1 Spill Conditions 19

4.3.2 Oil Fate, Behaviour and Movement 19

4.3.3 Dispersed Oil Case 20

4.3.4 Spill Impact and Net Environmental Benefit Analysis 20

5 Views on the Way Forward **21**

5.1 Industry Comments in the Closing Panel Session (Ian Denness) 21

5.2 Government Comments in the Closing Panel Session (John Korec) 22

5.3 Inuvialuit Community Comments (Lawrence Amos) 22

Appendix 1 – Participants **26**

Appendix 2 – Questions **27**

Appendix 3 - Acronyms **30**

1 Introduction

The “Workshop on Dispersant Use in the Canadian Beaufort Sea”, sponsored by the Oil Spill Preparedness and Response Working Group of the Beaufort Regional Environmental Assessment, was held in Inuvik, NWT on July 26 – 28, 2011. The general objectives were:

a. To inform regional stakeholders about dispersants and the implications of including them as a response tool for cleaning potential oil spills in the Canadian Beaufort Sea; and

b. To help identify paths forward for planning for including chemical oil spill dispersants in the “toolbox” of spill response countermeasures available to responders in the Beaufort Sea, along with mechanical containment and recovery, in-situ burning, and shoreline cleanup.

While recognizing that the primary aim of oil and gas proponents of exploratory drilling is to prevent accidental spills from happening, it is clear that the risk of accidental spills is always present. That being the case, it is important to be prepared to respond to them. Spill response methods in the Arctic, as elsewhere in the world, include:

a. Controlling the spill source;

b. Monitoring the movements and fate of the spilled oil;

c. Selecting the appropriate spill countermeasure(s) from the following, based on factors such as safety and environmental protection:

   i. Containing and recovering as much of the oil as possible;

   ii. Chemically-dispersing and burning (in-situ burning) as much of the oil as possible in offshore areas before it can contaminate shorelines or ice-edges; and

   iii. Cleaning up shorelines and ice edges if and when they become oiled.

Information about most spill response technologies other than dispersants (e.g., mechanical containment) had been provided to stakeholders in recent months. The objective of this workshop was to deal with dispersants, so the workshop focused narrowly on this countermeasure. To that end the workshop aimed to provide stakeholders with an understanding of:

a. The fundamentals of dispersants as a means of responding to oil spills;

b. The capabilities and limitations of dispersants and dispersant operations;

c. The potential environmental risks from oil spills and dispersant use;

d. The use of Net Environmental Benefits Analysis (NEBA) in spill response planning; and

e. Dispersant regulation and planning in Canada and dispersant guidelines, regulations and planning in other jurisdictions.

Participants included more than 50 persons from key stakeholder organizations, including the Inuvialuit communities, government and the oil industry (Appendix 1). The workshop agenda (Table 1.1) included:

a. A series of presentations designed to inform participants on critical dispersant subjects, including important recent developments in dispersant research, particularly regarding

b. Tabletop exercises were used to illustrate the practical use of the information provided in the presentations.

c. The workshop concluded with brief statements from the major stakeholder groups regarding their view of the next steps needed to plan for dispersant use spill response in the Beaufort Sea. These are provided in their entirety below.

Table 1: Workshop Agenda

Tuesday July 25, 2011

	Item	Speaker
9:00	Call to Order / Welcome	Lawrence Amos (IGC)
9:05	Introductions	John Korec (NEB)
	INTRODUCTION/SETTING	
9:15	Industrial Setting	James Hall (IOL)
9:30	Environmental Setting (Community View)	Lawrence Amos (IGC) James Hodson (CWS)
10:30	Environmental Setting (Natural Resource Trustee Perspective)	Lisa Loseto/James Reist (DFO)
10:45	Introduction to Dispersants and History of Dispersants in Canada	Ken Trudel (SL Ross)
1:00	**OPERATIONS**	
1:00	Dispersant Effectiveness and Logistics Considerations	Ken Trudel (SL Ross)
1:30	Dispersants and the Deepwater Horizon Spill	Steve Potter (SL Ross)
2:15	**ENVIRONMENTAL RISKS & NEBA**	
2:15	Environmental Risks and NEBA	Ken Trudel (SL Ross)
3:00	Dispersant Toxicology Research at BIO	Ken Lee (DFO)
3:45	Dispersant Toxicity and Oil Degradation Research (Alaska)	Jack Word (Newfields)
5:00	Adjourn	
6:00	Reception and Presentation by Ken Lee: 2010 Macondo Oil Spill	

Wednesday, July 27, 2011

9:05	**REGULATIONS, GUIDELINES, PRE-APPROVAL**	John Korec (NEB)
9:05	Regulator's View on Coordinating Response Planning Participation: ISR Communities, Industry, and Government Agencies	John Korec (NEB)
9:45	Oil Spill Dispersants - Evaluation and Scientific Support	Carl Brown (Env Can)
10:45	Overview of Dispersant Planning in Atlantic Canada	Roger Percy (Consultant)
11:30	Dispersant Policies and Plans in Other Jurisdictions	Ken Trudel (SL Ross)
1:00	Basics of NEBA for Dispersants	Ken Trudel (SL Ross)
1:30	**TABLETOP EXERCISE**	
1:30	Presentation of Spill Scenario #1 – Tanker Spill	Ken Trudel (SL Ross)
2:00	Breakout Groups - Discuss Valuation of Threatened Resources	All
3:00	Present and Discuss Spill Impacts	

Thursday, July 28, 2011

9:00	Breakout Groups Discuss NEBA for Dispersant Use: Scenario #1	All
9:45	Presentation of Group Results and General Discussion	All
10:00	Summary of Scenarios #2 and #3	All
10:15	Caucus of Stakeholder Groups	All
	THE WAY FORWARD	
11:15	The way forward – Capitalizing on Strengths; Priorities for Addressing Weaknesses	John Korec (NEB) Ian Denness (CPC) Lawrence Amos (IGC)
12:00	Closing Remarks	Ruth McKechnie (AANDC)
12:15	Adjourn	

2 Welcome

The workshop began with Lawrence Amos welcoming participants to Inuvik on behalf of the Inuvialuit Game Council.

3 Presentations

The presentations addressed three main subjects.

a. The setting for workshop discussions, namely:
   i. Proposed industry activity and industry's approach to spills and spill response in the Beaufort Sea; and
   ii. Environmental protection priorities of the Inuvialuit people and government trustee agencies in the event of spills and concerns about spill response, with particular reference to dispersants.
b. Information critical to proper dispersant use and planning, specifically:
   i. An introduction to dispersants, dispersant use and decision-making;
   ii. Capabilities and limitations of dispersants and dispersant operations in dispersing oil slicks;
   iii. Risks to the Beaufort Sea environment from marine oil spills and the potential benefits and risks of dispersants in spill response;
   iv. The use of Net Environmental Benefit Analysis (NEBA) in identifying spill cases or conditions under which dispersants offer clear environmental benefits or disadvantages in the Beaufort Sea; and
c. Regulatory controls on dispersant use and the roles of stakeholder groups, specifically the Inuvialuit and government agencies, in response planning and decision-making for potential oil spills from exploratory drilling in the Beaufort Sea, with particular reference to dispersants.

3.1 Setting

The first presentations established the setting for the workshop discussions by describing: a) the industrial setting and b) the environmental protection priorities for each of the stakeholder groups in the event of an oil spill; and c) any concerns of the stakeholders regarding dispersant use in the Beaufort Sea.

Industrial Setting: Perspectives on Dispersant Use in the Beaufort Sea (James Hall, IOL)

The presentation was an overview of potential development in the Beaufort Sea, noting that present proposals are for a much lower level of exploration activity than occurred in the 1970s and 1980s. It emphasized that the first priority of proponents of oil exploration is to operate safely and protect the environment within which they operate by preventing any accidental oil releases. In the event of a spill it would be critical that all response options be available to responders. Both dispersants and in-situ burning will be key response options in the Beaufort.

Dispersants in particular have obvious advantages in the Beaufort Sea given their low risk for people and the environment and their obvious logistical advantages during a spill response.

Environmental Setting: The Community View (Lawrence Amos, IGC)

Lawrence Amos emphasized: a) the importance of environmental protection to allow the Inuvialuit to maintain their way of life; and b) the opposition of the Inuvialuit to the use of dispersants.

Environmental Setting: Natural Resource Trustee Perspective

(James Hodson, CWS; Lisa Loseto, James Reist, DFO)

These speakers provided an overview of their roles and legislative responsibilities; their concerns regarding potential effects of spills on bird, fish and marine mammal species and their habitats; spill cleanup activities and dispersants in the Beaufort Sea; and studies in progress and planned to develop information on key Beaufort Sea ecosystems.

James Hodson (CWS) emphasized the high sensitivity and vulnerability of important Beaufort Sea wildlife populations to marine oil spills, mentioning specifically nesting and moulting areas and migratory routes of migratory species (e.g., King and Common Eiders). He expressed particular interest in understanding the toxic effects of oil and dispersants on wildlife species and potential effects of food web transfer.

Lisa Loseto/James Reist (DFO) described the role of DFO in studying and managing risks to fish and in-water species in the Beaufort. They highlighted the current lack of information concerning life in the deep, offshore waters of the Beaufort, where some exploratory drilling activity may take place, as well as plans for addressing these gaps. They expressed an interest in learning more about direct impacts of oil and dispersants on marine species and potential effects of interactions of these with other stressors, such as climate change.

3.2 Technical Aspects of Dispersants and Effectiveness of Operations

These presentations explained the basics of dispersants and explained, in quantitative terms, the capabilities and limitations of dispersants in removing slicks from the sea surface in the Beaufort Sea. It also compared dispersants to other oil spill technologies planned for use on potential spills in the Beaufort, including mechanical containment and recovery.

Introduction to Dispersants and Dispersant History in Canada (Ken Trudel, SL Ross)

The presentation described the basics of how dispersants work; how and why they are used; and demonstrated the effect of dispersants on oil-water mixing. There was a demonstration of how oil interacts with marine water and what happens when a dispersant is added to the oil-water mixture. Participants were able to see how the dispersant breaks up the oil into smaller droplets. The strengths and weaknesses of dispersants were compared to those of mechanical containment and recovery.

It also provided an overview of the history of dispersant planning and research in Canada and elsewhere that is particularly relevant to spill planning in the Beaufort Sea (e.g., the BIOS study).

The history highlighted the large amount of work already done by Canadians in this area and the need to utilize this information in future planning, rather than “re-inventing the wheel”.

Dispersant Effectiveness and Logistics Considerations (Ken Trudel, SL Ross)

This presentation described the capabilities of dispersants in dispersing slicks. It described the roles of factors that limit their effectiveness (e.g., viscosity of oil and oil emulsions, temperature (oil and water), dispersant type and dose, mixing energy (from braking waves or other external sources), water salinity, ice, weather. It also provided an overview of the logistics considerations when using dispersants to respond to spills, highlighting the large differences in logistics capabilities among the various types of spraying platforms such as vessels, helicopters and large fixed wing aircraft.

Dispersants and the Deepwater Horizon Spill (Steve Potter, SL Ross)

This presentation provided an overview of the use of dispersants to disperse surface oil slicks in the 2010 Macondo oil spill in the Gulf of Mexico. It used this concrete example of a response in order to illustrate information presented in the previous presentations. It described the operations and their very large scale; the response assets used; the coordination of dispersant operations with other response technologies, including booms and skimmers and in-situ burning; and summarized some lessons learned about dispersant use during the spill.

3.2.1 The Environmental Risks of Oil Spills and Risks and Benefits of Dispersant Use

These presentations described the environmental risks of oil spills based on studies of past spills and the risks and benefits of dispersant use based on 30 years of dispersant research. NEBA and its use in dispersant planning were explained. Finally, results of two important recent research initiatives concerning dispersant use in the Arctic were presented.

Environmental Risks and NEBA (Ken Trudel, SL Ross)

This presentation summarized the risks posed by marine oil spills to marine species in the Beaufort Sea and the potential benefits and drawbacks of using chemical dispersants to treat oil slicks. It addressed existing knowledge about risks posed by oil spills to important Beaufort Sea groups including marine mammals, marine birds and sea ducks, marine fish, fisheries, plankton and benthos. The presentation:

a. Summarized the absolute and relative toxicities of spilled untreated oil to different groups, as well as differences in spill vulnerability and recovery potential of different groups, based on research on past oil spills.

b. Emphasized that dispersants help to remove spilled oil from the sea surface in order to protect spill-vulnerable species like marine birds, some mammals and shorelines. It also emphasized that dispersant use does not remove the oil from the environment, but disperses it from the sea surface into the water column. In the water column it can dilute and biodegrade more quickly than if left on the surface. However it is critical to recognize that dispersion increases the potential exposure of in-water species to the spilled oil.

c. Explained toxicities of dispersants and chemically dispersed oil and contrasted these with risks from untreated oil.

In addition, the presentation emphasized that the risks posed by oil spills are temporary and localized. The impact of any given spill will vary with:

a. The sensitivity and vulnerability of local species; and

b. The location of the spill;

c. The size of the spill and persistence of the spilled oil.

In summary the presentation showed:

a. Species vary widely in their sensitivity (toxicity) and vulnerability to spilled oil;

b. Dispersants pose far less of a toxic risk to biota than the oil that they disperse; and

c. While dispersant use can cause temporary, localized elevated concentrations of oil in the water column, these concentrations decline quickly by dilution (especially when used offshore in deep water) and biodegradation.

The presentation described Net Environmental Benefit Analysis (NEBA). NEBA is a procedure used to aid decision-makers understanding, in quantitative terms, the potential environmental risks posed by the spill and the merits or consequences of using countermeasures like dispersants or in-situ burning. It is needed because while dispersants may reduce the potential risks from a spill to some environmental components, they may increase the risk to others. Hence decisions involve trading-off environmental gains versus environmental losses in order to understand whether dispersants offer **a net benefit or a net loss.** The process provides insight into:

a. The potential risks from spills to local environmental components;

b. The degree to which these might be mitigated by using spill countermeasures like dispersants; and

c. The level of risk to local environmental components that might result from the use of countermeasures, like dispersants or in-situ burning.

NEBAs are conducted on specific spill scenarios during planning. They involve:

a. Computing the fate, persistence and trajectory of the spilled oil for the untreated spill;

b. Identifying the valued environmental components (VECs) at risk from the spill;

c. Estimating the impact on each quantitatively using appropriate algorithms;

d. Repeating the process assuming that dispersants were used as a countermeasure; and

e. Comparing spill potential impacts of the untreated spill with the dispersed spill in order to understand whether dispersants clearly offer a net environmental benefit.

Discussions on this subject emphasized the importance of including Traditional Knowledge in any NEBAs employed in spill planning for the Beaufort Sea.

Dispersant Toxicology Research at BIO (Ken Lee, DFO)

Ken Lee provided an overview of recent studies on the toxicity of chemically dispersed oil to temperate zone fish species being conducted at the Bedford Institute of Oceanography. Lee studied sub-lethal effects caused by physically dispersed and chemically dispersed oil in Atlantic and Pacific herring embryos (Blue Sac Disease) and Atlantic cod juveniles (ethoxyresorufin-O-deethylase or EROD induction). The herring work showed that all 14-day exposures to dispersed and untreated oils caused effects at concentrations ranging from 0.5 to 10 ppm (TPH); oils tested were equally toxic and toxicity was associated with the concentration of aromatic hydrocarbons in the exposure suspensions. In the Atlantic cod study, Lee reported that a) exposure to chemically dispersed oil for 4 hours produced somewhat higher levels of EROD induction than exposure to physically dispersed oil; and b) EROD induction declined quickly after exposures ceased.

Ken Lee also made a very informative presentation on the “Dispersion of Oil Released from the Deepwater Horizon MC 252 Oil Spill following Subsea Injection of Dispersants” and the role of his DFO group.

Dispersant Toxicity and Oil Degradation Research (Jack Word, Newfields)

Jack Word presented results of recent research into the toxicity of chemically dispersed oil to Arctic species and the biodegradability of chemically dispersed oil in Arctic waters being conducted under a Joint Industry Program sponsored by a number of partners including:

Shell; ExxonMobil; Statoil; ConocoPhilips; and BP. The toxicity study determined that the toxicity of chemically dispersed TPAH oil to arctic copepods (0.31 to 1 ppm), cod (0.9 to 2.5 ppm) and sculpin larvae (0.3 to 0.9 ppm) was similar or less than sensitivities of temperate species. The work showed that:

a. Chemically dispersed oil was no more toxic on a per unit oil basis than physically dispersed oil; and
b. Corexit 9500 when used at recommended doses was not acutely toxic to the copepods.

The oil biodegradation studies were designed to determine whether naturally occurring microbes in arctic waters could degrade petroleum significantly and whether these rates changed when the oil was fresh or weathered or physically or chemically dispersed. Results showed that:

a. Indigenous microbes in arctic waters degrade petroleum hydrocarbons;
b. Biodegradation of chemically dispersed oil mineralized >60% of dispersed oil in 57 days in raw arctic water under arctic temperatures with indigenous microbes;
c. Non-chemically dispersed oil also mineralized but at lower totals ~26%;
d. Fresh oil PAH components underwent primary degradation with removal of ~60% of the starting concentration;
e. The presence of Corexit 9500 in oil does not inhibit microbial degradation in the arctic; and
f. Chemically dispersed fresh oil degrades more quickly and completely than weathered oil.

3.2.2 Dispersant Regulation in Canada and Elsewhere

This section summarized the role of government in spill planning and dispersant planning in Canada; considered the current status of dispersant planning; and summarized the extensive history of Canadian dispersant planning. The section also provided an overview of dispersant policies and practices in jurisdictions outside Canada.

Regulator's View on Coordinating Response Planning Participation: ISR Communities, Industry, and Government Agencies (John Korec, NEB)

This presentation described the process by which industry plans for exploratory drilling in the Beaufort Sea would be reviewed and the roles of key stakeholder groups in the process. It summarized the responsibilities and role of the National Energy Board in planning for offshore petroleum development and associated spills in the Beaufort Sea and initiatives undertaken to address this including the Spills Working Agreement and the Arctic Offshore Drilling Review. It described the process by which organizations will participate in reviewing plans for offshore oil exploration in the Beaufort Sea.

Oil Spill Dispersants - Evaluation and Scientific Support (Carl Brown, Environment Canada)

Carl Brown described the roles of Environment Canada and the Emergencies Science and Technology Section (ESTS) in spill response planning and dispersant use in Canada. ESTS provides scientific advice and operational support to the Environmental Emergencies Program and to the Regional Environmental Emergencies Team (REET) during oil spill incidents. He pointed out the need to evaluate the NEBA of all oil spill countermeasures, including mechanical recovery, in-situ burning, Spill Treating Agents (STAs) (including dispersants) and natural attenuation. He also pointed out the need for the evaluation of the physical and chemical properties of the crude oils involved as soon as possible to ensure this knowledge is available in a spill event. ESTS also conducts basic and applied research and tests new STAs for efficacy and effects. With respect to dispersants, the presentation described the existing decision framework for the use of spill treating agents on oil spills and addressed ESTS' role in the evaluation of those agents and providing input into the development of guidelines for the use of spill treating agents.

Overview of Dispersant Use Planning in Atlantic Canada (Roger Percy, Consultant)

Roger Percy provided an overview of the history of dispersant use planning in Atlantic Canada, a region that has been active in spill response planning in recent years. He provided a brief history of planning in the region and summarized spill cases where dispersant use had been requested. A list was presented of factors to consider for planning, including what impact existing Canadian federal legislation may have on dispersant planning (e.g., Fisheries Act, Canadian Environmental Protection act and Species At Risk Act). He concluded with his view of the next steps for dispersant use planning in Canada, including:

a. Resolving current regulatory impediments to the approval of dispersants [in Canada];
b. If dispersants are accepted as legitimate tools in the spill response toolbox, putting in place solid planning and streamlined mechanisms for decision-making;
c. Update dispersant use guidelines and ensure their applicability to the Arctic;
d. Determining the spill-related properties of potentially-spilled crude oils must be thoroughly documented;
e. Assess the effectiveness and impact of dispersant use in the 2010 Deepwater Horizon spill in the Gulf of Mexico and apply to planning in Canada; and

f. Broaden the discussion on dispersants and other countermeasures that currently focuses on offshore oil exploration/production in Canada to include the shipping industry and Canadian spill response organizations.

Dispersant Policies and Plans in Other Jurisdictions (Ken Trudel, SL Ross)

Dispersant policies and practices in a number of countries other than Canada were discussed. In short, many sets of policies, plans, guidelines and decision systems for dispersant use have been put in place around the world at the international, national and regional level. These offer a variety of regulatory models to choose from in developing policies and guidelines for Canada. The content of typical guidelines and decision-trees were discussed. Features of guidelines included: protocols for consulting with authorities; product restrictions; guidelines for operations; and the need to have monitoring capabilities in place. Features of decision-trees generally include:

a. Whether there is an urgent need to use dispersants to protect human health or the environment;
b. Whether dispersants might provide a clear net environmental benefit;
c. Whether the oil is dispersible;
d. Whether suitable dispersant product is available;
e. Whether suitable application equipment and trained personnel are available;
f. Whether the dispersant can be applied safely?

In short, there is plenty of experience in dispersant planning available, to serve as a model for planning in Canada.

Regulations Governing Dispersant Use on Spills from Oil Exploration and Production Installations in the North Sea (Ian Denness, CPC)

This presentation summarized regulations governing dispersant use for spills from exploration and production operations in waters of the United Kingdom and Norway in the North Sea. In the UK, approval for the use of dispersant in any emergency is granted by Marine Management Organization (MMO). Approval is based in part in the Operator’s Oil Pollution Emergency Plan (OPEP). The OPEP has been reviewed and approved by the Department of Energy and Climate Change (DECC) as a precondition for offshore operations. In an emergency, the spiller quickly gathers and assesses information needed to implement a suitable response strategy. Additional information is contained in the operator’s OPEP Justification Document OPEP Justification Document, including

a. A discussion on the acceptability of the chosen response strategies in the OPEP;
b. Details on chemical dispersant efficacy and testing;
c. Trajectory and fate and behaviour modelling based on worst case discharge scenario;
d. Information on environmental sensitivities; and
e. Provisions for drilling a relief well.

Government approves specific products for use in UK waters based on testing conducted in approved labs and based on standard test specifications and protocols governing efficacy and toxicity. Dispersants are pre-authorized for use in offshore waters, but for shallow waters (< 20 m or within 1 nautical mile of such depths) dispersant use is approved on case-by-case basis.

In Norway approval for dispersant use is granted by the Climate and Pollution Agency. In general, booms and skimmers have been considered the primary response technologies, but since the Macondo spill dispersant use has received much more attention. Operators have the option of including dispersants in their Operator's Oil Spill Response Plan. Once the plan is approved operators can use them in spill response. As in the UK, approval of specific dispersant products is granted by government based on tests of acute toxicity and effectiveness. In Norway as in many jurisdictions, dispersants may be used without a special permit if an unacceptable risk of danger to life and health arises in connection with oil pollution.

4 Tabletop Exercise

4.1 Introduction

The tabletop exercise is a teaching tool in which students consolidate information conveyed in lectures by using it to solve local spill planning problems. In the present case the exercise allowed participants to:

a. Apply information on dispersants to address decision-making problems for spills in the Beaufort Sea environment;

b. Explore details and refinements about dispersants not addressed in the classroom presentations; and

c. Identify dispersant use issues that might arise during actual spill response planning in the area.

Exercises involved deciding whether or not dispersants would actually reduce the overall impact of hypothetical spill scenarios in the Beaufort Sea by conducting a Net Environmental Benefit Analysis. Several spill scenarios (described below) were selected in consultation with the Steering Committee. Preparations were made for the participants to work through the steps in a NEBA analysis for a simplified scenario (a simple batch spill) and formulate a dispersant use/non-use decision. Participants were then given an analysis for one or two more complex continuous spill scenarios and discussed the dispersant decisions in the more complex scenario. Unfortunately time constraints allowed only the first simplified scenario to be considered, in part.

It is important to recognize that completing an actual NEBA for a single spill scenario is a complex and time process that involves compiling and integrating large amounts of information and completing many calculations and analytical steps. For that reason, completing a full NEBA was not possible in the length of time available in the workshop (one day). In some jurisdictions NEBA analyses in dispersant planning workshops can span many days. For that reason the NEBAs for the BREA Dispersant workshop scenarios were simplified for teaching purposes, using a) simplified spill scenarios; b) only a short list of Valued Ecosystem Components (VECs), and c) only involving the dispersant option. In addition, much of the analytical work was done in advance and was simply presented to the workshop participants for their consideration. For example, the first scenario involved a simple batch spill from a tanker rather than a more complex blowout scenario. Even though a tanker spill was unrealistic for the Beaufort, it has the clear advantage of being sufficiently simple to use as a teaching tool. The more realistic continuous spill from a surface blowout was also considered to illustrate the differences between the two types of spills.

For each spill scenario, the NEBA involves preparing estimates of impact for the spill if left untreated (baseline) and if treated with dispersants. The two cases are compared to identify:

a. The environmental impacts of the untreated spill itself;

b. The environmental gains and losses accruing from dispersant use; and

c. Whether or not dispersants clearly reduce the overall impact of the spill.

The process is as follows.

a. Estimate the impact of the Untreated Spill

   i. Compute the trajectory and fate of the untreated spill.

   ii. Compute the location and extent of the area contaminated with oil by the untreated spill using the fate, trajectory and persistence of the UNTREATED oil spill.

   iii. Identify and prioritize the VECs at risk from the untreated spill.

   - Identify the VECs at risk from the spill.
   - Simplify and reduce the list of species by selecting model species to represent the key oil sensitivity groups (e.g., polar bears represent hairy mammals, beluga whales for toothed whales, bowhead for baleen whales, common eiders for marine birds, polar cod for finfish, fishing area for the Tuktoyaktuk community, etc).
   - Develop meaningful definitions of target populations for each VEC based on management practices (e.g., sub-species, reproductively isolated populations)
   - Set the environmental protection priority for each VEC relative to others based on criteria relevant to the local population (cultural, subsistence, economic value, critical food web link, protected species, etc). Set priorities at High (H), Medium (M), and Low (L) (See Impact Table 1.1).
     - Assign a protection priority for each based on criteria meaningful to stakeholders

   iv. For each VEC, estimate of the proportion of the target populations impacted (killed) by the UNTREATED spill using existing information on distribution and concentrations of spilled oil, oil toxicity, resource vulnerability (proportion of the population likely to be in the area of the Beaufort exposed to high levels of oiling).

   v. List species and impacts in an Impact Table (See Impact Table 1.1 below).

b. Estimate the impact of the Chemically Dispersed Spill.

   i. Compute the location and extent of the area contaminated by the chemically dispersed spill and the areas where oil concentrations exceed toxic levels using the fate, behaviour and trajectory of the DISPERSED oil spill (computed in advance).

   ii. Identify and prioritize the VECs at risk from the dispersed spill.

   - Identify the VECs at risk from the spill.
   - Simplify and reduce the list of species by selecting model species to represent the key oil sensitivity groups (e.g., polar bears represent hairy mammals, beluga whales for toothed whales, bowhead for baleen whales, common eiders for marine birds, polar cod for finfish, fishing area for the Tuktoyaktuk community, etc).
   - Develop technically meaningful definitions of target populations for each VEC based on current resource management practices (e.g., subspecies, reproductively isolated populations);
   - Set the environmental protection priority for each VEC relative to others based on criteria relevant to the local population (cultural, subsistence, economic value,

iii. For each VEC, estimate of the proportion of the target populations impacted (killed) by the dispersed spill using existing information on oil distribution and concentrations, oil toxicity, VEC spill vulnerability data (proportion of the population likely to be in the area of the Beaufort exposed to high levels of oiling).

iv. Add the VEC and impact data to the Impact Table (See Impact Table 1.1 below).

c. Decide Whether Dispersants Reduce the Overall Impact of the Spill and Why

i. Based on the summarized information in the Impact Table identify:

- The greatest potential impacts of the untreated spill;
- The degree to which these are mitigated by dispersant use;
- The most important impacts of the dispersant use; and
- Form an opinion as to whether the environmental benefits from using dispersants exceed the environmental losses.

ii. Document this.

The spills considered are these.

Spill Types	Oils	Spill Conditions
Tanker spill	Alaska North Slope crude oil	Batch spills 30,000 cu.m (=188,700 barrels) of crude oil.
Above-sea blow-out	Alaska North Slope crude oil	50,000 BOPD (8000 cu.m.) x 20 days for a total of 1,000,000 barrels (160,000 cu m.) of crude oil.
Sub-sea blow-out	Alaska North Slope crude oil	50,000 BOPD (8000 cu.m.) x 20 days for a total of 1,000,000 barrels (160,000 cu m.) of crude oil.

4.2 Scenario #1 - Batch Spill From a Tanker

4.2.1 Spill Conditions

Spill and Environmental Conditions (Open water condition only)	
Spill Location	71° 24’ N, 132° 00’ W. on the 500 m isobath
Spill Condition	Spill Type: Tanker spill Oil Type: Alaska North Slope crude oil Spill conditions: Batch spills 30,000 cu.m (=188,700 barrels) of crude oil.
Wind	Wind speeds and directions are based on conditions Aug-Sept. 1998. During that time winds were variable, with a prevailing tendency from the E or SE at 18 km/hr
Currents	Wind driven and very low.
Air Temp	5° C
Sea Temp	5° C

4.2.2 Oil Fate, Behaviour and Movement

Untreated Spill Case

The fate and behaviour of the untreated spill are summarized in Figure 1. In short, the spilled oil persists for many days, so that oil moves considerable distances from the spill site. In this hypothetical scenario the winds have it moving WNW under influence of westward currents and

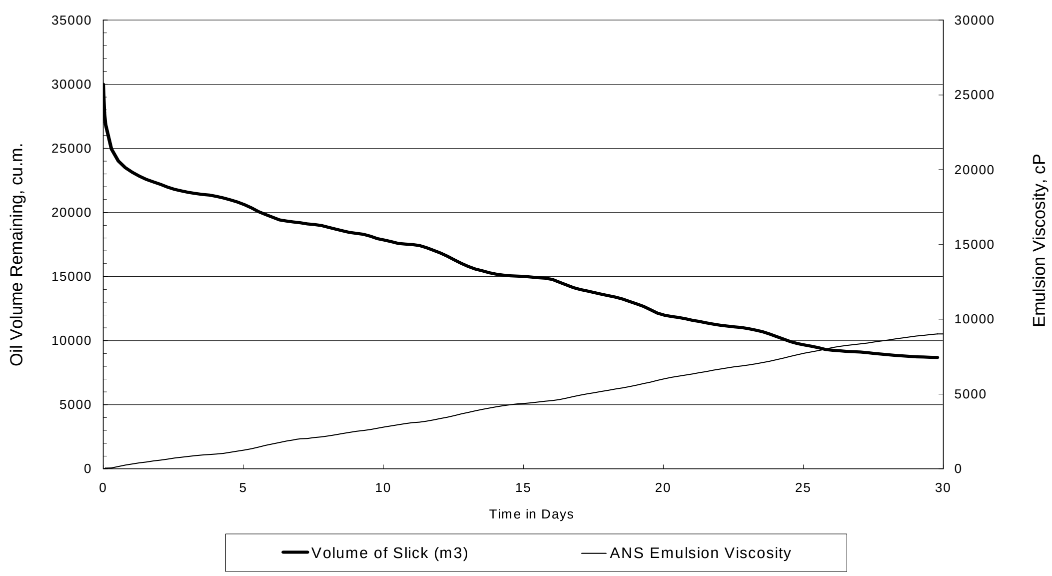


Figure 1: Oil fate and dispersant response parameters: 30,000 m^3 tanker spill of crude oil

winds, encountering the area of 1/10 to 3/10 ice coverage after 8-10 days, at which time from 15,000 to 20,000 cu. m. of spilled oil persists. Some oil strands on the ice edge; no oil reaches the shoreline; and no oil persists to reach U.S. waters. The oil weathers and emulsifies slowly. It reaches a viscosity of less than 5000 cP by the time it strands on the ice edge and remains dispersible until that time.

Dispersed Oil Case

The dispersed oil scenario assumes that all of the oil spilled is dispersed (worst case from a toxicity point of view). It is assumed that oil is restricted to the upper 10 m of the water column and no degradation takes place (worst case). Oil concentrations in the cloud of dispersed oil ("cloud") are elevated initially and decline with time through dilution only. Concentrations fall to less than 20 ppm (reasonable threshold for impact on in-water species) within 10 days at which time the "cloud" is 100 km from the spill site. At that point the "area of effect" of the dispersed oil is approximately 122 km^2, or 0.02% of the area of the Beaufort Sea. Since the Beaufort Sea population of polar cod is assumed to be distributed evenly throughout the Beaufort Sea, the worst-case level of impact on that population is 0.02%. (These dimensions are smaller when the "areas-of-effect" are calculated based on smaller clouds of dispersed oil generated by individual sorties of C-130 aircraft, but cumulative "areas-of-impact" may be similar.)

4.2.3 Spill Impact and Net Environmental Benefit Analysis

Predicted impacts are summarized in Table 2 below.

Table 2: Impact Summary - 30,000 m^3 Batch Spill ANS at 500 m Isobath – September					
Species	**Population/Stock**	**Relative[a] Importance (H, M, L)**	**Impact Untreated Spill**	**Impact Chemically Dispersed Spill**	**Explanation**
King Eider	Western arctic breeding ppn	H,H,H	50%	10	Area-of-effect large, numbers present high
Northern Phalarope[a]	Western arctic breeding ppn	L,L,L	<.1%	<.1%	Area-of-effect large, but numbers present small
Polar Bear	Southern Beaufort Sea Stock	H,H,H	8%	0	Mortality
Ringed Seal	Alaska	M,H,H	> 1%	0	Mortality?, sublethal effects
Beluga	Chuckchi-Beaufort	H,H,H	40%	0	Insensitive to oil
Bowhead Whale	Chuckchi-Beaufort	M,H,M	2%	0?	Sensitivity to dispersed oil ??
Arctic Char	MacKenzie R. Stock (e.g.)	L,L,H	0	0	Oil does not reach shore
Polar Cod (Arctic Cod)	Beaufort Sea ppn	M,H,H	0%	.3%	0.3% of the target population lies within the “area-of-effect” or toxic footprint
Plankton	Beaufort Sea ppn	L,H,H	0%	.1%	0.3% of the target population lies within the “area-of-effect” or toxic footprint
Tuktoyaktuk Community Nearshore Marine Fishery	Area of Tuktoyaktuk nearshore fishery in marine waters	L,M,H	0%	0	Oil does not reach shore
Ice Edge	N/A	H,H,H	1000 m^3 oil / km ice	0	Initial contamination will be 20,000 m^3 on 20 km of ice-edge all of which will require cleaning.
Trans-boundary Transport	N/A	NA	0	0	No oil reaches US Border

a. Now called Red-necked Phalarope.

b. Set priorities at High (H), Medium (M), Low (L) (See Section 4.1 above). Priorities were established by three mixed groups. Values reported by all three have been reported.

4.3 Scenarios #2 and #3 – Above-sea (#2) and Sub-sea (#3) Blowout Spills

4.3.1 Spill Conditions

Spill and Environmental Conditions (Open water conditions only)	
Spill Location	71° 24' N, 132° 00' W. on the 500 m isobath
Spill Condition #2	Spill Type: Above-sea blowout Oil Type: Alaska North Slope crude oil Spill conditions: 50,000 BOPD (8000 cu.m.) x 20 days for a total of 1,000,000 barrels (160,000 cu m.) of crude oil.
Spill Condition #3	Spill Type: Above- blowout Oil Type: Alaska North Slope crude oil Spill conditions: 50,000 BOPD (8000 cu.m.) x 20 days for a total of 1,000,000 barrels (160,000 cu m.) of crude oil.
Wind	Wind speeds and directions are based on conditions Aug-Sept. 1998. During that time winds were variable, with a prevailing tendency from the E or SE at 18 km/hr
Currents	Wind driven and very low.
Air Temp	5° C
Sea Temp	5° C

4.3.2 Oil Fate, Behaviour and Movement

Untreated Spill Case

The fate and behaviour of the untreated blowout spill are summarized in Figure 2. The model simulates the fate of continuous spills by dividing them up into small spillets, in this case spillets of 35 m^3 of oil were used, corresponding to 6 minutes of discharge. In this simulation, spillets of ANS dissipate within 6 to 15 days (average 9 days) depending on the prevailing wind speeds on the day of discharge and thereafter. For the example spillet shown in Figure 2.1, approximately 23 cu.m. persists after 4 days, 14 cu.m. after 8 days and oil dissipates completely after 12 days. Approximately 30% of the oil discharged from this spill oils the edge of the ice pack for a distance of approximately 180 km extending from the NW to the E of the spill site; no oil reaches the shoreline; and no oil persists to reach U.S. waters.

For the subsea blowout (not shown), the model estimated that the droplets of discharged oil surfaced over a large area forming a very thin slick dissipating within hours. Based on experience in the Macondo spill, some of this oil might be expected to concentrate into stringers of emulsion in convergence zones and windrows, however existing models cannot predict this.

4.3.3 Dispersed Oil Case

The dispersed oil scenario assumes that the freshly discharged oil would be dispersed effectively near the spill site using continuous spraying sorties from large, fixed wing aircraft. This would produce relatively small clouds of dispersed oil that would dissipate more quickly than in the batch spill case. However, because of the large volume of oil discharged (5 times as much oil), the area of impact of the dispersed spill (and hence the amount of impact) would be approximately 5 times as large as the batch spill case.

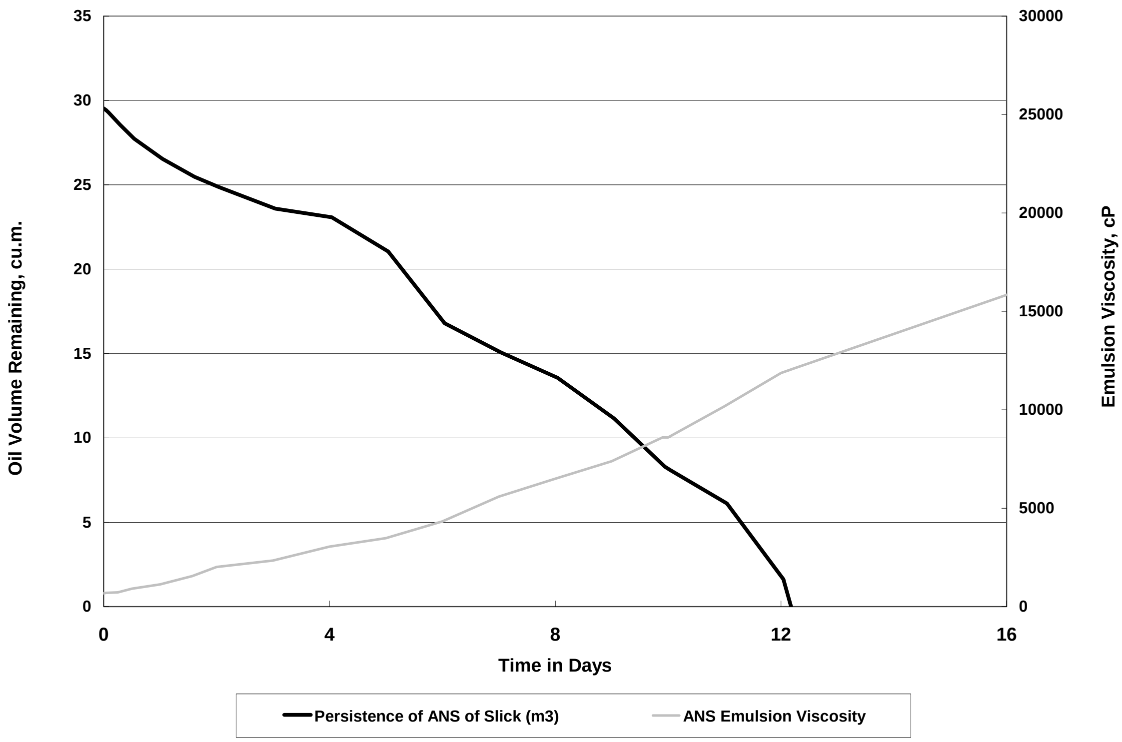


Figure 2: Oil fate and dispersant response parameters - 8,000 m^3/day, 20-day blowout

4.3.4 Spill Impact and Net Environmental Benefit Analysis

Not completed due to time constraints.

5 Views on the Way Forward

Each of the stakeholder groups attending, namely the Inuvialuit, government and the petroleum industry were asked to describe their vision of the way forward to planning for dispersant usage in the Beaufort Sea. These edited statements of vision are below.

5.1 Industry Comments in the Closing Panel Session (Ian Denness)

Firstly, the industry would like to show its appreciation for all the hard work done by the Workshop organizers in putting together this session in such a short time. We would also like to thank all of the participants for attending the workshop and especially the Inuvialuit for their interest in the topic and for asking many insightful questions. Finally, we thank the IGC for hosting the workshop.

Some general comments, before I come to what the industry would like to see as the next steps. We believe the workshop met its primary goal, which was to provide some initial information to our stakeholders and regulators on the topic of dispersant use. This however, is just the first step in an ongoing dialogue. We've heard some concerns expressed at the workshop and therefore need to continue to work with the Inuvialuit to resolve them.

We heard comments about the lack of oil spill response infrastructure and training capability. Once an Operator decides to make an application for a drilling or development permit, they will ensure that the necessary plans, procedures and infrastructure will be established in order to make all regulatory requirements, as well as any conditions that may be attached to their Authorization approval.

It is also worth reiterating that Operators will always continue to put, as a primary focus, the prevention of any major incident, such as a blowout. There is no way that a responsible Operator would ever consider that by using dispersants, for example, in an oil spill, they could reduce the amount of preventative measures needed to put in place for their operation.

From the information provided, we can see that the decision on whether to use dispersants, in the event of a major spill would not be a knee jerk reaction. The decision relies on a series of well defined steps e.g. dispersants are subjected to both effectiveness and toxicity tests, before they are approved by Environment Canada. We can also state that dispersants are just one of the tools in the countermeasures toolbox to be used when and as appropriate.

In terms of next steps,

a. The industry in its spirit of continuing collaboration with the Inuvialuit would like to pursue the opportunity of seeing whether the IGC could participate in some way in the Joint Industry Project (JIP) currently under way in Barrow, Alaska, which is looking at the toxicity of dispersants and dispersed oil on Arctic specific species.

b. We also see an opportunity to work with the Inuvialuit on helping them and the regulators understand the need for field trials to demonstrate the effective use of different countermeasures under realistic spill conditions. This would involve the controlled release of a known quantity of oil into the Beaufort Sea.

c. We will explore with CAPP to see if there is any way we can assist Environment Canada (EC) in their examination of the regulatory approval process on the potential use of dispersants. As it stands now, I don't think anyone is happy over the lack of clarity over the legal status on the use of dispersants.

d. EC stated that there is a need to update their guide on the use of dispersants, industry would also like to offer it's assistance in this project, especially in the area of dispersant usage in the Arctic.

5.2 Government Comments in the Closing Panel Session (John Korec)

Input from Government and Regulators Caucus discussions were combined into three themes, as follows.

a. First, government representatives felt that they had tried to provide a specific, single topic workshop, just on dispersant use, without establishing the 'big picture context', such as the regional development, climate change impacts, and so on[1].

b. Second, they believe that they must listen to the Inuvialuit and include the Inuvialuit in planning what, how and the kind of information to be provided. We can learn from traditional knowledge.

c. Finally, we need Industry to help deliver the information and we need to hold community tours on dispersants.

Government was pleased to hear what Lawrence Amos and the Inuvialuit Caucus have discussed and presented. Government representatives had had similar thoughts when preparing for the presentation. Government believes that the current dispersant use 'approvals process' is understood by the regulators and somewhat by Industry. Second, the communities are interested in knowing when they will have an opportunity to be a part of the decision process. And finally, government must create a roadmap of the current process, possibly a decision tree, and get the stakeholders' input on how it can strengthen and improve the decision process for all in order to provide certainty for all parties.

5.3 Inuvialuit Community Comments (Lawrence Amos)

General Comments

- Some parts of the workshop were too technical and some presentations too long – the information should have been simplified to explain in laymen's terms for community people
  - How do we (the Inuvialuit participants) explain the technical information back to the communities?
  - Inuvialuit participants felt it was difficult to formulate appropriate questions sometimes
- Workshop too short; not enough time to digest information; Timelines need to be lengthened for workshop

[1] Oil spill dispersants is a large and complex subject and as such requires a single-topic workshop as was presented here. However, future discussions of dispersants would benefit from more information on other countermeasures in the spill response "toolbox" and the pros and cons of each.

- NOTE: it was acknowledged that due to weather delays the workshop had to be compressed

- It is not clear how harvesters would be compensated in a timely manner in the case of an oil spill
  - Due to the potential scale of impact it was not well understood how a straightforward compensation system might be set up to ensure compensation claims could be dealt with to compensate harvesters quickly (e.g. within the same season where loss has occurred)
- During NEBA exercise got confused by group valuations vs. facilitator's assessment table – the NEBA exercise needed more background explanation (e.g. in the context of environmental trade-offs)
  - This exercise was not sufficiently understood
  - Not clear how the calculations were done for the facilitator's assessment table
- An oil spill would have a chain-effect impact on the ecosystem – it would be a "shock to the system"
- Not much is known about wildlife resources/ecosystems present in the deep offshore Beaufort Sea
- Need assurances that appropriate research will continue to ensure potential impacts from a spill are understood as much as possible
- Need assurances from Industry that they will have properly trained personnel dealing with any spill that might occur
- NEBA process is difficult for indigenous populations because it is difficult to put a value on parts of the culture
  - Inuvialuit view the environmental holistically
  - Environmental health is closely associated with well-being of Inuvialuit
- Community consultation doesn't equal consent for what is proposed
- **<u>The whole of the Beaufort Sea is important to the Inuvialuit</u>**

<u>Next Steps</u>

- Could be beneficial to present TK information for industry and government
  - BREA Project (Trudel): VEC workshop could provide opportunity for this kind of information to be communicated
- A Community Tour should be arranged to explain all the oil spill countermeasures that could be employed in the case of a spill
  - Communities need to better understand all the options and the pros and cons of each
  - Need to get information to a broader audience to foster more understanding in the Inuvialuit Settlement Region (ISR)
- Industry and Government should ensure that countermeasures equipment and supplies are available in the region prior to any drilling occurring

- Adequate training for Inuvialuit needs to be provided on different countermeasures options

  – Inuvialuit are considered part of "first responders" by Canada, but very little training has taken place in recent years

- Responsible Authority's need to do appropriate toxicity testing on dispersants (for both acute and chronic impacts)
- Understanding needs to be gained about Inuvialuit understanding of "significant"

  – They way Inuvialuit understand a "significant" or "not significant" determination of impacts may be different than what the regulators or the proponents understanding of "significant" is

- Results of studies of impact in Gulf of Mexico should be provided (e.g., impacts and recovery of shrimp industry)

  – Inuvialuit communities want information on what the impacts have been (and continue to be) on the ecosystem and people in the region from the Macondo oil spill

- Clarification on who makes final decision on the use of dispersants – step-by-step process (decision-tree) on how decision would be made

  – Understanding is needed about the process that would be followed to come to a decision on whether dispersants are utilized or not, and who has the ultimate authority in the end to approve their use in the case of responding to a spill

- Modern guidelines need to be established for the use of dispersants (specific to ISR?)

  – Current guidelines are dated and need to be modernized

  – If this cannot be done for Canada in a timely manner, it should at least be done for the Beaufort Sea in the interim

- Written overview of industry standards for all oil spill countermeasures should be provided to Inuvialuit (communities)
- Inuvialuit are interested in knowing what standards Industry has in place for the expected performance and use of dispersants (as well as other countermeasures)

Closing Comments

- Development will always have some level of impact on the environment.
- Regulators have to update regulations and ensure that developers are adhering to these regulations
- Proponents will have to do development in a sustainable way so as to not effect the ecosystem, which the Inuvialuit rely on
- I believe this dispersant workshop should not be the deciding factor to drill in the Beaufort Sea. This is an information workshop to make Inuvialuit understand what regulators and developers know about dispersant use and the effects of this deleterious substance
- Developers, regulators and science (researchers) will have to work together on safe drilling [to ensure the integrity of the Beaufort Sea ecosystem is maintained] as the Inuvialuit had done in our culture before southerners disrupted our lives.

- Guidelines will have to be developed before any drilling occurs in the Beaufort Sea

Developers, regulators and science (researchers) will have to consider Inuvialuit culture when making decisions on the use of dispersants in the Beaufort Sea

One of the goals of the Inuvialuit Final Agreement states that the Inuvialuit and Government of Canada must work to preserve and protect the arctic wildlife, environment and biological productivity in the ISR.

Appendix 1 – Participants

Workshop Participants (Based on sign-in sheets, in alphabetical order)					
#	Organization	Person	#	Organization	Person
1	Aklavik	Joe Arey	33	AANDC BREA	Ruth McKechnie
2	Sachs Harbour	Lawrence Amos	34	Aklavik	Wilson Malegana
3	Parks Canada, Inuvik	Matthew Armstrong	35	ConocoPhillips	Karen Muggeridge
4	IGC/JS	Steve Baryluk	36	ExxonMobil	Heide Mairs
5	Environment Canada	Carl Brown	37	CCG – Environ. Resp.	Joanne Munroe
6	Imperial Oil	Evan Birchard	38	Tuktoyaktuk	John Noksana Jr.
7	Wildlife Management Advisory Council (NWT)	Larry Carpenter	39	JS/Environmental Impact Review Board	Eli Nasogaluak
8	ExxonMobil	Tom Coolbaugh	40	Tuktoyaktuk	Darrel Nasogaluak
9	ConocoPhillips	Chantale Campbell	42	Ulukhaktok	Joshua Oliktoak
10	Chevron Canada	David Dickens	43	SL Ross	Steven Potter
11	ConocoPhillips	Ian Denness	44	Parks Canada, Inuvik	Nelson Perry
12	AANDC, Inuvik	Jan Davies	45	GNWT – ENR	Todd Paget
13	CCG ER	Robert Estensen	46	Aklavik	Charles Pokiak
14	OGR YTG Whitehorse YT	James Ewert	47	Consultant	Roger Percy
15	CCG – Environ. Resp.	Scott Gray	48	Environnmental Impact Screening Committee	Albert Ruben
16	Wildlife Management Advisory Council (NWT)	Bruce Hanbidge	49	Paulatuk	Nelson Ruben
17	CWS- Canadian Wildlife	James Hodson	50	Paulatuk	Lawrence Ruben
18	Imperial Oil	James Hall	51	DFO Habitat	Jim Reist
19	Ulukhaktok	Joseph Haluksit	52	IGC/JS	Norm Snow
20	Sachs Harbour	Charlton Haogak	53	Inuvialuit Regional Corporation	Duane Smith
21	JS/Fisheries Joint Management Committee	Kayla Hansen-Craik	54	Aklavik	Billy Storr
22	Inuvik	Christine Inglangasuk	55	SL Ross	Ken Trudel
23	AANDC-Water Resources	David Jessiman	56	Chevron Canada	Jennifer Wyatt
24	DFO – Habitat	Amanda Joynt	57	Newfields, NW	Jack Word
25	Imperial Oil	Al Kennedy			
26	NEB Calgary	John Korec			
27	IHTC	Jimmy Kalinek			
28	Ulukhaktok	Margaret Kanayok			
29	Paulatuk	John M. Kudlak			
30	NEB Calgary	Robert LeMay			
31	DFO – COOGER	Dr. Ken Lee			
32	DFO, Winnipeg	Lisa Loseto			

Appendix 2 – Questions

The following questions and comments were raised during the presentations section of the workshop. Answers to these questions were found in workshop presentations and will be included in the final report.

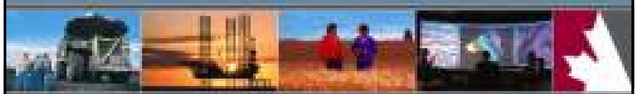
1. Dispersants are low risk on people and animals. Are there studies that show this?
2. Are there incidents in winter spills where dispersant used?
3. Do you have to apply dispersants and does it work in all oil types (Beaufort Sea oils?)
4. Is the Alaskan North Slope oil similar to the Beaufort Sea oil?
5. Is the viscosity of North Slope crude oil 12 cP?
6. Weathering - Once oil evaporates, viscosity increases – can you disperse it? Time window – key component?
7. Concern of oil properties; are properties similar to those of Alaska North Slope crude oil?
8. Is salinity of waters in the Gulf of Mexico similar to that in the Beaufort Sea? A. Yes, ≈ 32-35 ppt in the GOM and 28-30 ppt in the Beaufort Sea offshore.
9. Concerns re weather. Would foggy conditions in July impair ability to use dispersants?
10. In 1990's CWS changed policy on cleanup and capture of migratory birds. Do they no longer support cleaning of oil birds unless "species at risk".
11. What is success of cleaning birds? Answer - Results are preliminary. Success rate species specific.
12. Is there information on species sensitivity [to dispersants and dispersed oil] in deeper water offshore?
13. What can be done to minimize risk to birds?
14. Regarding the goo (soft-bodied zooplankton), do they have this in Gulf of Mexico? Answer - Organisms are components to all ecosystems. Need to know their importance.
15. What is the timeline for deep-water research? (2011-2015)
16. What is NEB's position re incorporating advice of other agencies?
17. What is the Canadian Wildlife Service role in spill response plan?
18. In a spill situation, if there were 10 contaminated birds that are Species at Risk (SAR) and 1000 contaminated birds that are not SAR, would CWS still focus only on rescuing SAR species?
19. Why is it important to break oil down into small drops?
20. Is the Alaskan North Slope oil similar to the Beaufort Sea oil and are the impacts different?
21. Information - Just prior to freeze up there may be little wave action. What is the possibility of dispersion effectiveness under these conditions?

22. What is viscosity of oils produced in the Beaufort? Answer – The Environment Canada Oil Properties Database contains considerable information. It can be accessed at http://www.etc-cte.ec.gc.ca/databases/OilProperties/oil_prop_e.html
23. It took many tens of boats and manpower to clean up Gulf of Mexico spill – concern that there is a need in the Beaufort to have this same ability to clean up.
24. How much time was lost in Gulf re dispersants that impacted their effectiveness?
25. What is shelf life of dispersant? (Storage is key)
26. What was the effectiveness of injection of dispersants subsea?
27. Know your oils
28. Need to understand acute versus chronic effects of dispersed oil.
29. Is adherence and toxicity of the oil/dispersant dependent on life stage of organisms?
30. Beluga eat krill whales are filter feeders- if they filter out dispersed oil with the krill how does this affect the whale (this actually covered below)?
31. How long were the fisheries closures? (in the Macondo spill). Concerns re Inuvialuit fishing along coastal areas. Concern that there will be compensation.
32. Comment: American Chemical Society report showed that measurement of hydrocarbons in samples of fish taken during the Macondo spill. Most samples were low (1860 fish samples) from Gulf spill most were not measurable; those measurable were below closure requirements.
33. When oil comes out from well it is sticky hard to get rid of. Dispersants in oil how long is this continue to be sticky?
34. Need to know the impacts [characteristics?] of Beaufort Sea oil versus Alaskan North Slope oil.
35. Finfish have gills and filter water – how can you say the dispersed oil will not affect them?
36. Bowheads filter water for food. How will the dispersed oil affect them if a bowhead goes to the surface, takes in a mouthful of krill and dispersant? What will be the impact? Similar to above point.
37. Need to know where the bowhead feeds, how it filters and what is the state of the dispersed oil.
38. Three (3) key points the communities still things to consider include: toxicology, exposure, and biodegradation (of dispersed oil).
39. Are there microbes (organisms?) degrading petroleum (in the Beaufort Sea?)
40. Community request to follow-up with BP on results of the water samples taken when dispersants used – toxicity reports. (Results of toxicity tests on water samples taken under oil slicks and areas sprayed?)
41. Comment that it is important to remember that it is the communities that will be most affected by an oil spill. They eat the fish and are at the top of the food chain. Therefore need to understand to what degree spills and dispersant use will affect the Inuvialuit.

42. Need to consider Traditional knowledge (TK) when making the decision on whether to use dispersants. When considering mitigative measure consider TK.
43. When Devon drilled Paktoa in winter 2005 – 2006 there was no same season relief well capability.
44. How are valued ecosystem components identified?
45. By using dispersants are you not simply moving the problem elsewhere?
46. How toxic is dispersed oil versus the untreated oil?
47. How far do dispersants bring the oil down into the water?
48. Who will have the final decision on the use of dispersants to respond to a spill?
49. Would there be enough dispersants available in the event of a spill?
50. How does industry get approval to use dispersants?
51. Who is the incident commander?
52. Are the communities going to be involved in the decisions for dispersants?
53. A comment was made that steps should be taken now to change the legislation to allow dispersants to be used legally.
54. The guidelines should be revised now, so that they are ready before drilling starts.
55. Is subsea injection possible during freeze up?
56. Would dispersants be effective on oil under ice?
57. Is the size of the spill important to the use of dispersants?
58. A comment was made that the sub-lethal effects and uptake considerations should be included in the spill scenario along with biodegradation.
59. More information is needed to understand how hydrocarbons are taken up in organisms.
60. From the communities perspective the Beaufort Sea is the source of their food as well as their livelihood.
61. Communities would appreciate more information on toxicity and the effects of oil and dispersants on species and their life stages. Communities would like to have more information on dispersants communicated in their communities.
62. How much do we know about the interactions of oil spills and dispersants with other stressors such as climate change?
63. Dispersants are one tool in the tool box of spill response countermeasures. There are many factors that need to be taken into account before the decision to use dispersants would be made.

Appendix 3 - Acronyms

Acronyms	**Definition**
AANDC	Aboriginal Affairs and Northern Development
BIO	Bedford Institute of Oceanography
BIOS	Baffin Island Oil Spill Project
BOPD	Barrels of oil discharged per day
BREA	Beaufort Regional Environmental Assessment
CPC	ConocoPhilips
CWS	Canadian Wildlife Service
DFO	Department of Fisheries and Oceans
EROD	Ethoxyresorufin-O-deethylase
ESTS	Emergencies Science and Technology Section
IOL	Imperial Oil Limited
IGC	Inuvialuit Game Council
IRC	Inuvialuit Regional Corporation
NEB	National Energy Board
NEBA	Net Environmental Benefit Analysis
SLR	SL Ross Environmental Research
VEC	Valued Ecosystem Component



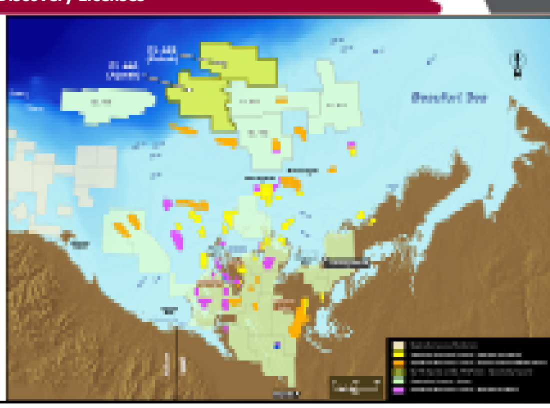
Perspectives on Dispersant Use in the Beaufort Sea

BREA Dispersant Workshop, July 25, 2011

Prevention of a spill is the Priority

- **The first priorities of the oil and gas industry are to operate safely and protect the environment within which we operate**
  - Prevention of a spill is the key focus to meet these priority
- **Eighty-nine offshore wells have been drilled in the Beaufort Sea over the past 40 years in a wide range of ice conditions**
  - Zero major oil spills associated with well control incidents in the history of Beaufort Sea exploration
- **Comprehensive and responsible planning for low probability events is critical**
- **All oil spill response options, including the use of dispersants need to be available to industry in the unlikely event of a spill**

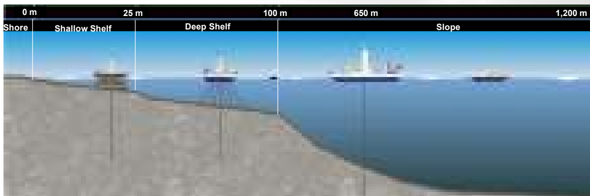
Beaufort Sea Exploration and Significant Discovery Licenses



Future Beaufort Sea Oil and Gas Industry Activity

- **Outlook for Production Drilling**
- **There are a number of existing SDLs in the Beaufort, some of which could be developed in the future**
- **The time horizon for offshore development drilling is expected to be 5 years or more from present**
- **Outlook for Exploration Drilling**
- **Pending the outcome of the Public Review of Arctic Safety and Environmental Drilling requirements, industry operations over the next ten years in the Beaufort are likely to be mainly exploration focused – seismic and possibly drilling**
- **Exploration drilling could include deeper water than in the 1970s and 1980s**
  - Deeper water exploration wells primarily conducted during open water and in light ice conditions during the summer and fall
- **Significant cost will limit the number of deepwater offshore wells drilled**
  - For example, if Imperial Oil and partners decide to move forward on EL 446 and/or EL 449, only one or two exploration wells would be drilled in the next ten years

Physical Environment of Deepwater Licenses



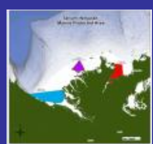
Factors	Shallow Shelf	Deep Shelf	Slope
Water Depth	▪ 0 m–25 m	▪ 25 m–100 m	▪ 100 m–1,200 m
Ice	▪ land-fast, first-year ice ▪ limited multi-year ice	▪ multi-year ice intrusions	▪ multi-year ice present
Type of Offshore Drilling Rig	▪ bottom-founded and moored drilling	▪ moored drilling	▪ dynamically positioned drilling
Open Water Season	▪ 85 days	▪ 70 days	▪ 50 days
Winter Season	▪ 120 days	▪ None	▪ none

*Source: Geologic Survey of Canada

Dispersant Use in the Beaufort Sea

- Dispersant application, and in situ burning, are key spill response options for offshore Beaufort Sea
  - **Dispersants help prevent oil slicks from stranding on shorelines and reduce potential exposure of birds and marine mammals that might encounter a persistent oil slick**
- The benefits of modern dispersants are widely recognized and have been documented in various studies over many years
  - **Dispersants have a low risk for both people and animals**
  - **Dispersants are a desirable spill response option in many Beaufort Sea scenarios particularly given the logistical challenges**

Fisheries and Oceans Canada Regulatory and Research Perspectives in the Beaufort Sea

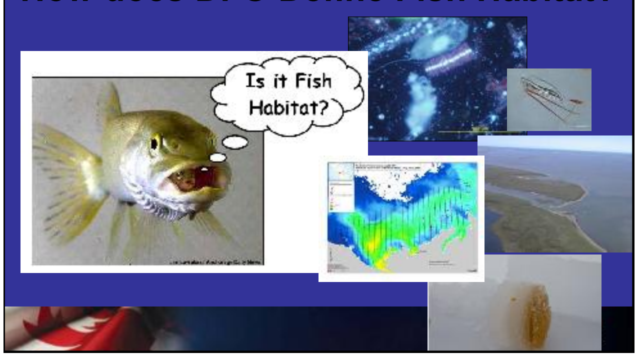


Amanda Joynt – Habitat Mgmt, Inuvik
Lisa Loseto – Science, Winnipeg
Jim Reist – Science, Winnipeg

Fish: How does DFO Define Fish?

Parts of fish, shellfish, crustaceans, marine animals, fish, eggs, juveniles, marine mammals

How does DFO Define Fish Habitat?



Fisheries Act

Section 35(1) HADD

Harmful
Alteration,
Disruption, or
Destruction
of fish habitat

Fisheries and Oceans Canada / Pêches et Océans Canada

Fisheries Act

Section 36 (3)

Deposit of deleterious substances — DFO

Sec 32. — EC

Fisheries and Oceans Canada / Pêches et Océans Canada

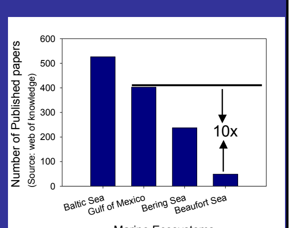
Environmental Impact Review

What are the valued ecosystem components?

Fisheries and Oceans Canada / Pêches et Océans Canada

Beaufort Sea DFO Research: Past and Present

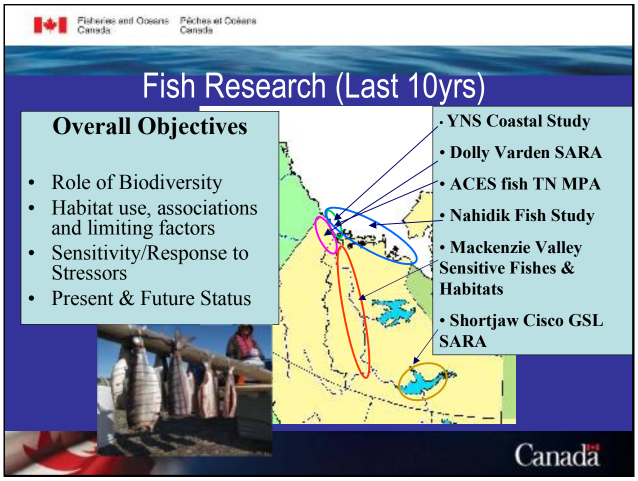
- Beaufort Environmental Monitoring Program (BEMP) 1987-1988
- Northern Oil and Gas Action Program (NOGAP), 1: 1984-1989, 2: 1990 1994.
- Other programs (CASES 2002 – 2004, ArcticNet 2004 – present, MGP 2004-2008, Nahidik 2003-2009, IPY 2007-2009)
- Research Relative to other Canadian Arctic Regions

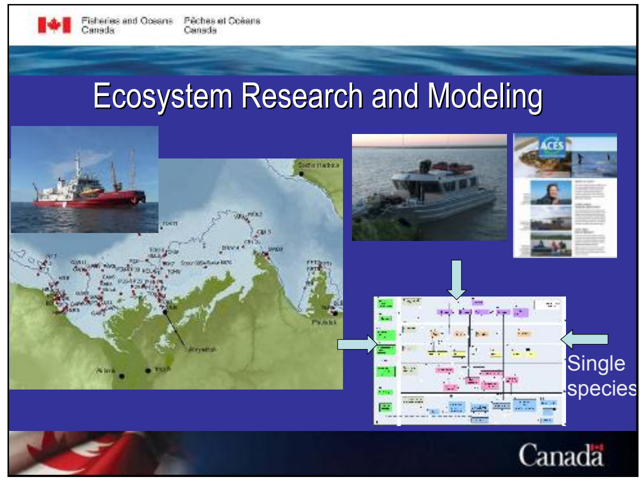


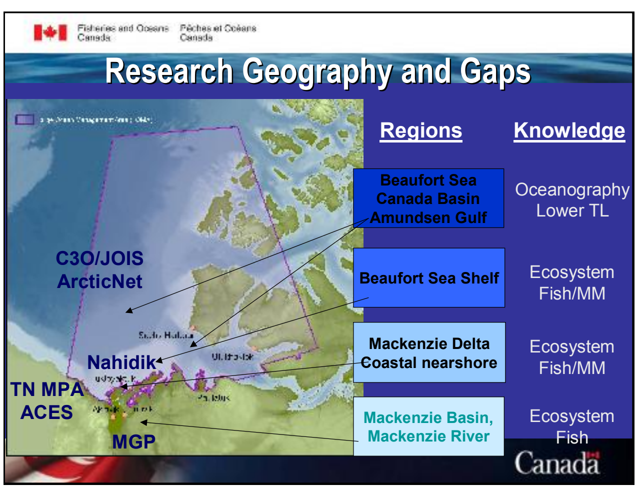
Fisheries and Oceans Canada / Pêches et Océans Canada

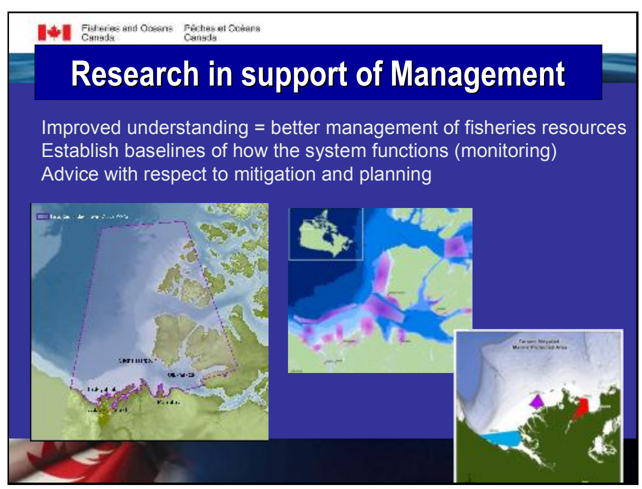
Marine Mammal Research (last 10 yrs)

- **Tracking/Surveys**
  - **Ringed Seals**
  - **Beluga**
  - **Bowheads**
- **Harvest and Health**
  - **Ringed Seals**
  - **Beluga**


Fisheries and Oceans Canada
Pêches et Océans Canada
Fish Research (Last 10yrs)
Overall Objectives
• Role of Biodiversity
• Habitat use, associations and limiting factors
• Sensitivity/Response to Stressors
• Present & Future Status
• YNS Coastal Study
• Dolly Varden SARA
• ACES fish TN MPA
• Nahidik Fish Study
• Mackenzie Valley Sensitive Fishes & Habitats
• Shortjaw Cisco GSL SARA
Canada


Fisheries and Oceans Canada
Pêches et Océans Canada
Ecosystem Research and Modeling
ACES
Single species
Canada

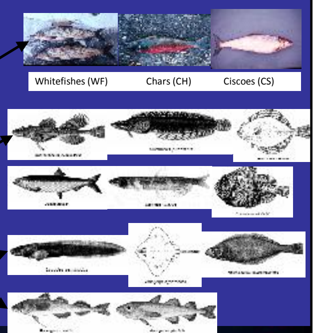

Fisheries and Oceans Canada
Pêches et Océans Canada
Research Geography and Gaps
Regions
Knowledge
Beaufort Sea
Canada Basin
Amundsen Gulf
Oceanography
Lower TL
Beaufort Sea Shelf
Ecosystem
Fish/MM
Mackenzie Delta
Coastal nearshore
Ecosystem
Fish/MM
Mackenzie Basin,
Mackenzie River
Ecosystem
Fish
C3O/JOIS
ArcticNet
Nahidik
TN MPA
ACES
MGP
Canada


Fisheries and Oceans Canada
Pêches et Océans Canada
Research in support of Management
Improved understanding = better management of fisheries resources
Establish baselines of how the system functions (monitoring)
Advice with respect to mitigation and planning

Fisheries and Oceans Canada | Pêches et Océans Canada

BREA – Fishes, Habitats and Oil & Gas Development in the Beaufort Sea

- Offshore fishes & their role in the ecosystems identified as gaps.
- ~ 70 fish species present in Canadian Beaufort Sea; 16-36 occur offshore (depth dependant) – 33 benthic + 3 pelagic.
- Benthic species affected by physical habitat changes.
- Pelagic species affected by noise, habitat (ice) changes & suspended materials.
- All affected by spills and dispersants.

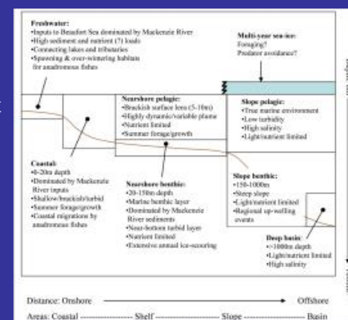


Canada

Fisheries and Oceans Canada | Pêches et Océans Canada

BREA Offshore Fishes Project

- Sub-ecosystems present in area.
- Semi-independent but connected.
- Fishes & habitats differ so different susceptibilities.

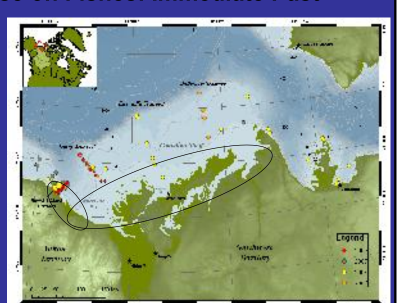


Canada

Fisheries and Oceans Canada | Pêches et Océans Canada

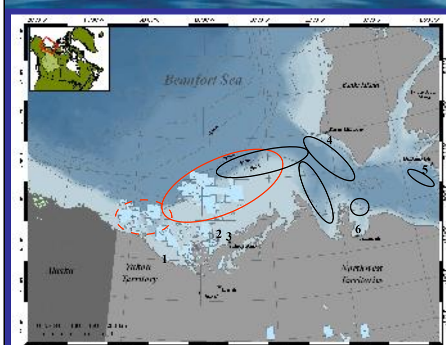
Knowledge Base on Fishes: Immediate Past

- Transects & feature-based trawling stations for marine fishes, Northern Coastal Marine Studies (2006 – 2009).
- Coastal work, nearshore marine & anadromous fishes (PERD, 2007-2011).
- Coastal & shelf work (1980's-1990's), NOGAP, PERD, ESRF, etc.



Canada

Fisheries and Oceans Canada | Pêches et Océans Canada



Legend

1-6: Coastal monitoring sites (CIMP) 2011-2013+ timing:
1) Shingle Point (Aklavik);
2) Hendrickson Island;
3) Tuktoyaktuk coast;
4) Sachs Harbour;
5) Ulukhaktok;
6) Darnley Bay (Paulatuk).

Lease Blocks Canada

Lease Blocks Alaska

2012 Focal area (50-1000m) (BREA+ESRF+PERD)

2012 Focal area (20-1000m) (IGS)

2013 Focal area (20-1000m) (BREA+ESRF+PERD)

Canada

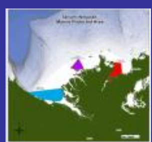
Fisheries and Oceans Canada Pêches et Océans Canada

DFO concerns with respect to spill and dispersant impacts

- Knowledge gaps on the diversity of species in the offshore: species/life history/habitat/***relevance
- Direct toxicological impacts of Oil and Dispersants (lethal, sub lethal) on various species and their life stages that will vary in sensitivities
- Indirect impacts of changing ecosystem structure and function (i.e. a species at the bottom of the food web removed will impact the transfer of energy to top predators)
- Loss of Habitat/Avoidance of critical habitat
- Interactions of the spill/dispersant with other stressors, specifically climate change – Cumulative Impacts on the ecosystem that may impede the ability to recover
- Collection of the appropriate data to support advice to regulators

Canada

Fisheries and Oceans Canada Regulatory and Research Perspectives in the Beaufort Sea

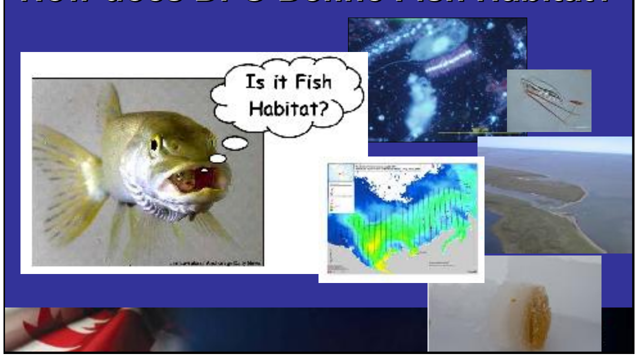


Amanda Joynt – Habitat Mgmt, Inuvik
Lisa Loseto – Science, Winnipeg
Jim Reist – Science, Winnipeg

Fish: How does DFO Define Fish?

Parts of fish, shellfish, crustaceans, marine animals, fish, eggs, juveniles, marine mammals

How does DFO Define Fish Habitat?



Fisheries Act

Section 35(1) HADD

Harmful
Alteration,
Disruption, or
Destruction
of fish habitat

Fisheries and Oceans Canada | Pêches et Océans Canada

Fisheries Act

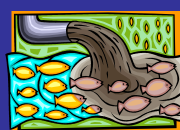
Section 36 (3)

Deposit of deleterious substances

DFO

Sec 32.

EC



Canada

Fisheries and Oceans Canada | Pêches et Océans Canada

Environmental Impact Review

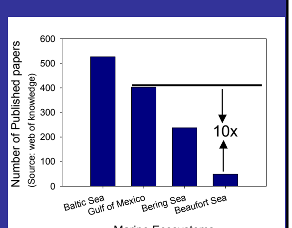
What are the valued ecosystem components?

Canada

Fisheries and Oceans Canada | Pêches et Océans Canada

Beaufort Sea DFO Research: Past and Present

- Beaufort Environmental Monitoring Program (BEMP) 1987-1988
- Northern Oil and Gas Action Program (NOGAP), 1: 1984-1989, 2: 1990 1994.
- Other programs (CASES 2002 – 2004, ArcticNet 2004 – present, MGP 2004-2008, Nahidik 2003-2009, IPY 2007-2009)
- Research Relative to other Canadian Arctic Regions



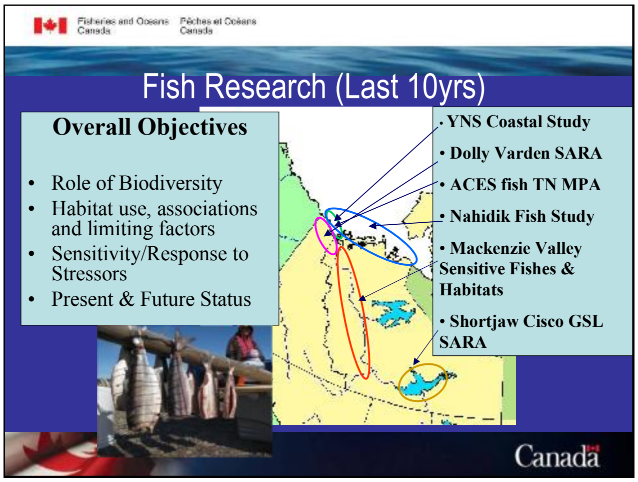
Canada

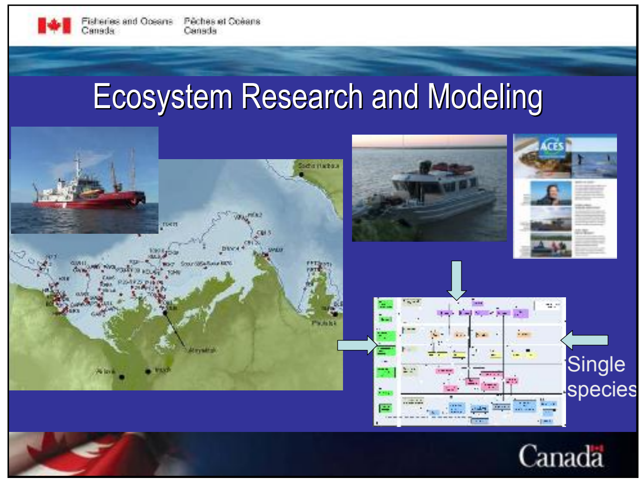
Fisheries and Oceans Canada | Pêches et Océans Canada

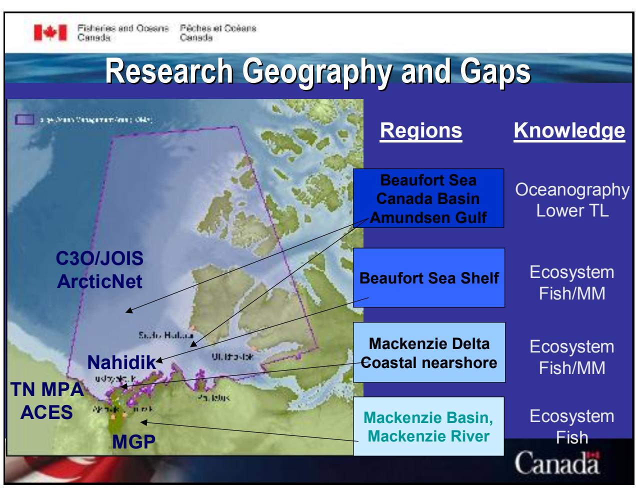
Marine Mammal Research (last 10 yrs)

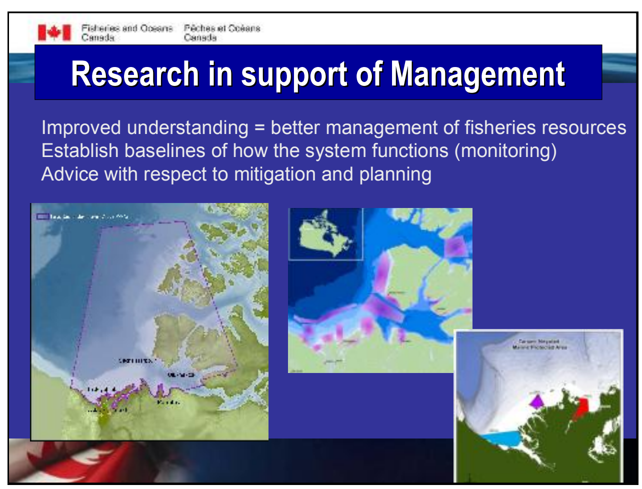
- **Tracking/Surveys**
  - **Ringed Seals**
  - **Beluga**
  - **Bowheads**
- **Harvest and Health**
  - **Ringed Seals**
  - **Beluga**

Canada


Fisheries and Oceans Canada
Pêches et Océans Canada
Fish Research (Last 10yrs)
Overall Objectives
• Role of Biodiversity
• Habitat use, associations and limiting factors
• Sensitivity/Response to Stressors
• Present & Future Status
• YNS Coastal Study
• Dolly Varden SARA
• ACES fish TN MPA
• Nahidik Fish Study
• Mackenzie Valley Sensitive Fishes & Habitats
• Shortjaw Cisco GSL SARA
Canada


Fisheries and Oceans Canada
Pêches et Océans Canada
Ecosystem Research and Modeling
ACES
Single species
Canada

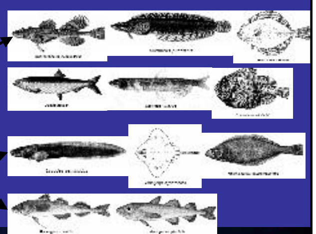

Fisheries and Oceans Canada
Pêches et Océans Canada
Research Geography and Gaps
Regions
Knowledge
Beaufort Sea Canada Basin Amundsen Gulf
Oceanography Lower TL
Beaufort Sea Shelf
Ecosystem Fish/MM
Mackenzie Delta Coastal nearshore
Ecosystem Fish/MM
Mackenzie Basin, Mackenzie River
Ecosystem Fish
C3O/JOIS ArcticNet
Nahidik
TN MPA ACES
MGP
Canada


Fisheries and Oceans Canada
Pêches et Océans Canada
Research in support of Management
Improved understanding = better management of fisheries resources
Establish baselines of how the system functions (monitoring)
Advice with respect to mitigation and planning

Fisheries and Oceans Canada / Pêches et Océans Canada

BREA – Fishes, Habitats and Oil & Gas Development in the Beaufort Sea

- Offshore fishes & their role in the ecosystems identified as gaps.
- ~ 70 fish species present in Canadian Beaufort Sea; 16-36 occur offshore (depth dependant) – 33 benthic + 3 pelagic.
- Benthic species affected by physical habitat changes.
- Pelagic species affected by noise, habitat (ice) changes & suspended materials.
- All affected by spills and dispersants.

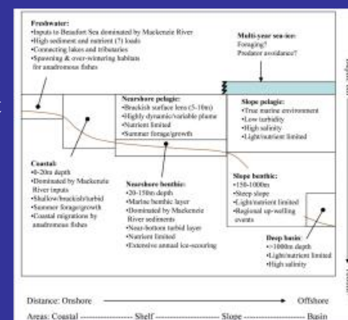


Canada

Fisheries and Oceans Canada / Pêches et Océans Canada

BREA Offshore Fishes Project

- Sub-ecosystems present in area.
- Semi-independent but connected.
- Fishes & habitats differ so different susceptibilities.

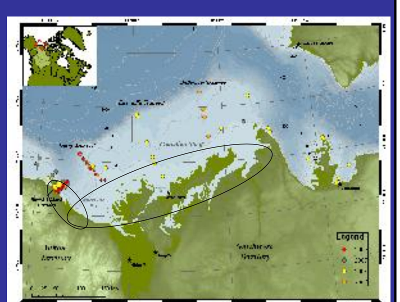


Canada

Fisheries and Oceans Canada / Pêches et Océans Canada

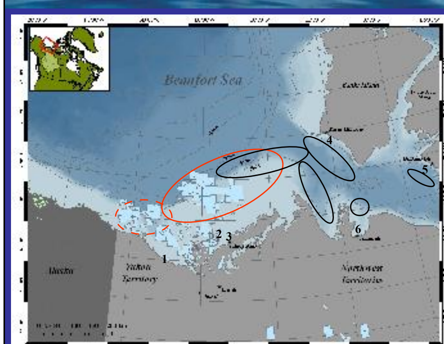
Knowledge Base on Fishes: Immediate Past

- Transects & feature-based trawling stations for marine fishes, Northern Coastal Marine Studies (2006 – 2009).
- Coastal work, nearshore marine & anadromous fishes (PERD, 2007-2011).
- Coastal & shelf work (1980's-1990's), NOGAP, PERD, ESRF, etc.



Canada

Fisheries and Oceans Canada / Pêches et Océans Canada



Legend

1-6: Coastal monitoring sites (CIMP) 2011-2013+ timing:
1) Shingle Point (Aklavik);
2) Hendrickson Island;
3) Tuktoyaktuk coast;
4) Sachs Harbour;
5) Ulukhaktok;
6) Darnley Bay (Paulatuk).

Lease Blocks Canada

Lease Blocks Alaska

2012 Focal area (50-1000m) (BREA+ESRF+PERD)

2012 Focal area (20-1000m) (IGS)

2013 Focal area (20-1000m) (BREA+ESRF+PERD)

Canada

Fisheries and Oceans Canada Pêches et Océans Canada

DFO concerns with respect to spill and dispersant impacts

- Knowledge gaps on the diversity of species in the offshore: species/life history/habitat/***relevance
- Direct toxicological impacts of Oil and Dispersants (lethal, sub lethal) on various species and their life stages that will vary in sensitivities
- Indirect impacts of changing ecosystem structure and function (i.e. a species at the bottom of the food web removed will impact the transfer of energy to top predators)
- Loss of Habitat/Avoidance of critical habitat
- Interactions of the spill/dispersant with other stressors, specifically climate change – Cumulative Impacts on the ecosystem that may impede the ability to recover
- Collection of the appropriate data to support advice to regulators

Canada

Fisheries and Oceans Canada Pêches et Océans Canada

Thank You

Wildlife concerns and priorities for oil spill response

BREA Dispersants Workshop
Inuvik, NT
James Hodson
Canadian Wildlife Service
July 25, 2011

Contents

- EC-CWS role in conservation and management of migratory birds and species at risk
- Spill impacts on wildlife
- Vulnerability of northern wildlife
- CWS role in oil spill response
- Sensitive areas, times and species in the Beaufort Sea
- Questions about dispersants

Migratory Birds and Species at Risk

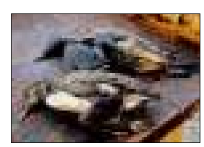
- Environment Canada is charged with the administration of the *Migratory Birds Convention Act*, a responsibility that requires management and conservation of migratory bird species
- Section 5.1 of the MBCA prohibits persons from depositing substances harmful to migratory birds in waters or areas frequented by birds
- EC is also responsible for administering the federal *Species At Risk Act* for terrestrial wildlife and migratory birds
- Section 32 of SARA makes it illegal to kill, harm, harass, capture or take a species listed as endangered or threatened

Red Knot Ivory Gull Polar Bear

Spill Impacts on Wildlife

- Ingestion or absorption of contaminants
- Destruction of insulation and buoyancy provided by feathers or fur, leading to hypothermia or drowning
- Sublethal contamination may affect fertility, egg production, hatch, and survival of young
- Destruction/contamination of food sources (plants, invertebrates, fish)

A small oil drop can be fatal in severe Arctic conditions!



Vulnerability of Northern Wildlife

- Some northern animals congregate in large numbers in marine areas (e.g., murres, eiders, brant, phalarope)
- Animals can be attracted spills (e.g., long-tailed ducks)
- Harsh Arctic environment reduces odds of survival of contaminated wildlife


Arctic REET

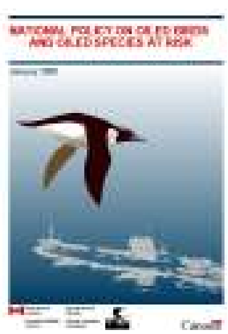
Arctic Regional Environmental Emergencies Team

- Consolidates environmental advice during major environmental emergencies for the Government Lead Agency
- Objective is to minimize damage to sensitive resources and habitats, while maximizing the use of limited response resources
- Provides advice but does not become involved with hands-on spill response operations
- Includes federal, territorial and local government and others

CWS National Policy

Key Principles:

- Prevent further damage to wildlife and their habitat
- Ensure humane treatment of contaminated wildlife



CWS National Policy

**** Birds and Species at Risk under EC jurisdiction only*

CWS response:

- Provide information to prevent further damage to wildlife and habitat, assess damage, and for restoration planning
- Minimize damage by deterring wildlife from spill areas
- Ensure humane treatment of contaminated wildlife by determining the appropriate response and treatment strategies

CWS response: Bird & SAR Info

- Provide advice on wildlife populations and environmental priorities to AREET
- Provide input on response activities through AREET, and approve emergency response actions for birds and SAR
- May conduct surveys of bird resources in spill area
- May document wildlife and wildlife habitat damage
- May advise on monitoring programs to assess long-term impacts on birds and SAR, and their habitats

CWS response: Minimizing Damage

- Assess threats to birds and SAR
- Determine strategies to exclude uncontaminated wildlife from the affected areas
- Provide advice on hazing and exclusion techniques
- Cooperate with agencies removing pollutants and contaminated wildlife from the environment
- Issue authorizations to deter birds from contaminated areas, operate bait stations, capture migratory birds, or provide humane treatment
- Monitor operations for which CWS authorizations were issued

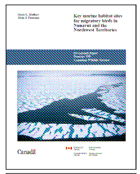
CWS response: Humane Treatment

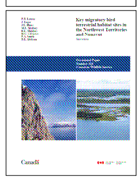
- Require cleaning and rehabilitation only for Species at Risk
- Recommend euthanization when rehabilitation not done
- Issue authorizations to allow contaminated birds to be rehabilitated or euthanized
- Ensure potential applicants for authorizations have expertise and logistic capability to carry out activities humanely and competently, and facilities and personnel for after-care
- Monitor groups collecting, cleaning or euthanizing birds

Key periods and locations of sensitivity to oil spills

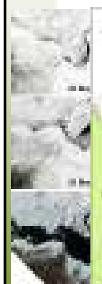
- The timing and location of an oil spill, rather than the size of the spill, are the primary factors influencing bird mortality rates
- Migratory birds concentrate in coastal areas, shore leads and polynyas for feeding, moulting, staging and migration

Key Habitat Sites for Migratory Birds



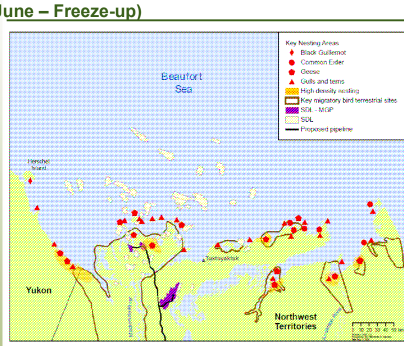


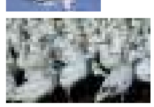
Common and King Eider – Spring Staging
(mid-May to mid-June)

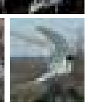


A large hydrocarbon spill in late May in the open water off Tuktoyaktuk Peninsula would put nearly the **entire Canadian breeding population of Pacific Common Eiders at risk, as well as over half the western King Eiders**

Key nesting areas for marine birds
(June – Freeze-up)



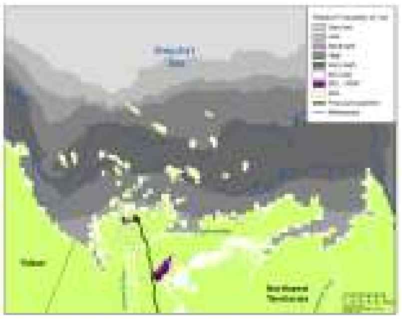




Key moulting areas for marine birds

Coastal bays and sheltered waters behind barrier islands along the coast are used by over 100,000 ducks during moult in mid-July to mid-August

Polar Bear – Winter Habitat Use



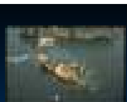
Dispersants – CWS concerns

- What are the relative direct effects of oil, dispersants, and oil/dispersant mixtures on feathers and fur?
- What is the relative toxicity of oil, dispersants, and oil/dispersant mixtures if ingested or transferred to eggs?
- What are the short-term vs. long-term impacts from dispersant application on the marine food web and habitats used by migratory birds and species at risk?

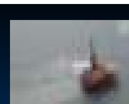
Questions?

Oil Spill Behaviour

- Types of Spills
- Characteristics of Petroleum
- Overview of Spill Processes



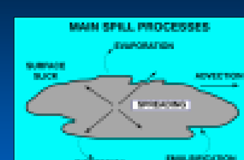
Types of spills



- Types of Spills
  - Production spills (offshore wells)
    - Very small batch spills of rig liquids(light refined products)
    - Continuous spills of crude oil
    - e.g., Deepwater Horizon, Ixtoc-1
    - Fresh oil produced continuously
  - Transportation spills (tankers, pipelines)
    - Smaller spills refined oil
    - Large spills of cargo (crude oil)
    - e.g. Exxon Valdez
    - Oil spilled over brief period, then weathers

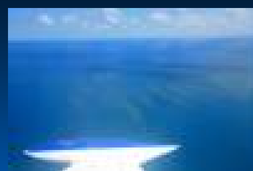
Fate and Effects

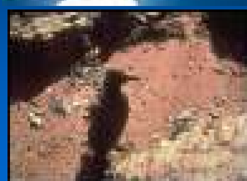
- Overview of Spill Processes
  - Crude Oil Floats
  - Spreading
  - Slick Movement
  - Evaporation
  - Dispersion
  - Degradation
  - Emulsification
  - Oil in ice



Fate and Effects

- Overview of Fate Processes
  - Oil slicks may:
    - Dissipate offshore
    - Strand on ice or shore
    - Impact wildlife
  - Risks reduced by cleanup - dispersants



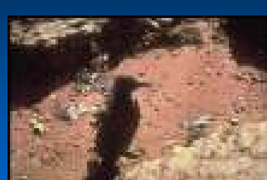


Basics: What are Dispersants?

- Specialized shampoo-like industrial chemicals
- For example, Corexit 9500, Dispersit SPC 1000
- Used to treat oil slicks at sea
- Help mix oil slicks into water at sea
- Are NOT other oil spill chemicals (shoreline cleaners, herders, elastifiers, biodegradation agents)

Basics: Why Use Dispersants?

- To reduce the environmental impact and persistence of spills.

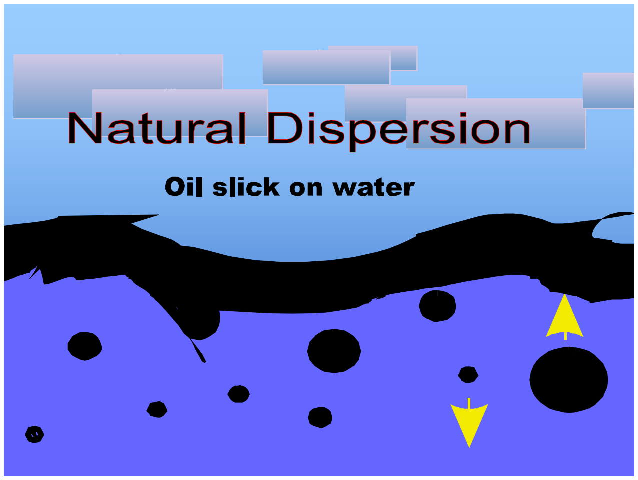


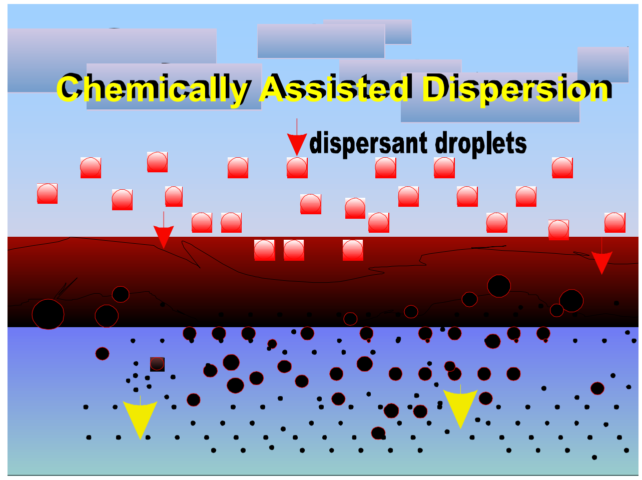
Basics: What do they do?

- Dispersants help oil slicks to mix with seawater

With Dispersant Without Dispersant

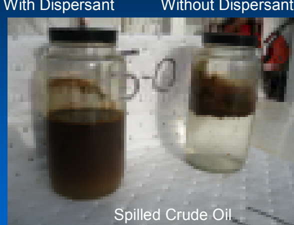
Aquarium demonstration of dispersants in action.





Basics: What do they do?

- Dispersants help oil slicks to mix with seawater
- Next
  - Ohmsett Demonstration of dispersant

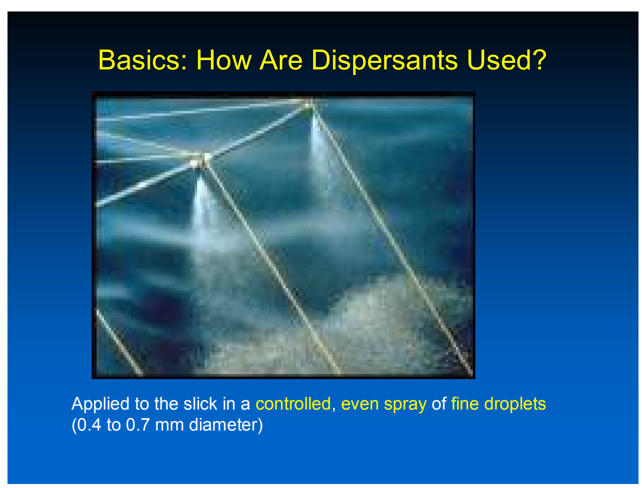


Aquarium demonstration of dispersants in action.


Behavior of Dispersant-Treated Oil in Waves
TEST NO.
10
1
2
Alaska North Slope Crude Oil x Corexit 9500 @ DOR=1:20

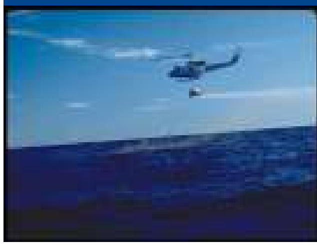

Tests in broken ice conditions show mixing energy adequate to disperse Alaskan oils. Warrant further work in full-scale tests

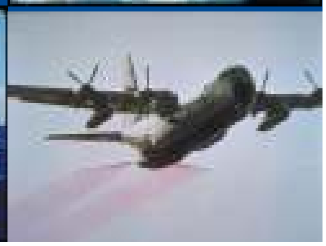

Behaviour of Dispersant-treated oil at sea
(Deepwater Horizon Spill, 2010)


Basics: How Are Dispersants Used?
Applied to the slick in a controlled, even spray of fine droplets (0.4 to 0.7 mm diameter)

Basics: How Are Dispersants Used?

Using a different types of spraying platforms





Basics: How Dispersants Are Used?

- Organization
  - Command/Control
  - Spotter
  - Sprayer
  - Monitor (SMART)
  - Resupply/Support

Basics: How Dispersants Are Used?

Coordinate with Other Countermeasures

- -Spill Control
- -Offshore countermeasures
  - -Booms and skimmers
  - -Dispersants
  - -In-situ Burning
- -Shoreline Cleanup

Why Use Dispersants?

- Disperses oil slicks off the sea surface
- Prevents oil from being driven into areas of higher environmental sensitivity
- Facilitates dilution and degradation of oil
- Eliminates slicks faster than booms and skimmers

Why Use Dispersants?

- Rapid protection of sensitive areas
- Rapid response to very large spills
- Response to spills long distance from base

Dispersants vs Physical Recovery

Booms/Skimmers	Dispersants
Advantages of Dispersants	
- low oil encounter rates	- higher oil encounter rates
- limited in waves >4-5 feet	-can operate in somewhat higher waves
- response time limited by ship transit speeds	- aircraft have much faster transit speeds
- requires spotter, boom/skimmer, at-sea storage and transport	- operational simplicity, equires only spotter, sprayer & monitor
- oil storage and disposal needed	- oil storage and disposal NOT NEEDED
Disadvantages of Dispersants	
- Effectiveness NOT limited by oil/emulsion viscosity	- Effectiveness limited by oil/emulsion viscosity
- No environmental side-effects	-Potential ecological side-effects

History of dispersants in Canada etc

- Main Questions in Dispersant Planning
  - Will the OIL disperse?
  - Is the DISPERSANT effective? / Are they effective?
  - Do we have ENOUGH EQUIPMENT/SUPPLIES for this spill?
  - Is there a NET ENVIRONMENTAL BENEFIT from using dispersants?
  - Are we in compliance with guidelines?

	Spill	Effectiveness/Operations
1960s	Torrey Canyon (UK, 1967)	•Dispersants invented (1960) Lessons learned from Torrey Canyon Oil Spill (UK)
1970s	Tanker Arrow	• Effectiveness testing done in Canada (Oda, 1969)
	Ixtoc 1 Blowout Main Pass Blowout	• Vessel & Aircraft Spray Systems System • Field trials in Canada • CCG equipped w spray systems
1980s		• C130/ADDS-Pak developed • U of T Research on Dispersants (D. MacKay) • Halifax Dispersant Sea Trial (1983)
	Exxon Valdez (1989)	• Beaufort Sea Dispersant Trial (1986)
1990s		• Env Can Research on dispersants
	Sea Empress (UK,1996)	
2000s		• Dispersant Researchers at Ohmsett
2010s	Deepwater Horizon	

	Environmental	Decision-Making
1960	• Lessons Learned (Torrey Canyon)	
1970's	• Low-toxicity dispersants invented (e.g. Corexit 9527)	• 1972 Canada's Environ. Emerg. Serv. formed
	• Wells research dispersant toxicity	
1980	• Toxicity of dispersed oil due to toxicity of oil • Toxicity testing on arctic species	• US develops dispersant guidelines • Canada develops dispersant guidelines
	• Net Environmental Benefit Analysis Developed • BIOS Experiment (Arctic) • Beaufort Sea Dispersant Decision System Developed	• Dispersants pre-approved in US Gulf of Mexico
1990	• Corexit 9500 invented	• OPA 1990 requires US pre-approval plans
2000	• ESRF Workshop on Dispersants in Atlantic Canada	•Canada updates dispersant use guidelines
2010		

Summary

- Dispersants help oil slicks mix into seawater
- Protects wildlife and reduces persistence
- Has side-effects
- Dispersant application is carefully controlled
- 50 years of experience and research with dispersant, much in Canada and Arctic

BC: In-Situ Burning and Dispersants Aspects

- ❑ Introduction
- ❑ Regional Setting
- ❑ Oil Spill Basics
- ❑ In-situ Burning (ISB)
  - ❑ ISB Basics
  - ❑ ISB Capabilities and Limits
  - ❑ ISB Environmental and Health Considerations
  - ❑ Monitoring
  - ❑ New Developments
- ❑ Dispersants
  - ❑ Dispersant Use –Basics
  - ❑ Dispersants – Capabilities and Limits
  - ❑ Environmental Considerations - NEBA
  - ❑ Monitoring
  - ❑ New Developments

Dispersant Use

- Main Questions in Dispersants Planning
  - What spray systems/platforms to use?
  - Will they be effective? / Are they effective?
  - Is there a net environmental benefit?
  - What spray systems/platforms to use?
  - Are we in compliance with guidelines?

Various Definitions of "Effectiveness"

- "Dispersant effectiveness index"
  - as measured in the laboratory (DEI)
  - 0-100%
  - Used to compare relative effectiveness of products
- "Field effectiveness" (FE)
  - effectiveness in the field or Ohmsett
  - Qualitative measure
  - High, partial, no effectiveness
  - Ohmsett tests allow some quantitative measurements
- "Operational effectiveness" or efficiency (OE)
  - Overall contribution of dispersants to response

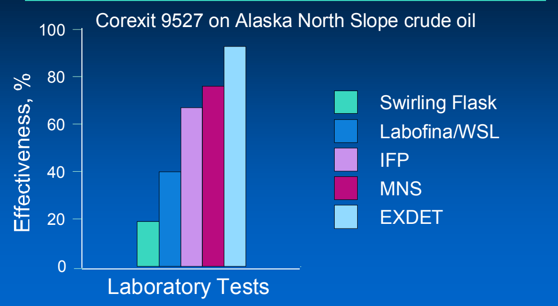
Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
  - parent oil
  - effect of weathering/emulsification
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature

Sources of information re effectiveness

- Bench scale tests (Swirling Flask, Baffled Flask, EXDET, IFP, Warren Spring Laboratories (WSL)[a], etc)
- Wave tank tests (BIO, SL Ross, Delft, etc)
- Large tank tests (Ohmsett, COSS)
- Sea trials (dozens since 1970s)
- Spills (dozens since Torrey Canyon, 1976)

Results from five dispersant effectiveness laboratory tests



Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
  - Parent oil
  - Effect of weathering/emulsification
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature

Effectiveness Factors:Oil Viscosity

- resistance of a fluid to flowing
- Two influences on dispersants:
  - In all oils resists shearing by breaking waves
  - In very viscous oils resists penetration of dispersant into oil

Liquid	Viscosity (cP)
Water	1
Kerosene	10
SAE 10 motor oil	100
Glycerin or castor oil	1000
Corn syrup	10,000
Molasses	100,000
Peanut butter	1,000,000

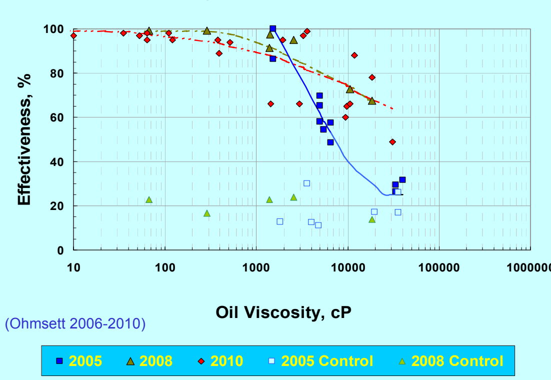
Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
  - **Rule of thumb:**
  - **Oils < 2000 cP easily dispersible**
  - **Oils > 20,000 cP not dispersible**
  - **Oils > 2000 cP < 20,000 cP partially dispersible**
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature)

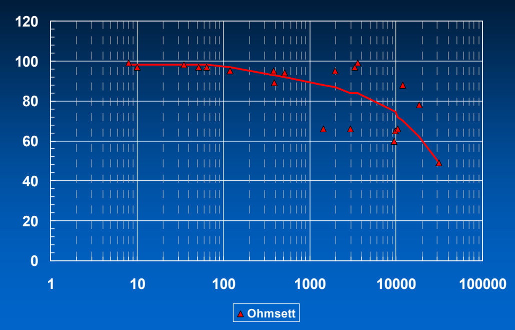
BC: Comparison of Oil Properties

Oil Type	API Gr.	Density g/ml	Viscosity cP (15^{0}C)	Pour Point (^{o}C)	Emulsion Forming
Typical crude oils		**.85 to .99**	**10 to 5000**	**-40 to 25**	**Varies**
MC-252 (86F/30C) (GoM)	39	.83	2	<-9	Some
Alberta Sweet Mixed Blend	36	.84	6	-30	Stable
Alaska North Slope (AK)	30	.87	12	-32	meso-stable
Cold Lake Bitumen	10-13	.98	235,000	9	?
Cold Lake Blend	22	.92	150	-45	?
Cold Lake Diluent	69	.71	1	<-75	Probably not
Typical Fuels		**.85 to .99**	**10 to 5000**	**-40 to 25**	**Varies**
Gasoline	62	.73	0.6	<-63	no
Jet Fuel (JP-1)	45	.8	1	-45	no
Marine Distillate Fuel	34	.85	4+	<-30	no
Marine Fuel Oil (IFO 180)	15	.97	variable approx. 2500	variable -10	yes
Bunker C – Residual Fuel	13	.98	45030	variable	yes

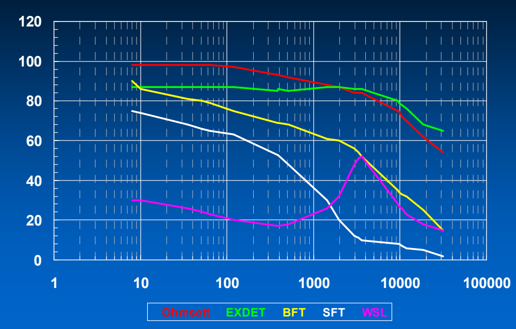
Oil ViscosityThat Limits Dispersion



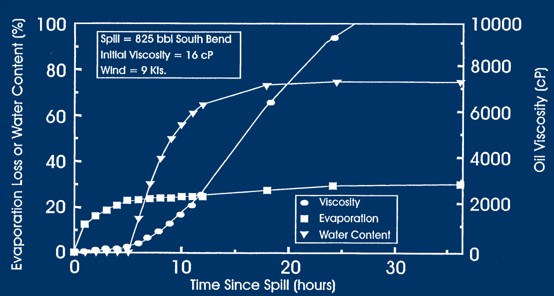
Dispersibiity vs Emulsion Viscosity



Dispersibiity vs Emulsion Viscosity



Weathering Effect on Viscosity



Oil Type vs. Effectiveness: Weathering / Emulsification

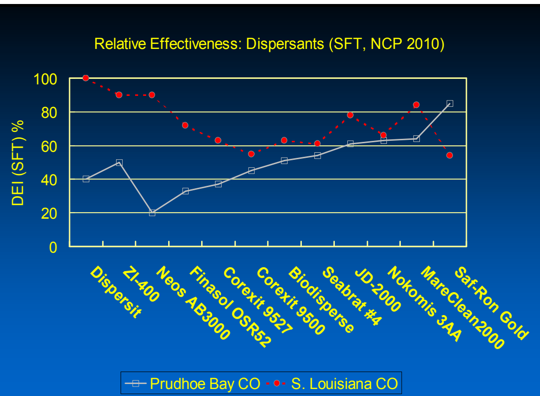
- Weathering/emulsification determines "Time Window"
- Some oils do not emulsify; others emulsify slowly; others emulsify quickly
- Know your oils
- Decisions based on efficacy monitoring

Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
  - Rule of thumb:
  - Oils < 2000 cP easily dispersible
  - Oils > 20,000 cP not dispersible
  - Oils > 2000 cP < 20,000 cP partially dispersible
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature)

Factors Influencing Dispersant Effectiveness

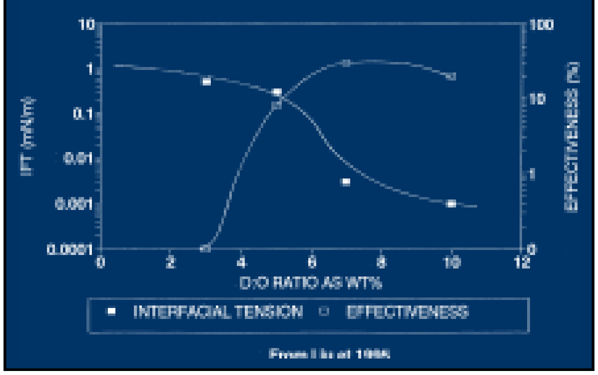
- Oil Properties (viscosity)
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature)



Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature)

Effectiveness vs DOR



Effectiveness vs. DOR

- Dosages from as low as 1:75 to as high as 1:1 have been effective in spills
- DOR of 1:20 is usually recommended (see Canevari 1969)
- Plan to use DOR of 1:20

Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
- Dispersant Type & Dosage
  - Dispersant products vary widely in effectiveness
  - Dispersant product effective if on NCP Product Schedule?
  - Plan for DOR of 1:20
    - Achievable by vessel, but multiple passes needed for aircraft
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature)

Factors Influencing Dispersant Effectiveness

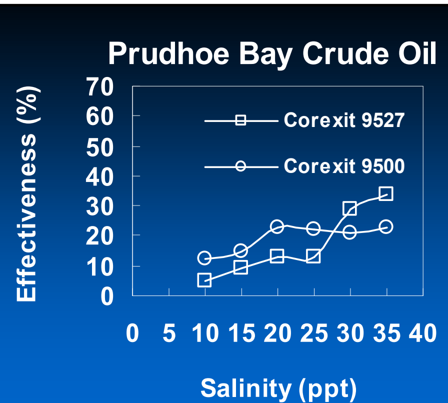
- Oil Properties (viscosity)
  - parent oil
  - effect of weathering/emulsification
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature)

Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity, pour point x temperature)
  – Parent oil
  – Effect of weathering
- Dispersant Type & Dosage
- Sea State
  – At Ohmsett, breaking waves effective, non-breaking waves not effective
  – In general, at sea - breaking waves effective; without breaking waves ?, need SMART
  – In DWH Spill dispersants prohibited in waves < 2 feet
- Water Salinity
- Temperature (x pour point)

Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
  – parent oil
  – effect of weathering/emulsification
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  – pour point x temperature)



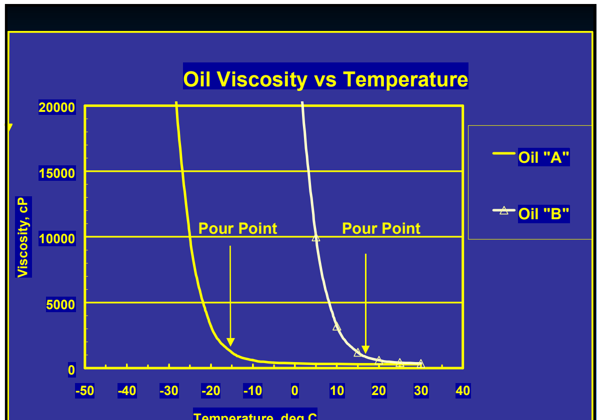
Blondina et al. 1999

Effect of Salinity on Dispersibility

- Dispersant effectiveness influenced by salinity of water
- Most dispersants are intended for salt water (including Corexit 9527 and 9500 and others on NCP List)
- Freshwater dispersants available, but not in U.S.
- Salinity issues addressed locally in planning

Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
  – parent oil
  – effect of weathering/emulsification
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  – pour point x temperature)



Effect of Temperature on Dispersibility

- Decrease in temperature leads to increase in oil viscosity
- This <u>may</u> or <u>may not</u> affect dispersant effectiveness. Depends on
  - viscosity of original oil
  - amount of temperature drop
  - nearness of ambient temperature to oil pour point

Effect of Temperature on Dispersibility

- Decision regarding dispersibility:
  - ambient temperature is less than 10ºF (5.5ºC) above pour point of oil.

Factors Influencing Dispersant Effectiveness

- Oil Properties (viscosity)
- Dispersant Type & Dosage
- Mixing Energy / Sea State
- Water Salinity
- Temperature
  - pour point x temperature)

Dispersant Use – Application Methods

BC: In-Situ Burning and Dispersants Aspects

- Introduction
- Regional Setting
- Oil Spill Basics
- In-situ Burning (ISB)
  - ISB Basics
  - ISB Capabilities and Limits
  - ISB Environmental and Health Considerations
  - Monitoring
  - New Developments
- Dispersants
  - Dispersant Use –Basics
  - Dispersants – Capabilities and Limits
  - Environmental Considerations - NEBA
  - Monitoring
  - New Developments

Dispersant Use

- Main Questions in Dispersants Planning
  - What spray systems/platforms to use?
    - Operational Demands
    - Capabilities and Limitations of Platforms
    - Weather / Sea Characteristics
  - Will they be effective? / Are they effective?
  - Is there a net environmental benefit?
  - What spray systems/platforms to use?
  - Are we in compliance with guidelines?

Dispersant Use: What spray systems/platforms to use?

Platform	Payload USG	Distance to Spill, mi	Volume of dispersant, cu. m. per 10-hr day
Vessel	variable	30	variable
Small Helo	300	30	6.8
DC-3	1200	30	50
DC-4	2100	30	79
C-130	5000	30	208

Dispersant Use: What spray systems/platforms to use?

Platform	Payload (m3)	Transit Speed (km/hr)	Start-up Time (hr)	Time to treat 320 m3 Spill[a] (hr)
Vessel	31	15	1	2.4
Small Helo	.9	222	1	16.5
FRAMO Helo	2.7	130	?	5.6
Bombardier 415MP	6.1	333	?	10.8
C-130 Nimbus	12.0	540	24	10.7

a. SL Ross 2008

Dispersant Use: What spray systems/platforms to use?

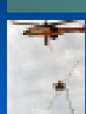
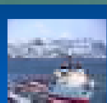
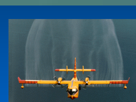
Platform	Payload (m3)	Transit Speed (km/hr)	Start-up Time (hr)	Treatment Rate 9000 m3/day Blowout (a) (m3 / hr)
Vessel	31	15	1	141
Small Helo	.9	222	1	13
FRAMO Helo	2.7	130	?	34
Bombardier 415MP	6.1	333	?	41
C-130 Nimbus	12.0	540	24	62

a. Blowout =375 m3/hr; 12-hour day

Logistics/Operations: What is New?

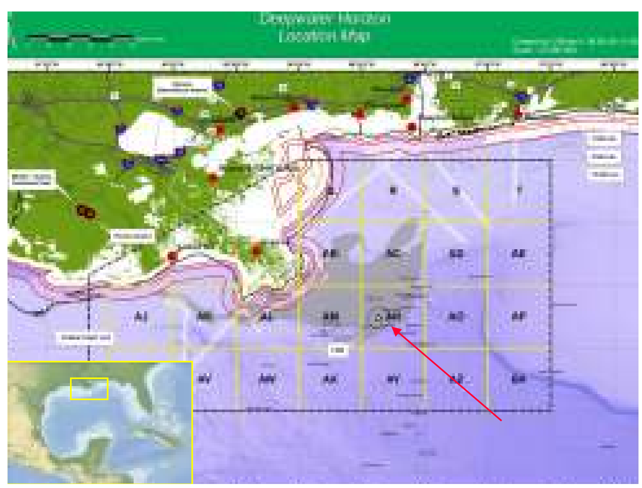
- Nalco can produce 30,000 gal Corexit 9500/day
- In DWH, Max. sorties/platform/day=4
- Ayles Fernie Single Nozzle Vessel Spray System

Dispersant Use – Application Methods

- SL Ross Work on DWH Spill (May 7 – date)
  - Improve SMART Protocol for dispersants
  - Assess “alternative” dispersant products
  - Assess properties and dispersibility of weathered/emulsified MC252 oil
  - Support UCS dispersant risk communication
  - Assess spotter anomalies (things that resemble oil patches)

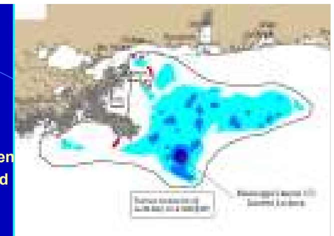
Overview of DWH Spill

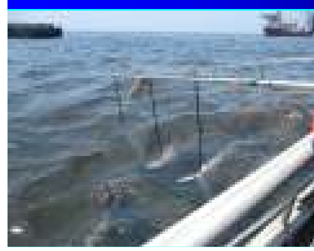


Overview of DWH Spill

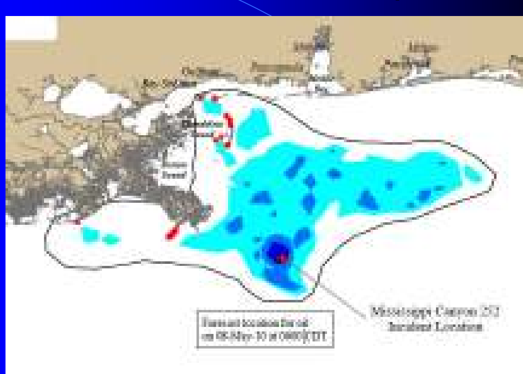
- **Spill**
  - Subsea blowout, water depth 5000 ft (1500 m)
  - 9500 M^3 crude oil / day (APPROXIMATELY)
  - Apr 22 to July 15 (85 days)
  - Total = 807,000 tonnes crude oil (APPROXIMATELY)
  - MC 252 crude oil density = 36 API Gravity

- **Spill Fate/Behavior**
  - Subsurface
  - Surface
    - Slick of fresh oil at "The Source" (few mi diameter)
    - Patches of emulsion (a few tens of square metres w sheen
    - Patches of emulsion stranded on shore

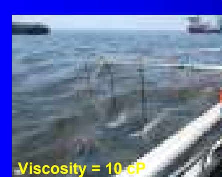




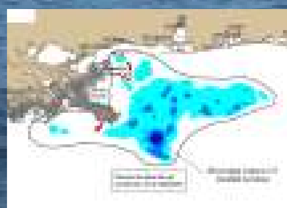
Overview DWH Spill



Overview of DWH Spill



- **Countermeasures**
  - **Purpose –**
    - **keep oil out of marshes/bays and off beaches**
  - **Lines of defence**
    - **Sub-sea**
      - **Source Control**
      - **Subsea Injection of Dispersants**
      - **Subsea Collection**
    - **Surface Offshore**
      - **Containment – Recovery**
      - **Containment – In-situ burning**
      - **Surface Application of Dispersants (Remediation & VOC control)**
    - **Shoreline cleanup**

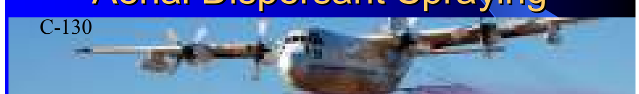


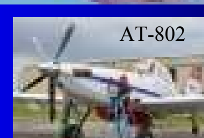
- **Dispersants**
  - **Purpose:**
    - **Keep oil out of the marshes/bays and off the beaches**
  - **Dispersant Operation Tasks**
    - **Aerial dispersant spraying**
    - **Vessel spraying (at "Source"for VOC control**
    - **Problem Solving (alternate dispersants, oil fate/time window)**

Dispersant Operations

- Dispersants
  - Purpose:
    - **Keep oil out of the marshes/bays and off the beaches**
  - Dispersant Operations
    - **Aerial dispersant spraying**
    - **Vessel spraying (at "source"for VOC control)**
    - **Problem Solving (alternate dispersants, oil fate/time window, toxicity of dispersed oil)**

Aerial Dispersant Spraying





Organization

- Unified Command
  - Source Control
  - Reconnaissance
  - Recovery
  - In-situ Burning
  - Shoreline Cleaning
  - Dispersants
    - Aerial Dispersant Spraying
      - Planning/Coordination
      - Air Operations
        - Spotting/Spraying
      - Dispersant Stockpiles
      - Documentation and Communications
      - Dispersant Assessment Group (Address challenges)
      - Dispersant Effectiveness Monitoring

Resources: Aerial Spraying

Aircraft Type	Source	Payload, US gal (m^3)	Number	Max. Daily Capacity m^3
IN SERVICE				
DC-3	ASI	1000 (4)	2	16 /plane
BT-67	ASI	1800 (7)	1	28
C-130	OSR, MSRC	5000 (19)	3	76 / plane
C-130	IAR	3000 (11)	1	44
C-130	USAF	1700 (6)	3	24 /plane
At-802	NRC	800 (3)	1-3	12 / lane
Total operational daily spray max = 361 m^3 dispersant /day				
ADDITIONAL ASSETS				
C103	OSR (Sing)	5000	1	
At-802	NRC	800	many	

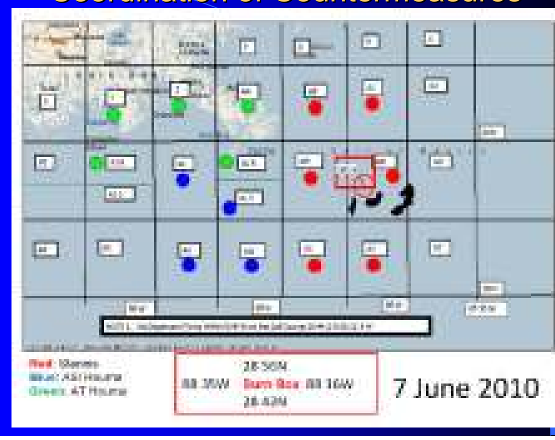
Resources: Aerial Spotting

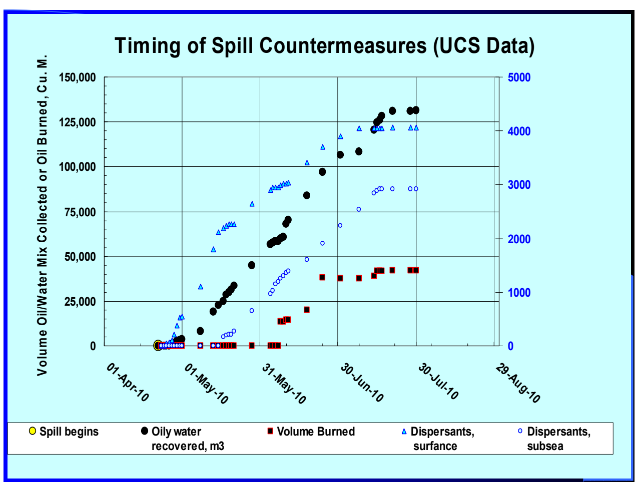
Type	Source	Number	Location
King-Air	ASI, MSRC	6	(Stennis (5) , Houma (1)
Aztec	ASI	1	(Houma)
Turbo-Comdr	ASI	1	Houma

Resources: Dispersant Stockpiles

Location	Corexit 9500	Corexit 9527	Other Products
Canada	0	19	0
US	670	745	0
OSR	122	48	205
Rest of World	498	1040	4233
Total	1290	1852	4438
Nalco Rate (max)	113 m^3/day		

Coordination of Countermeasures





DWH - Lessons Learned

- **General**
  - Dispersants can be deployed quickly if operators prepared
  - MC252 crude oil was highly dispersible
- **Airborne dispersant application/fixed-wing**
  - Challenges in assessing effectiveness of single-pass application using SMART

DWH - Lessons Learned

- **Surface vessel dispersant application**
  - Airborne spotting important
  - Comms with vessels challenging initially but problems solved
- **Oil Weathering and dispersant time window**
  - Changes in oil properties and dispersibility of emulsions (time-window) evaluated late in spill
- **Logistics**
  - If needed Nalco can produce 30,000 gal per day of Corexit 9500

DWH - Lessons Learned

- **Challenges for airborne spotters**
  - **Anomalies: windrows of sargassum and decaying vegetation mistaken for emulsion and targeted for collection, dispersant and ISB**

DWH - Lessons Learned

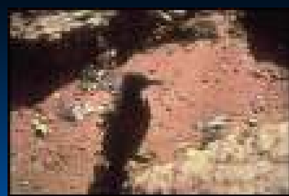
- **SMART effectiveness monitoring protocol**
  - **Monitoring teams should report to directly to Dispersant Operations as well as to USCG and UCS**
  - **Protocol for preparing and interpreting field reports must be in place and tested**
  - **Monitoring teams must have better knowledge of oil spills, dispersants and sampling protocols**
  - **Operating protocol must be updated**

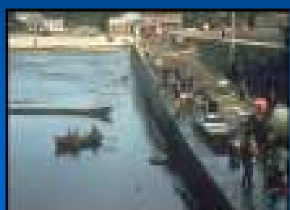
DWH - Lessons Learned

- **Operators and Regulators Must Have the Same Mental Model for Dispersant Use and be aware of current knowledge regarding:**
  - **Effectiveness**
  - **Net Environmental Benefits**
  - **Health and Safety**


Questions?
Deepwater Horizon Oil Spill
April - July 2010

Environment Risks from Oil Spills, Dispersants and Dispersed Spills
and
Net Environmental Benefit Analysis



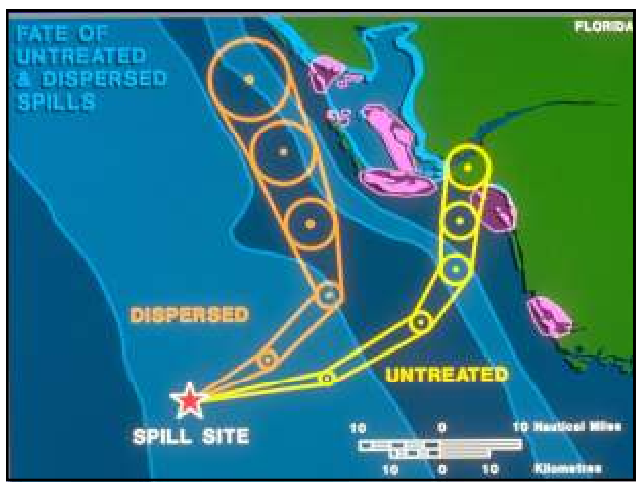


Outline / Agenda

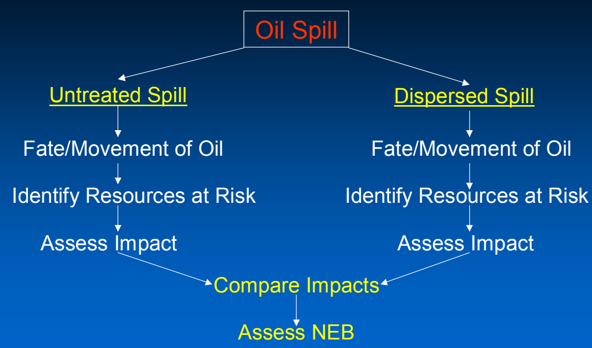
- Monday
  - Setting in the Beaufort
  - Introduction to Spills and Dispersants
- Tuesday
  - Effectiveness of Dispersant Operations
  - Environmental Benefits and Risks
  - Planning, Decision-making and Consultation
- Wednesday
  - Practice in decision-making
- Thursday
  - Critical review
    - Effectiveness / Environmental risks and benefits (NEBA) Planning and decision-making / Everything else
  - The next steps

Dispersant Use

- Main Questions in Dispersant Planning
  - Will the OIL disperse?
  - Is the DISPERSANT effective? / Are they effective?
  - Do we have ENOUGH EQUIPMENT/SUPPLIES for this spill?
  - Is there a NET ENVIRONMENTAL BENEFIT from using dispersants?
  - Are we in compliance with guidelines?



Method



Summary of Impacts of Dispersed and Untreated Spill: Charlotte, Florida

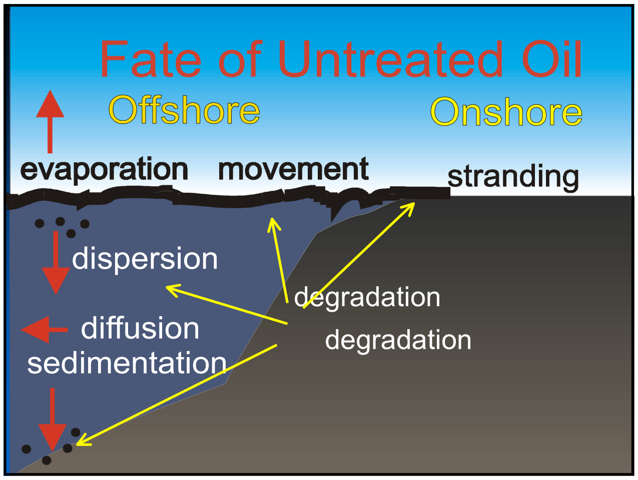
Resources (Stocks)	Impact, % Untreated	Impact, % Dispersed
Pink Shrimp (E. Gulf)	0.1 (0.5)	0.4 (1)
Blue Crab (E. Gulf)	0.2 (0.2)	0 (0)
Spotted Seatrout (Charlotte)	0.8 (3)	0.5 (3)
Least Tern (W. Florida)	5	0
Br. Pelican (E. Gulf)	3	0
Mangrove (Charlotte)	10	0
Marinas	8	0
Beach, non-amenity	8 km	0
Mangrove shoreline	39 km	0

Spill Effects and NEBA

- Overview of Fate and Effects of Oil Spills
  - Untreated spills
  - Chemically dispersed spills
- Understanding risks from dispersants and dispersed oil
  - Risks from Dispersants alone
  - Risks from dispersed oil
- NEBA

Spill Effects and NEBA

- Overview of Fate and Effects
  - Untreated spills
  - Chemically dispersed spills
- Understanding risks from dispersants and dispersed oil
  - Risks from Dispersants alone
  - Risks from dispersed oil
- NEBA



Impacts of Large Marine Oil Spills

- Impacts of historical spills
  - Amoco Cadiz (France, 1979)
  - Exxon Valdez (Alaska, 1989)
  - Braer (United Kingdom 1993)
  - Prestige (Spain 2002)
  - Erika (France 1999)

Overview of Fate and Effects: Untreated Oil

- Factors to be considered
- Effects
  - lethal, sublethal, contamination)
- Sensitivity (Toxicity)
- Vulnerability (Individuals, populations)
  - Likelihood of contacting slicks
- Recovery Potential (Populations)
  - Days, months, years, decades
- Value (to local human users)

Impacts of Untreated Oil (no dispersants)

Group	Examples	Effects	Sensitivity to oil	Vulnerability	Recovery of Populations
Marine Birds, Water fowl	Goldeneye, Murres	Mortality, Sublethal effects	High	High, Depends	Years
Mammals, Hairy	Sea otters, polar bears	Mortality, Sublethal effects	High	High, Depends	Years
Mammals, Pinnipeds	Ringed seals bearded seals	Mortality rare Mild sublethal	Low	High, depends	Months year
Mammals, Bare-skinned	Bowhead, beluga	Few, minor sublethal if any	Very low	Low, depends	Months
Finfish	Salmon, Cod ,herring	Sublethal, contamination	Moderate	Very limited, depends	Months to years
Fisheries	Finfish, shrimp, Oysters	Fishery closures	Slicks, habitat, tissues		Finfish-months Molluscs – years
Benthos	Starfish, mollusca	Sublethal and contamination	moderate	Only nearshore	Months to years
Plankton	copepods,Krill	Not likely	Not likely	unlikely	Rapid

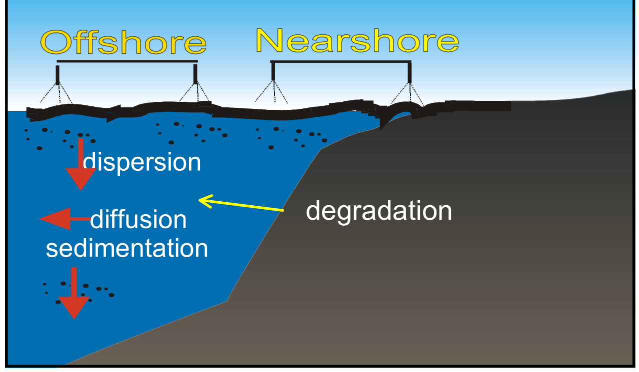
Spill Effects and NEBA

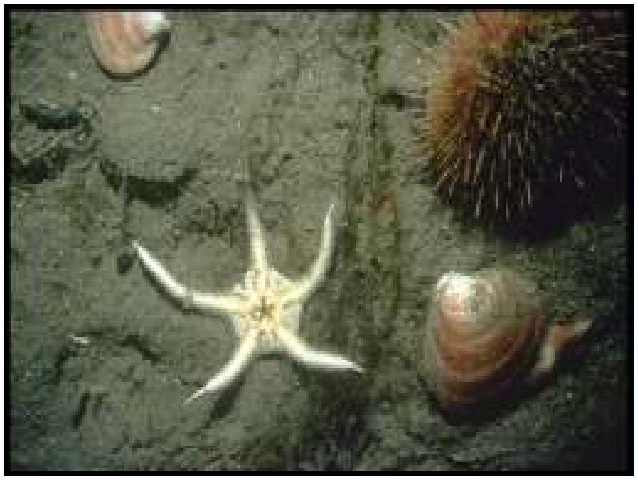
- Overview of Fate and Effects
  - Untreated spills
  - Chemically dispersed spills
- Understanding risks from dispersants and dispersed oil
  - Risks from Dispersants alone
  - Risks from dispersed oil
- NEBA

Overview of Fate and Effects

- Overview of Impacts of Dispersed Oil and Dispersants
  - Assumptions
    - Used offshore
    - Modern low-toxicity dispersant to be used (Corexit 9500)
    - Best Available Practices used.

Immediate Fate of Chemically Dispersed Oil





Potential Impacts of Dispersants

Group	Examples	Vulnerability	Effects	Sensitivity	Recovery Populations
Marine Birds, Water fowl	Goldeneye, Murres	Very Low	Adults, irritation Eggs,?	Low	Days
Mammals, Hairy	Sea otters, polar bears	Very Low	Adults, irritation	Low	Days
Mammals, Pinnipeds	Ringed seals bearded seals	Very Low	Adults, irritation	Low	Days
Mammals, Bare-skinned	Bowhead, beluga	Very Low	?	Low	NA
Finfish	Salmon, herring, Cod	Vulnerable, depends	Sublethal	Low	days
Fisheries	Finfish, shellfish	Vulnerable, depends	Contamination?	very	Not needed
Benthos	Starfish, mollusca	Vulnerable, depends	Sublethal, contamination	Low	days
Plankton	copepods, Krill	Vulnerable,upper waters only	Sublethal, contamination	Low	days

Potential Impacts of Dispersed Oil

Group	Examples	Vulnerability	Effects	Sensitivity	Recovery Populations
Marine Birds, Water fowl	Goldeneye, Murres	Very low, depends	?	Very low	Not needed
Mammals, Hairy	Sea otters, polar bears	Very low, depends	?	Very low	Not needed
Mammals, Pinnipeds	Ringed seals bearded seals	Very low, depends	?	Very low	Not needed
Mammals, Bare-skinned	Bowhead, beluga	Very low, depends	?	insensitive	Not needed
Finfish	Salmon, herring, Cod	Vulnerable, depends	Lethal, Sublethal, contamination	Moderate	Years to days, depends
Fisheries	Finfish, shellfish	Vulnerable, Depends	Lethality, contamination	Moderate	Days. months depends
Benthos	Starfish, mollusca	Vulnerable, Depends	Lethality, contamination	Moderate	Days. months depends
Plankton	copepods, Krill	Vulnerable,upper waters only	Lethality, contamination	Moderate	Days. months depends

Spill Effects and NEBA

- Overview of Fate and Effects of Oil Spills
  - Untreated spills
  - Chemically dispersed spills
- Understanding risks from dispersants and dispersed oil
  - Risks from Dispersants alone
  - Risks from dispersed oil
- NEBA

Toxic Risk from Dispersant

- Concern:
  - contribution of dispersant to toxicity of oil/water mix
- Legacy of *Torrey Canyon* spill, 1967
- Modern dispersants have measurable, but low toxicity
- Risk - Likelihood of effects under actual real world conditions
- Approach – Compare:
  - exposure conditions at sea to toxic threshold (LC50) for Corexit 9500

Understanding risks from dispersants and dispersed oil

- **Contamination cause by oil spills and dispersants are**
  - **Localized**
  - **Temporary**
- **When dispersant sprayed on oil they cause:**
  - **Elevated oil concentrations near slick sprayed**
  - **Oil concentrations decline quickly**

Understanding risks from dispersants and dispersed oil

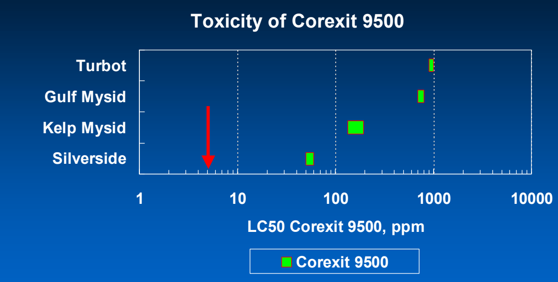
- Compare:
  - **Exposure conditions at sea vs toxic threshold (LC50) for Corexit 9500**
  - **What are Corexit 9500 concentrations under slicks?**
    - **Worst case = 5 ppm**
  - **How toxic is Corexit 9500?**

How to measure toxicity

- Toxicity:
  - Definition - Concentration of substance in water needed to cause injury (mortality) in organism
  - Estimated - laboratory tests
  - Expressed - LC50 (Lethal Concentration for 50% of organisms in test)

How to measure toxicity

- LC50 Method:
  - Aquaria with different concentrations of dispersant (or dispersed oil)
  - Place 10 organisms (e,g,fish) in each aquarium
  - Determine the concentration that injures 5 fish
  - That concentration = LC50



Exposure concentration at sea

Environmental Risks from Dispersants

Potential Effects
- Lethal – not likely
- Sublethal – not likely
- Tissue contamination – unlikely, non-persistent
- Bioaccumulation – no

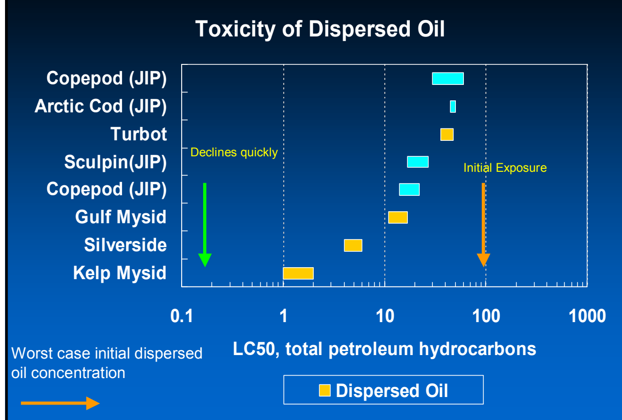
- Things to remember about dispersant toxicity
  - Toxic risk from dispersant alone low
  - Toxicity of oil-dispersant mixtures is caused by the oil not the dispersant

Spill Effects and NEBA

- Overview of Fate and Effects of Oil Spills
  - Untreated spills
  - Chemically dispersed spills
- Understanding risks from dispersants and dispersed oil
  - Risks from Dispersants alone
  - Risks from dispersed oil
- NEBA

Understanding Risks from Dispersed Oil

- Contamination cause by oil spills and dispersants are
  - Localized / Temporary
- When dispersant sprayed on oil they cause:
  - Elevated oil concentrations near slick sprayed
  - Oil concentrations decline quickly by dilution and degradation
- Compare Exposure conditions at sea vs LC50 for dispersed oil
  - Worst case dispersed oil concentrations under slicks =100 ppm
  - How toxic is dispersed oil?



Environmental Risks from Dispersed Oil

Potential Effects

- Lethal, sublethal
  - Only more sensitive species
  - Only surface waters in area sprayed
- Bioaccumulation – localized, limited, quickly lost

- Things to remember about dispersant toxicity
  - Risk is localized and short-lived
  - Exposure concentrations decline quickly; dilution, degradation
  - Bioaccumulation occurs, very quickly lost

Summary: Risk from Dispersant

- Dispersants have measurable toxicity
- Modern dispersants less toxic than *Torrey Canyon* products
- Exposure concentrations below toxic threshold for lethal and sublethal effects
- Toxicity of oil dispersant mix is caused by oil, not dispersant
- Role of dispersant is to increase level of exposure to oil

Summary: Risk from Dispersed Oil

- Contamination caused in real spill
- Taint caused in lab studies at realistic exposure condition
- In *Sea Empress*, no contamination of pelagic fish
- Taint/contamination lost in days

Cont.

Risks-- Summary (cont.)

- Exposure Conditions - Water
  - slick disperses slowly during spraying
  - dispersion slows quickly after spraying stops
  - small droplets mixed quickly to 3- 6 m depth
  - concentrations in mixing layer 1 to 10 ppm
  - dispersed oil, spikes to few 10s ppm
  - elevated concentrations decline in hours to days

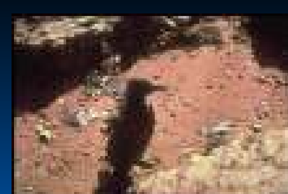
Cont.

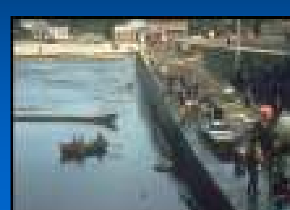
Risks-- Summary (cont.)

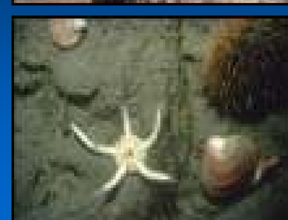
- Toxicity
  - Dispersants themselves pose little risk
  - Initial oil exposures may be toxic for most sensitive species
  - Risks of toxicity are only in upper water under area sprayed
  - Risk of toxicity are localized and short-lived

Cont.

Questions?







Toxicity Effects of Chemically-Dispersed Crude Oil on Fish

Kenneth Lee, Thomas King, Brian Robinson, Zhengkai Li
Fisheries and Oceans Canada, Bedford Institute of Oceanography

Les Burridge, Monica Lyons, David Wong, Ken MacKeigan
Fisheries and Oceans Canada, St. Andrews Biological Station

Simon Courtenay, Sarah Johnson, Monica Boudreau
Fisheries and Oceans Canada, Gulf Region

Peter Hodson, Colleen Greer
Queens University

Albert Venosa
US EPA

Fish Embryo Sensitivity

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



Objectives

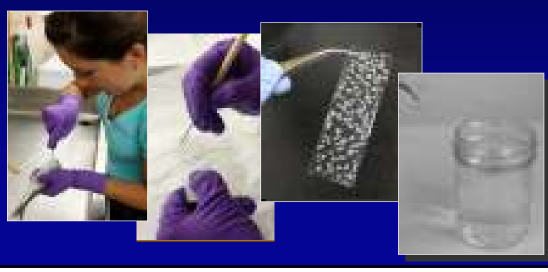
- To evaluate the toxicity of various physically dispersed vs. chemically dispersed oils to fish early life stages
- To use biomarkers
- To be able to compare data using identical protocols

Experimental Parameters

- Test oils, weathered by evaporation and sparging with air:
  - Alaska North Slope (ANS)
  - Medium South American (MESA)
  - Arabian Light (AL)
- Measurements of mortality, hatch, and blue sac disease (BSD) were made for Atlantic and Pacific herring
- Oil toxicity has been linked to alkyl PAHs in the water accommodated fraction (WAF)
- Dispersants Corexit 9500 and SPC-1000 used to create a chemically enhanced water accommodated fraction (CEWAF)
- Measurements of mortality and PAH exposure in juvenile Atlantic cod

Experimental Protocol

- Eggs and milt were obtained from ripe running Pacific herring in British Columbia, and from Atlantic herring in Nova Scotia and New Brunswick
- Fertilized herring eggs were affixed to slides



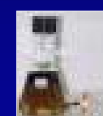
WAF and CEWAF Generation

WAF

- Mix oil and water in baffle flasks on a shaker 18 hours, settle for 1 hour (Singer et al. 2000)
- Drain and make test dilutions 0.01, 0.1, 1.0%, etc. v/v

CEWAF

- Mix oil and water in a baffle flask on a shaker for 18 h (Singer et al. 2000)
- Add dispersant, stir 1 hour and allow to settle 1 hour
- Drain for dilution (0.0001, 0.001, and 0.01% v/v) and testing



Blue Sac Disease (BSD) Features

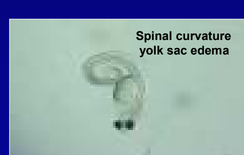
Decreased

- Survival
- Normalcy
- Hatch time
- Heart rate
- Length (mm)
- Swimming ability

Increased

- Pericardial edema*
- Yolk sac edema
- Spinal curvature
- Craniofacial malformation
- Skin lesion

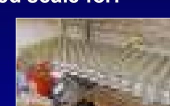
*edema – blue fluid



Scoring BSD

- Embryos were scored within 24 h of hatch
- Scoring for was on a graduated scale for:
  - Pericardial edema
  - Yolk sac edema
  - Spinal curvature

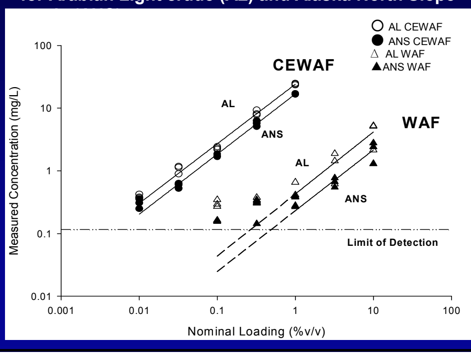
  3 = most severe response, 0 = no response



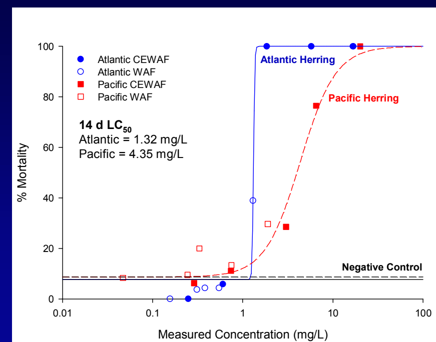
- Fin rot and craniofacial deformities were scored as present (1) or absent (0)
- Number of mortalities

Chemical Analyses

- Chemical dispersion increased concentration of fluorescing hydrocarbons in CEWAF compared to WAF for Arabian Light crude (AL) and Alaska North Slope

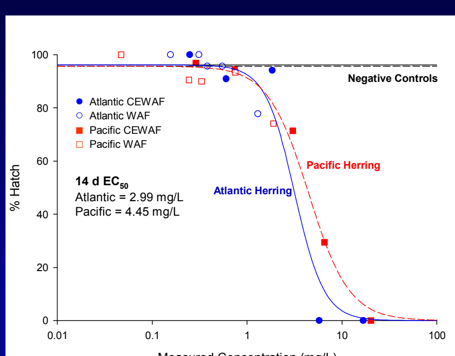


Atlantic vs. Pacific Herring (Lethality)



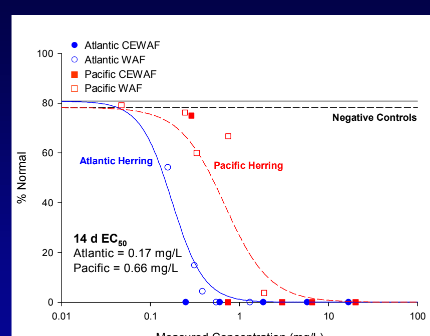
No significant difference **in lethality with ANS**

Atlantic vs. Pacific Herring (Hatch)



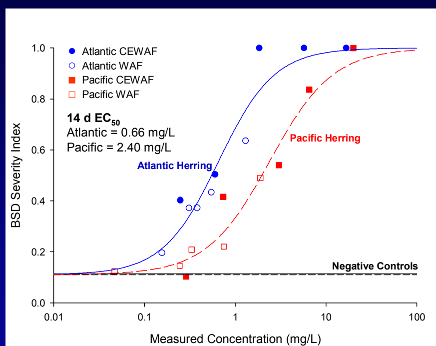
No significant difference **in hatch success with ANS exposure**

Atlantic vs. Pacific Herring (Abnormalities)



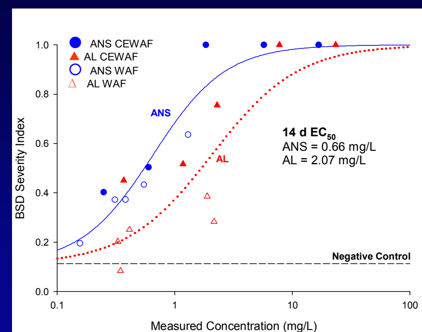
Higher incidence **of abnormalities associated with Atlantic herring embryos (ANS)**

Atlantic vs. Pacific (BSD Severity Index)



Higher incidence **of BSD associated with Atlantic herring embryos (ANS)**

Oil Type: ANS vs. AL (BSD Severity Index)



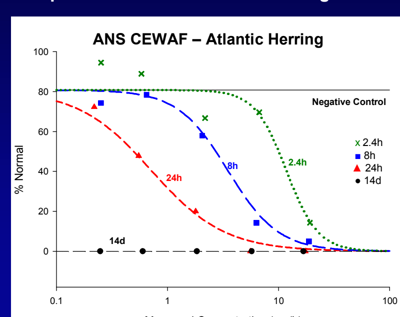
BSD Severity Index *significantly higher* with exposure to ANS vs. AL in Atlantic herring embryos

Oil Toxicity

- **ANS was not significantly more toxic than AL to Atlantic herring for lethality or hatching success**
- **EC_{50} for Normalcy was significantly lower with ANS in comparison to AL**
- **BSD Severity Index:**
  - **significantly higher for Atlantic herring**
  - **significantly higher with ANS in comparison to AL**
- **Overall, there appeared to be no difference in toxicity between MESA and ANS oils for each parameter tested with Pacific herring embryos**
- **Toxicity correlated with the % aromatics in the test oils**

CEWAF Toxicity with Exposure

- **Toxicity increases with exposure time**
- **EC_{50} decreases (*higher toxicity*) over time**
- **Response was similar for Arabian Light crude CEWAF**

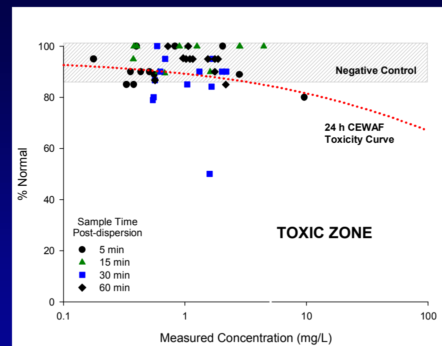


EC_{50}:
2.4 h = 11.74 mg/L
8 h = 3.16 mg/L
24 h = 0.76 mg/L
14 d < 0.25 mg/L

DFO / US EPA Wave Tank

- WAF is generated using breaking waves
- CEWAF is generated by adding the oil and spraying dispersant during breaking wave action
- Can be operated in flow-through mode to simulate natural dilution processes in the environment following dispersant application

Dispersed AL Prepared in Wave Tank



Hydrocarbon concentrations for AL were not high enough to cause toxicity in Atlantic herring embryos

Juvenile Atlantic Cod: Wave Tank Tests

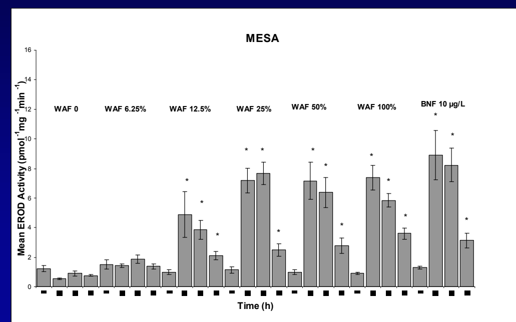
- WAF or CEWAF (~ 10 mg/L) produced with plunging breaking waves was diverted to five 200 L glass aquaria with dilution rate at 100%, 50%, 25%, 12.5%, and 6%
- Two more aquaria were for the negative control and positive control (β -napthoflavone at 10 μ g·L-1)
- Exposure was for 4 h to simulate short-term uptake of dispersed oil followed by transferring fish into flow-through cages to simulate depuration in clean water

Juvenile Atlantic Cod: Wave Tank Tests

- Samples were collected at 0, 4, 24, 48, & 72 h for chemical and biochemical EROD (ethoxyresorufin-*O*-deethylase) activity in fish
    - established indicator (*in vivo* biomarker) of exposure and uptake of contaminants such as polycyclic aromatic hydrocarbons (PAHs)
    - provides evidence of receptor-mediated induction of cytochrome P450-dependant monooxygenases (the CYP1A subfamily specifically) by foreign (xenobiotic) chemicals

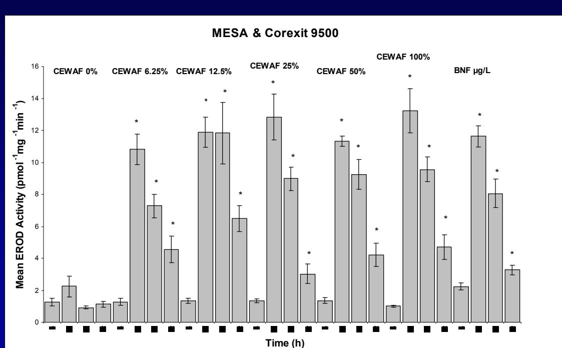
Juvenile Atlantic Cod and MESA WAF

- 24 h were highest for >6.25% test concentrations
- All values <10 pmol^{-1} mg^{-1} min^{-1}



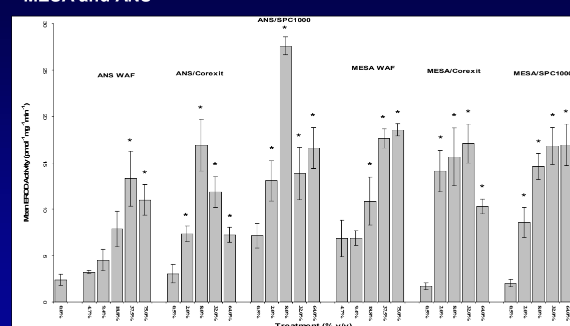
Juvenile Atlantic Cod and MESA CEWAF

- All 24 h values >10 pmol^{-1} mg^{-1} min^{-1}



EROD Response to Oil Concentrations

- Juvenile Cod 24 h after a 4 h exposure to WAF and CEWAF of MESA and ANS



- Increased concentrations elevated EROD activity

Atlantic Cod Response

- All fish survived, there was no mortality to either WAF or CEWAF
- Maximum EROD induction occurred at 24 h
- EROD activity remained elevated over 48 h, but declined relative to the 24 h sample
- WAF significantly affected EROD activity only at the highest concentrations
- CEWAF induced higher levels of EROD activity at 24 h than WAF

Ecological Relevance

- These preliminary studies were conducted with oil exposure under static conditions

  Dose response curves can be established.
  What's their ecological relevance?

- Actual concentrations encountered in the field during response operations may be below toxicity threshold limits observed in the laboratory experiments
- ANS CEWAF EC_{50} values of <1mg/L were only evident with exposure times exceeding 24h
- Future multi-trophic level studies and monitoring programs during spill events should be conducted in the wave tank operated in the continuous flow mode to account for the influence of natural dilution processes

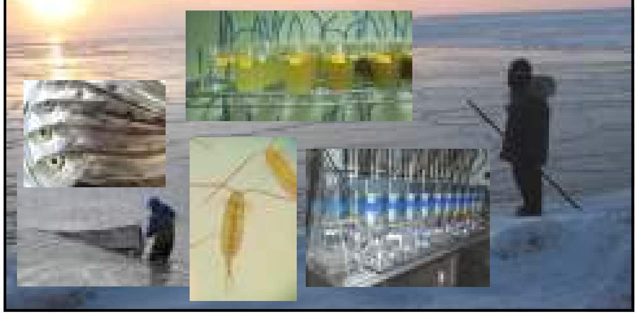
Toxicology and Biodegradation of Dispersed Oil in the Arctic Marine Environment

Joint Industry Program Research

BREA Workshop Inuvik, Canada

25-28 July 2011

Jack Q Word – NewFields NW



Program Management

Barrow Arctic Research Center
Barrow, Alaska

Sponsoring Partnership & Representatives

- *Shell Exploration & Production Company*
  - *Victoria Broje*
- *ExxonMobil Upstream Research Company*
  - *Tim Nedwed*
- *Statoil Petroleum ASA*
  - *Hanne Greiff Johnsen*
- *ConocoPhillips*
  - *Becky Silves*
- *BP*
  - *Oliver Pelz*

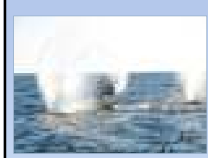
Technical Advisory Committee

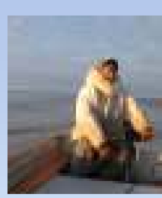
USCG, NOAA, USEPA, ADEC, NSB, CEDRE, UAF, COOGER, SINTEF, AkvaPlan Niva, BOERME

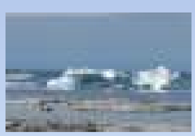
Research Partners

NewFields, UAF, BASC, BARC, Alpha Analytical, LGL

JIP Arctic Testing Program



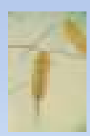




Goals of the Cold-water Testing Program:

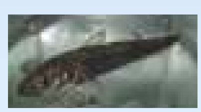
Evaluate toxicity and biodegradation of physically and chemically dispersed ANS using organisms indigenous to the Beaufort and Chukchi ecosystem

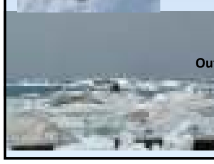
Primary Toxicity Questions



- What are toxicity responses of valuable ecosystem components?
- Are key Arctic and temperate species equally sensitive to petroleum?
- What are the primary constituents associated with toxicity?
- What is the toxicity of the dispersant?

All of this information is provided on an open-access ftp website that is updated regularly





Primary Biodegradation Questions

- Will indigenous microbes collected from pelagic marine waters degrade petroleum?
- Will application of dispersants alter the biodegradation of fresh or weathered oil?
- What are the primary biodegraded constituents?

Output for toxicity and biodegradation studies will be used in Net Environmental Risk Analysis for oil spill response planning

Approach for Toxicity Testing

Held Technical Workshop in Anchorage AK to discuss state of the science and frame central study questions

Identified target species represent the base of the Arctic food web:

- **Copepod (*Calanus glacialis*)**
- **Arctic Cod (*Boreogadus saida*)**
- **Larval fish (*Myoxocephalus* sp.)**

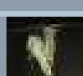
Follow established methods with revisions to mimic Arctic, open-water conditions

- **Spiked exposures of fresh oil with 4 hour half-life**
- **Extended test duration to allow for delayed effects**
- **Physically Dispersed** Water Accommodated Fraction (WAF) Breaking-wave WAF (BW-WAF)
- **Chemically Dispersed** Chemically Enhanced WAF (CEWAF)

Chemical Analysis on Test Solutions:

Total Petroleum (TPH), saturated hydrocarbons, and PAHs

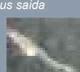
Key Species Selected for Arctic Toxicology Testing



Calanus glacialis

Boreogadus saida

Myoxocephalus sp

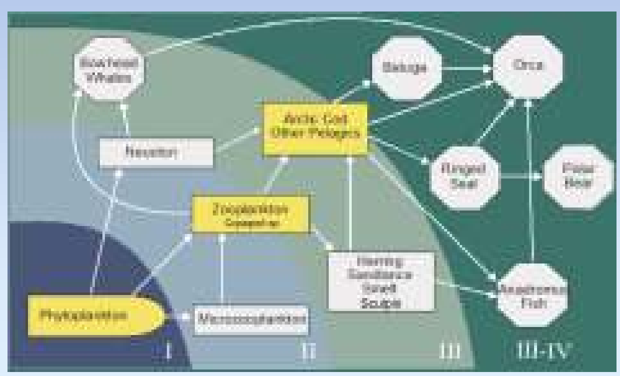


Euphasia pacifica

Bioassay Testing @ 0 ± 1 ° C

- *Calanus glacialis* – pelagic copepod representing significant Tier II food web contribution to Arctic invertebrates, fish, marine mammals and seabirds.
- *Boreogadus saida* – marine fish representing important Tier III food web contribution to Arctic fish, marine mammals and seabirds
- *Myoxocephalis sp* – marine/estuarine fish representing Tier III food web contribution to Arctic fish, marine mammals and seabirds.
- *Euphasia pacifica* – pelagic krill species representing important Tier II food web contribution to Arctic fish, marine mammals and seabirds

Shortened Food Webs in the Arctic and Valuable Ecosystem Components



Toxicology Testing

Copepods - *Calanus glacialis*:

- 6 tests with WAF and CEWAF in fall
- 6 tests with CEWAF, WAF and BWWAF in late spring
- 12 day endpoint

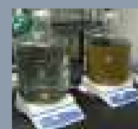
Fish: Arctic Cod (*Boreogadus saida*)

- 60 – 130 mm fish
- 4 tests with CEWAF; 3 tests with WAF and BWWAF
- 4 day endpoint; little change between 4 and 12 days

Fish: Sculpin (*Myoxocephalus* sp.)

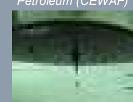
- 10-15 mm fish (30 to 60 days old)
- 4 tests with CEWAF, WAF and BWWAF
- 4 day endpoint; little change between 4 and 12 days

Methods – Test Preparations



Physically and Chemically Dispersed Petroleum Preparation

Chemically Dispersed Petroleum (CEWAF)



Physically Dispersed Petroleum (WAF)

WAF and CEWAF Preparation

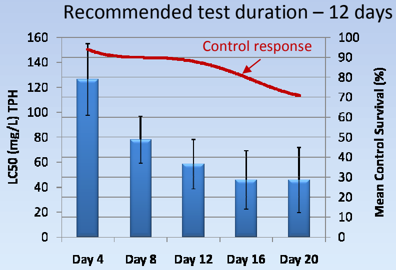
- WAF made with 1:100 dilution of fresh ANS to seawater
- CEWAF made with 1:20 dispersant to oil ratio (Corexit® 9500)
- 18 hours of mixing with 6 hour "resting" period

Breaking Wave-WAF Preparation

- Goal: to increase energy in physical dispersal preparation
- BW-WAF made with 1:100 dilution of ANS to seawater
- Shaking of oil-water mixture by rocking carboy for 30 seconds every 15 minutes for the first two hours of the mixing period.
- 18 hours of mixing with stir plates with 6 hour "resting" period

Test Duration – Sensitivity Over Time

Copepod: Increased sensitivity between Days 4 and 12
Increased control mortalities beyond Day 12
Recommended test duration – 12 days



Fish: No change in sensitivity between Days 4 and 12; use 4-day

Copepod Tests

WAF preparations

- Generally insufficient to elicit a response

BW-WAF preparation

- Higher TPH concentrations sufficient to elicit a response
- LC50s ranged from 2 to 3.2 mg/L TPH

CE-WAF preparation

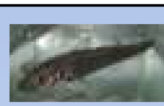
- Dose-response observed in all tests
- Late Season LC50s ranged from 30 to 79 mg/L TPH
- Early season LC50s ranged from 10 to 32 mg/L TPH

Chemically dispersed oil less toxic than physically dispersed ANS

Spring copepods less resilient than fall copepods

Treatment	Early Season	Late Season
CEWAF	**22** (9.5)	**62** (21)
WAF	NC	NC
BW-WAF	**4.0** (1.1)	--

Fish Tests



WAF preparations

- Generally TPH sufficient to elicit a dose-response for fish
- LC50s for Arctic cod: 1.4 to 2.7 mg/L TPH
- LC50s for Sculpin: 1.2 to 3.2 mg/L TPH

BW-WAF preparation

- Dose-responses similar to WAF; no significant difference
- LC50s for Arctic cod: 2.6 to 4.9 mg/L TPH
- LC50s for Sculpin: 1.7 to 5.8 mg/L TPH

CE-WAF preparation

- Cod more resilient than copepods or sculpin
- LC50s for Arctic cod: 45 to 80 mg/L
- LC50s for Sculpin: 17 to 50 mg/L

Treatment	Arctic Cod	Larval Sculpin
CEWAF	**55** (17)	**28** (14)
WAF	**1.6** (0.4)	**2.3** (1.0)
BW-WAF	**3.3** (2.2)	**4.0** (1.7)

Chemically dispersed oil less toxic than physically dispersed ANS per Unit of oil

Dose-Responses for TPAH

Copepods			Cod			Sculpin		
Spring	Fall							
CEWAF	CEWAF	BWWAF	CEWAF	WAF	BWWAF	CEWAF	WAF	BWWAF
1.2	0.3	0.1	2.5	0.06	0.07	0.3	>0.05	0.08
0.8	0.4	0.1	--	0.07	0.12	0.3	0.07	0.12
0.6	0.6	0.1	0.9	0.05	0.09	0.8	0.08	0.14
0.3	0.5	NC	1.2	NT	NT	0.9	0.08	0.16
1.3	0.1	0.3	**1.54**	**0.06**	**0.09**	**0.57**	**0.08**	**0.13**
	0.2	0.1						
0.83	**0.36**	**0.14**						

- No calculable LC50s for WAF for copepods
- Responses in WAF and BWWAF not significantly different
- LC50 in chemically dispersed ANS consistently higher than physically dispersed ANS

Comparison of CEWAF and WAF Toxicity in Other Studies

Test Species	Common Name	Mean LC_{50} (mg/L TPH) WAF	CEWAF	Ratio of CEWAF to WAF
Sciaenops ocellatus	Red drum	0.85	4.2	**4.9**
Scophthalmus maximus	Turbot	1.3	48.6	**36.5**
Crassostrea gigas	Pacific oyster	1.8	2.3	**1.3**
Americamysis bahia	Mysid	3.4	28	**8.2**
Menidia beryllina	Inland Silverside	8.5	26	**3.1**
Chionocetes bairdi	Tanner Crab	9.7	13	**1.3**
Atherinops affinis	Topsmelt	22.8	18	**0.8**
This Study				
Calanus glacialis	Copepod	3.7	22	**5.9**
Myoxocephalus sp.	Sculpin	3.4	28	**8.2**
Boreogadus saida	Arctic cod	2.4	55	**22.9**

Comparative Toxicity of Spiked Petroleum & Dispersants

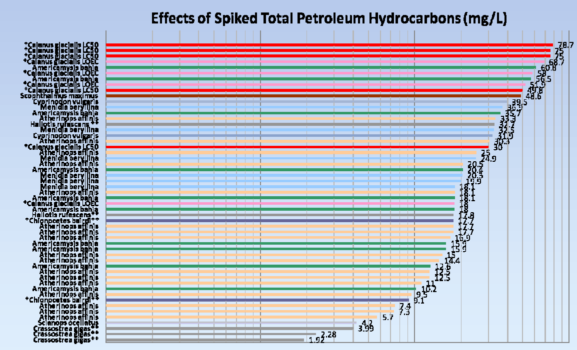
1. Younger stages are more sensitive
2. Corexit 9500 is ~100-fold less toxic than PAH
3. Corexit 9500 is ~3-fold less toxic than total petroleum
4. WAF and CE WAF preparations are equally toxic based on petroleum measurements
5. Arctic species (*C. glacialis* is less sensitive than temperate copepod (*E. affinis*)

Species	LC_{50} (µg/L) Total PAH -- Aurand et al 2009 (green shading)					
	Corexit 9500		WAF		CE WAF	
	24h	48h	24h	48h	24h	48h
Eurytoma affinis Copepod	19,200	15,300	28	79	60	51
Copepodite	14,600	9,600	32	46	43	15
Nauplii	9,500	6,300	81	16	40	10

Species	LC_{50} (ug/L)- JIP Program Results		
	Corexit 9500	WAF (PAH)	CE WAF (PAH)
Calanus glacialis (4 d)	~50,000 to 125,000		
Calanus glacialis (12 d)	~20,000 to 50,000		~500 to 1,000

Species	96h LC_{50} (ug/L) – Fuller and Bonner, 2001 (pink shading) JIP study light green shading		
	Corexit 9500	WAF (TPH)	CE WAF (TPH)
Menidia berylina	40,000 to 117,000	>14,500 to 32,300	24,900 to 36,900
Mysidopsis bahia (=Americamysis)	500,000 to 1,305,000	26,100 to 83,100	56,500 to 60,800
Cyprinodon vulgaris	593,000 to 750,000	>5,700	31,900 to 39,500
Vibrio fisheri	104,000 to 242,000	700 to 1,300	12,800 to 27,900
Calanus glacialis	20,000 to 125,000	3,700	22,000
Myoxocephalus		3,400	28,000
Boreogadus saida		2,400	55,000

Comparative Toxicity of Petroleum in Arctic, Subarctic and Temperate Regions



Red Bars show Arctic species response

Comparing Arctic and Non-Arctic Species

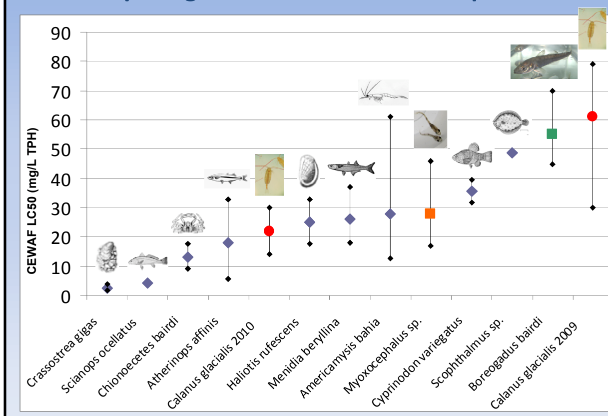
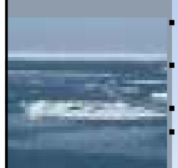


Table 3-18. Summary of LC_{50} Data for Corexit® 9500.

Test Species	Test Duration	LC_{50}/EC_{50} *(mg/L)*	Reference
Acartia tonsa	48h	34	Nalco MSDS
Artemia	48h	20.7	
Haliotis larva	48h	12.8 - 19.7	Singer et al. 1996
Holmesimysis costata	96h	158 - 245	
Menidia beryllina	96h	25.2	USEPA 2010 (Corexit® 9500A)
Mysidopsis bahia	48h	32.23	
Menidia beryllina	96h	130	Hemmer et al. 2010a,b
Mysidopsis bahia	48h	42	
Eurytoma affinis – copepods	24/48h	19.2/15.3	Aurand et al. 2009
Eurytoma affinis – copepodites	24/48h	14.6/9.6	
Eurytoma affinis – nauplii h	24/48h	9.5/6.3	
Eurytoma affinis –	12/33d	NOEC = >6.9	
Menidia beryllina	96h - spiked	41-117	Fuller and Bonner 2001; Fuller et al 2004
Americamysis bahia (Mysidopsis bahia)	96h - spiked	500- 1,305	
Cyprinodon variegatus	96h - spiked	593 - 750	
Vibrio fisheri	15 min	104 - 242	
Chionocetes bairdi (<24h larva)	96h	1267	Rhoton 1999
Mysidopsis bahia (6 day old)	96h	331	
Menidia beryllina (12 day old)	96h	115.2	
Fundulus grandis (subadult)	96h	172	Liu 2003
Litopenaeus sertiferum (subadult)	96h	31	
Ostrea edulis (subadult)	96h	167	
Calanus glacialis	96h LC_{50} Spiked	50-125	This Report
Calanus glacialis	96h LC_{50} Spiked + 8 d	20 - 50	

Arctic Toxicity Findings



- Pelagic organisms respond to the concentrations of petroleum in the water column (PAH)
- Although total oil in chemically dispersed ANS is higher than physically dispersed ANS, per unit toxicity is lower
- Dispersant concentrations do not add to the petroleum toxicity at recommended dispersant oil ratios (DOR 1:20)
- Dispersant (Corexit 9500) by itself at recommended use rates does not show significant toxicity to copepods
- Dispersant is ~10-fold lower toxicity than petroleum
- Toxicity is expressed over longer periods of time for Arctic copepods versus subarctic and temperate species (12 versus 4 days).
- Arctic species show equal or less sensitivity to petroleum exposure than temperate species after appropriate exposure periods.
- We have developed a 'breaking wave WAF' procedure that physically disperses petroleum into the water column sufficiently to produce biological effects based concentrations.

Approach for Biodegradation Testing

- Held Technical Workshop in Anchorage AK to discuss state of the science and frame central study questions
- Literature was equivocal on whether biodegradation occurs at the cold water temperatures and conditions in the Arctic
- Follow established methods with revisions to mimic Arctic, open-water conditions
  - Indigenous pelagic microbes collected in Beaufort and Chukchi Seawater – no pretreatment or augmentation of microbes
  - Temperatures represent open water (spring, summer and fall conditions) – ice not included in initial assessments of biodegradation
  - Weathered and unweathered petroleum with and without the addition of dispersants or small quantities of nutrients (nitrogen and phosphorus compounds generally missing in oil but present in the ocean)
  - Multiple assessment methods to address 'biodegradation'
- Analysis of Biodegradation Effectiveness
  - CO_2 Generation and Mineralization Assessment
  - Analytical chemistry (Total Petroleum, alkane and PAH)

Key Biodegradation Research Objectives

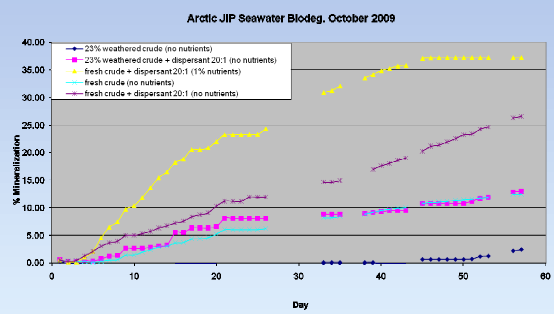
Respirometer

- ✓ Demonstrate biodegradation of petroleum in the Arctic under Arctic conditions (+5 to -2° C; 24 hour illumination and 24 hour darkness; ice-free) with indigenous microbes contained in natural seawaters. Temperatures reflect summer and winter conditions.
- ✓ Determine success of biodegradation of petroleum with and without dispersant application.
- ✓ Determine effect of weathering on biodegradation.

Biodegradation Assessment

- Respirometry measures CO_2 production and evaluates mineralization of carbon containing compounds via this pathway.
- Analytical chemistry examines the components of petroleum that are extractable within a specific solvent and then measureable using GC with various types of detectors
- Microbial biomass indicates the uptake of carbon to produce this community.

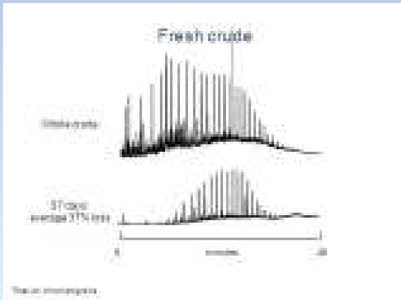
Respirometry Consumption of Oxygen and Mineralization - Fall 2009 Study



Weathered crude oil in the presence of dispersant uses more oxygen, indicating greater biogenic activity and mineralization.

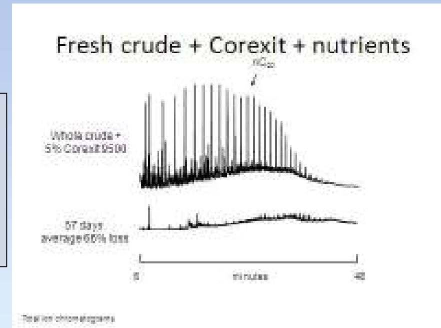
Chemical Assessment of Total Oil Loss During Incubation

Biodegradation of petroleum after 57 days of incubation in the absence of dispersant and nutrient. Some losses are seen (~37%)



Chemical Assessment of Total Oil Loss During Incubation

Substantial reduction of total oil over 57 days of incubation for dispersed petroleum + nutrients. Approximately 66% reduction in petroleum contaminants.



Biodegradation of Petroleum and Dispersed Petroleum - Arctic Conditions

(after 57 days in incubator; measured by GCMS)

	% Loss
weathered	25.7
weathered + Corexit	30.3
fresh	37.2
fresh + Corexit	56.0
fresh + Corexit + nutrients	65.6

Arctic Biodegradation Findings

- Indigenous microbes in natural Arctic seawater, at natural Arctic conditions degrade petroleum hydrocarbons
- The lab studies indicate that there is a lag phase followed by biodegradation (respirometry) which are comparable to rates under laboratory temperate conditions
- Respirometry measures biodegradation not volatilization because flasks are sealed with limited head space
- Fresh oil biodegrades more rapidly than weathered oil
- Respirometry is a good surrogate for estimating rates of biodegradation of total oil to CO_2 – chemistry evaluates degradation of individual components of oil
- The dispersant (Corexit 9500) does not inhibit biodegradation
- Chemically dispersed fresh oil degrades more rapidly than chemically dispersed weathered oil
- Biodegradation of chemically dispersed fresh oil removes >60% of the chemically measured components over a period of 57 days under Arctic conditions with natural seawater and it's component microbes

Environmental Risk Assessment Considerations

Sea Surface

- Concentrations of oil components in fresh surfaced materials are at maximum
- Chemical dispersion of petroleum (especially fresh oil) will reduce the quantity of oil on the surface of the water
- Surface oil will be transported principally by wind , and may collect on shorelines or in convergence zones
- Biodegradation of surface oils is thought to be reduced when oil is thicker or emulsified
- Surfaced petroleum is more exposed to UV stimulation
- Surface layers are abundantly occupied by multiple groups of organisms (larvae and eggs of many species as well as seabirds and marine mammals)
- Exposure concentrations are highest but exposure time may vary from continuous to intermittent depending on surface oriented behaviors of species and different life stages

Pelagic (upper 10m)

- Fresh oils in bulk waters will have low concentrations of soluble petroleum compounds
- Pelagic waters (upper 10M) will have increased concentrations of petroleum after dispersion
- Exposure times will vary based on behavior of organisms and their life stages and transport within or movement of organisms through petroleum/dispersant plumes
- Dispersed petroleum will be transported and diluted in three dimensions during transport via subsurface currents
- Chemically or physically dispersed petroleum is in the form of small globules with increased surface area
- Biodegradation is presumed to occur more rapidly with greater surface area

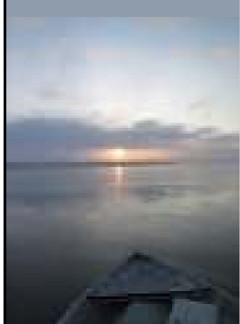
Toxicity Summary

Winter - Bear Guard

Winter -Close up of Pressure Ridge Ice

- Arctic species that have been tested with petroleum and Corexit exposures react with similar or increased resilience than temperate species.
- When results from this JIP research are compared to results provided by Akvaplan Niva and CROSERF, similar trends are evident.
- Chemically dispersed oil effects are less than physically dispersed oil toxicity on a per unit petroleum basis
- Corexit 9500 has an order of magnitude less toxicity than oil by itself

Biodegration Summary



Summary – Open Water Conditions

Photo credit: all photos taken by Jack D Word

- ✓ Petroleum biodegrades in the Arctic with indigenous microbes in pelagic waters under summer and winter conditions.
- ✓ Chemical dispersants appear to enhance the completeness of degradation of measured components in oil over undispersed petroleum
- (~60 % compared to <30 %);
- ✓ Degradation of weathered oil occurs at slower rates than fresh oil

Dispersion of Oil released from the Deepwater Horizon MC 252 Oil Spill following Subsurface Injection of Corexit 9500

Kenneth Lee
Centre for Offshore Oil, Gas and Energy Research (COOGER)
Fisheries and Oceans Canada
Ken.Lee@dfo-mpo.gc.ca

Fisheries and Oceans Canada Pêches et Océans Canada

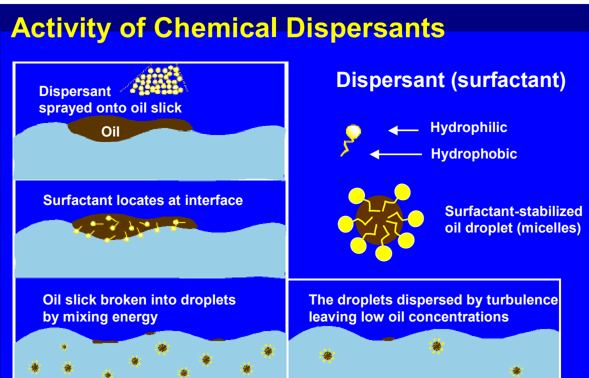
DFO Oil Spill Countermeasure Research

By the conduct of laboratory, mesocosm and "controlled oil spill" experiments in the field, DFO developed oil spill countermeasure technologies (bioremediation, phyto-remediation and surf-washing) and methodologies to quantify habitat recovery

Why Chemical Dispersants?

- There is no single response technique that is suitable for all circumstances
- Oil spill responses:
  - Booming and skimming
  - *In-situ* burning
  - Bioremediation
  - Chemical dispersion
- At open sea, dispersant use attracts most attention due to restrictions to other methods

Activity of Chemical Dispersants



Surfactant reduces the oil-water interfacial tension by orienting the interaction of hydrophilic groups with the water phase and the hydrophobic groups with oil

Reduced oil-water interfacial tension facilitates the formation of a large number of small oil droplets that can be entrained in the water column

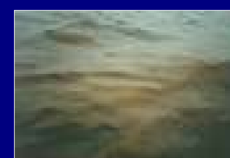
Chemical Constituents (Dispersant – Corexit)

CAS #	Name	Common Day-to-Day Use Examples
1338-43-8	Sorbitan, mono-(9Z)-9-octadecenoate	Skin cream, body shampoo, emulsifier in juice
9005-65-6	Sorbitan, mono-(9Z)-9-octadecenoate, poly(oxy-1,2-ethanediyl) derivs.	Baby bath, mouth wash, face lotion, emulsifier in food
9005-70-3	Sorbitan, tri-(9Z)-9-octadecenoate, poly(oxy-1,2-ethanediyl) derivs.	Body/Face lotion, tanning lotions
577-11-7	* Butanedioic acid, 2-sulfo-, 1,4-bis(2-ethylhexyl) ester, sodium salt (1:1)	Wetting agent in cosmetic products, gelatin, beverages
29911-28-2	Propanol, 1-(2-butoxy-1-methylethoxy)	Household cleaning products
64742-47-8	Distillates (petroleum), hydrotreated light	Air freshener, cleaner
111-76-2	** Ethanol, 2-butoxy	Cleaners

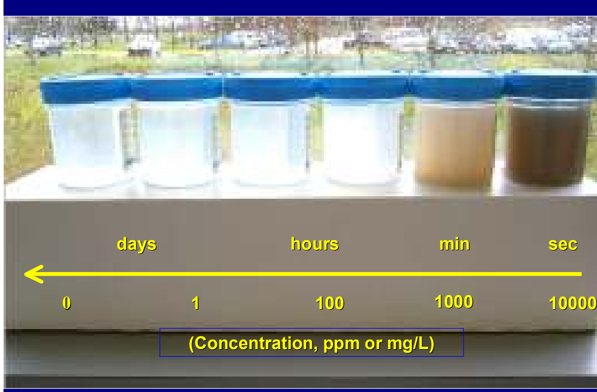
* Contains 2-Propanediol
** Ethanol, 2-butoxy-) is absent in the composition of COREXIT 9500

Enhanced Dispersion for Oil Spill Response

- Based on the concept of transferring oil from the sea surface into the water column, as small oil droplets
- These are diluted by natural processes to concentrations below toxicity threshold limits
- Dispersed oil droplets are degraded more rapidly by natural bacteria
- Achieved with chemical oil dispersants and/or facilitation of oil mineral aggregate formation



Dispersion and Dilution of Oil



DFO Research Priorities

Uncertainties remain high regarding dispersant use at sea

- Dispersant efficacy at different sea states is not clear
- Biological effects of dispersed oils are poorly understood

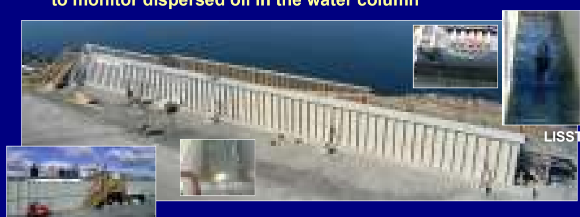
National Research Council (NRC) Committee on Understanding Oil Spill Dispersants: Efficacy and Effects (2005) Identified two factors to be addressed in oil dispersant efficacy studies:

- Energy dissipation rate (turbulence/sea state conditions)
- Particle size distribution and mass balance

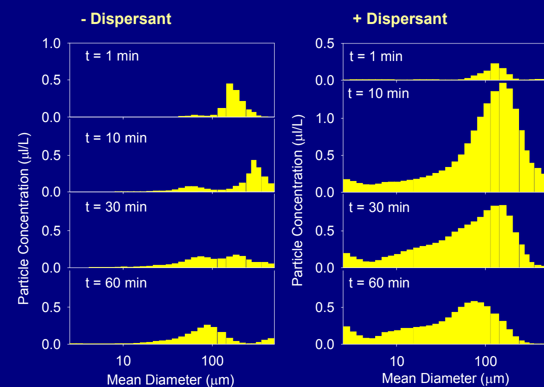
To address this issue, a wave tank facility was constructed by Fisheries and Oceans Canada (DFO) and the U.S. Environmental Protection Agency (EPA)

BIO Wave Tank

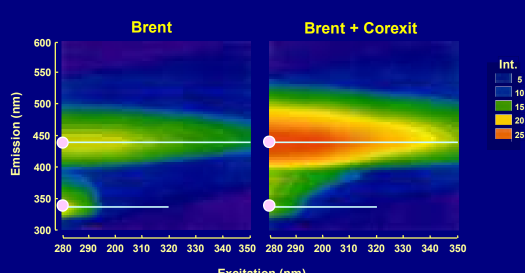
- Constructed with co funding from DFO A-Base, PERD, NOAA, US MMS, PWSRCAC.
- Tidal current simulation by vertical manifolds along the sides of the tank
- Reproducible breaking waves produced (of known energy dissipation rate) at precise locations along length of tank
- Development of experimental protocols and instrumentation to monitor dispersed oil in the water column



Oil Droplet Size Distribution



Oil Fluorescence – 3D Spectra



The 3D spectra can be summarized as the ratio of Slope or Em intensity at 340 nm divided by intensity at 445 nm. (FIR)

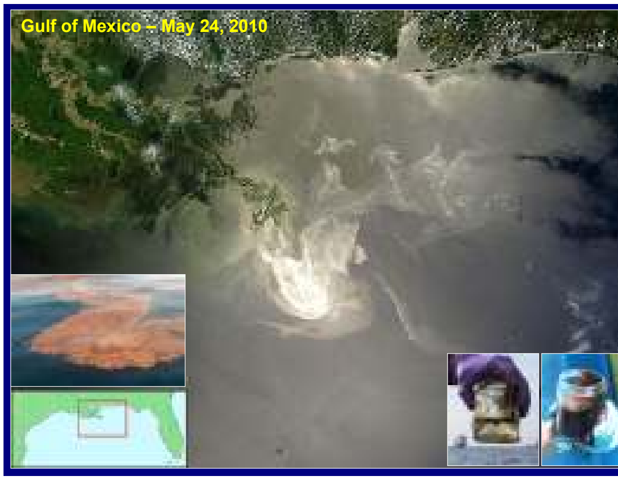
Gulf of Mexico Oil Spill

The Deepwater Horizon oil spill is the largest accidental marine oil spill in the history of the petroleum industry.

- Occurred as a result of an explosion on the Deepwater Horizon drilling rig, April 20, 2010. The explosion killed 11 platform workers and injured 17 others.
- On July 15, the leak was stopped by capping the wellhead which had released 4.9 million barrels (780×103 m3) of crude oil.
- On September 19, the relief well process was successfully completed and the federal government declared the well "effectively dead".

DWH Oil Spill Peak Statistics

- 4.9 million bbls of oil discharged
- 1.8 million gallons of dispersants used
- 411 in-situ burns conducted (265,450 bbls of oil burned)
- 48,200 responders
- 9,700 vessels (6,500 government owned)
- 127 surveillance aircraft
- 3.8 million ft of hard boom deployed
- 9.7 million ft of soft boom deployed



Encounter Rate is Key to Offshore Response

Application of Oil Dispersants - GoM

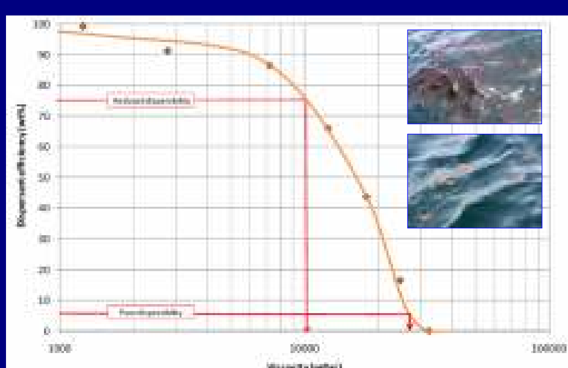
- Based on discharge rates - final estimate of 53,000 barrels per day (8,400 m^3/d) - each day the Gulf of Mexico Oil Spill would be considered a major incident
- In addition to mechanical recovery techniques (skimming and booming) and in situ burning, oil dispersants were used to prevent landfall of the oil in the Deepwater Horizon Spill
- Beginning in early May responders began injecting dispersants at the source of the release (~1500m depth) to reduce oil from reaching the surface
  - Advantages of subsurface injection:
    - Reduced VOCs (volatile organic compounds)
    - Reduced Oil Emulsification
    - Volume of dispersant needed

Dispersant Application on the Sea Surface

- Dispersant was applied from vessels by spraying when VOC levels near the source site reached unacceptable levels, enabling work to continue on the drilling and containment rigs/vessels

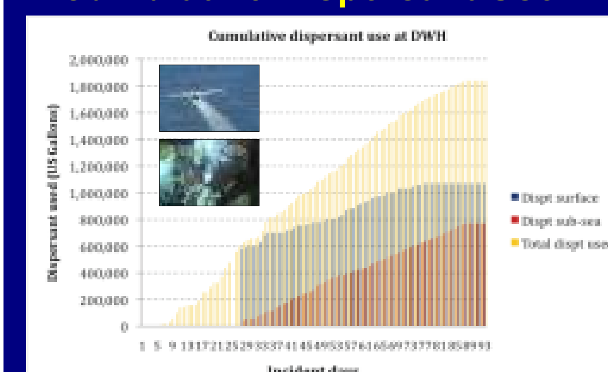
Subsurface Injection of Dispersants

Dispersant Effectiveness vs. Viscosity



Source: SINTEF

Cumulative Dispersant Use



* 4,200,000 L of dispersant added by subsurface injection

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

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

Following review by the RRT….

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

DFO COOGER was requested by US EPA to provide scientific expertise to implement the directive

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

DFO Sampling Effort

	Person Days	Stations	Samples
May	91	68	1020
June	136	107	1674
July	136	65	1060
August	143	92	1439
Total	**506**	**320**	**5193**

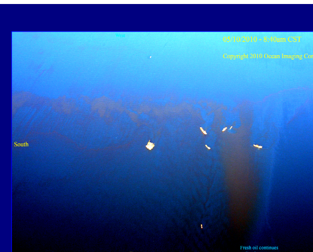
* Cost recovery from the U.S. Government with BP as the responsible party accountable for all cleanup costs

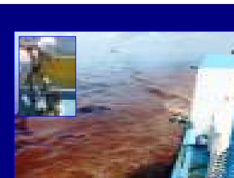

R/V Ocean Veritas

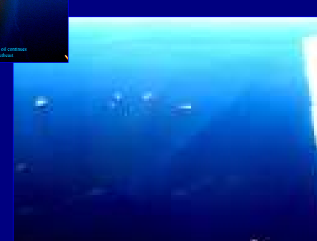

R/V Brooks McCall

Dispersant Monitoring and Assessment for Subsurface Dispersant Application

- **Directives issued by US EPA and USCG required BP to implement a monitoring and assessment plan for subsurface and surface use of dispersants**
  - **Shutdown Criteria**
    - **Significant reduction in dissolved oxygen (< 2 mg/L)**
    - **Rotifer acute toxicity tests**
- **Later addenda to implement SMART Tier 3 Monitoring Program**
  - **Droplet size distribution (LISST)**
  - **CTD instrument equipped with CDOM fluorometer**
  - **Discreet sample collection to measure fluorometry (FIR)**
  - **Eliminate surface application altogether**
  - **Subsea limited to < 15,000 gpd**





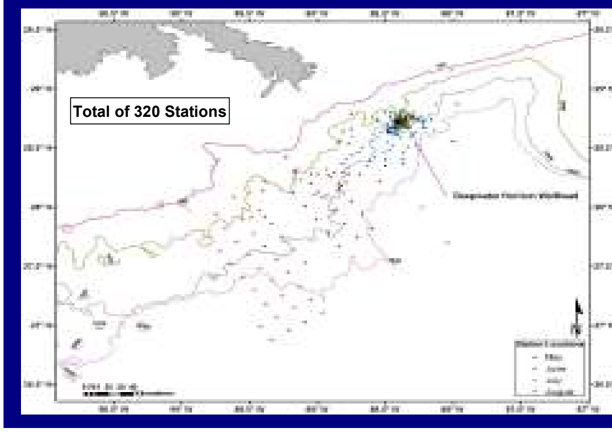


Joint Analysis Group (JAG)

Surface and Subsurface Oceanographic, Oil, and Dispersant Data

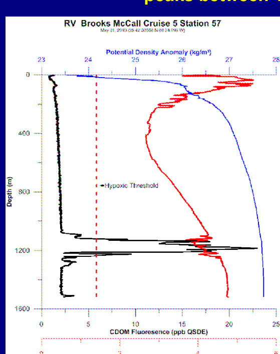
- Working group of scientists from EPA, NOAA, OSTP, BP and DFO
- Analyze an evolving database of sub-surface oceanographic data by BP, NOAA, and academic scientists
- Near term actions:
  - Integrate the data
  - Analyze the data to describe the distribution of oil and the oceanographic processes affecting its transport
  - Issue periodic reports

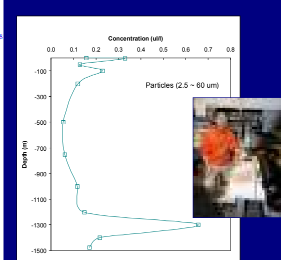
DFO Station Locations



Vertical Profile - DO_2 Depression

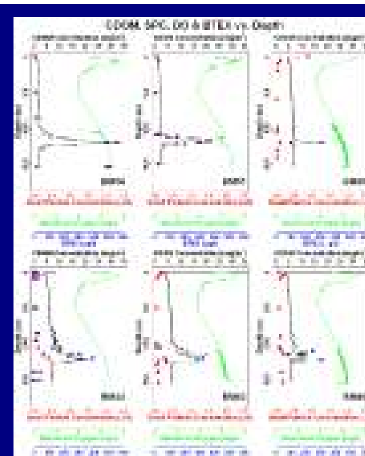
(coincident with fluorescence and <60µm LISST particle count peaks between 1100 and 1200 m)





Small particles (2.5 - 60µm) were indicative of oil droplets in the subsurface plume

Sub-surface Oil Profiles



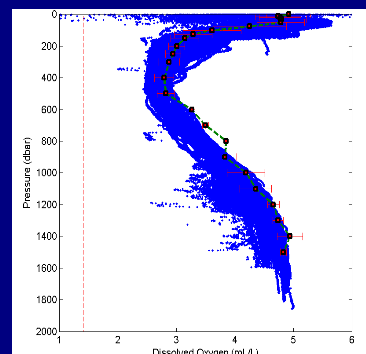
Oil Chemistry

Results as number in concentration range for subsurface plume samples (1000 – 1300 m Depth)

Concentration (ppb)	Total VOA	TPH
<10	1484	1836
10 - 100	104	33
100 – 1,000	129	0
> 1,000	16	0

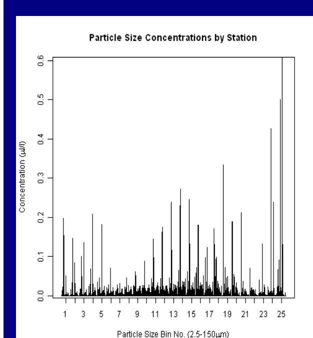
These results represent the chemistry results for 2779 individual samples from May 8 – July 22, 2010.

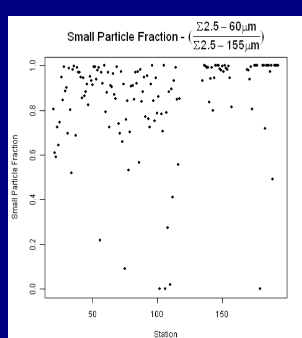
Level and Trend in DO_2 Depressions



Total of 419 DO_2 profiles compared to annual mean climatology

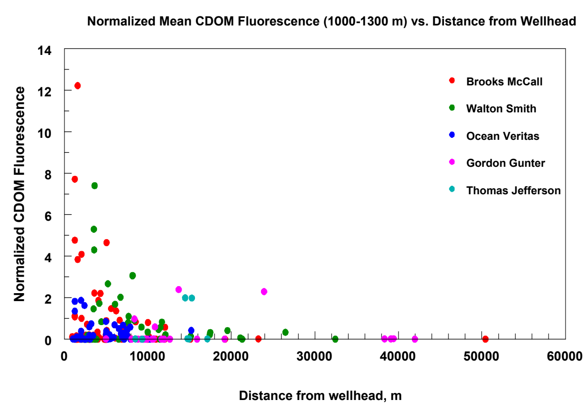
Particle Size Data
R/V Brooks McCall - Plume



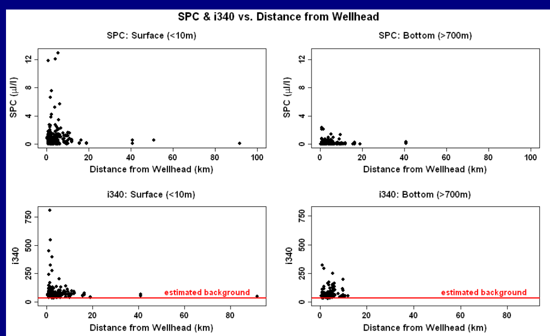


Plume = maximum small particle concentration below 800m

CDOM (Colored Dissolved Organic Matter Fluorescence)



UV-Fluorescence



Fate of Dispersed Oil Droplets

Source: *http://www.response.restoration.noaa.gov*

Analysis of Near-field Oil Droplet Data

(JAG Analysis DFO Data: Dr. J.A. Galt, NOAA, HAZMAT)

- **Within 15 km of the well and below 1000 m oil droplet concentrations (< 65 microns) were fully consistent with an essentially neutrally buoyant plume.**
- **The plume was filamentous, a significant fraction of the bottle casts missed it and thus exhibited little or no oil in droplet form. Significant non-zero sample results, assumed to be within the filaments, showed total droplet volumes in the 10 ppm range with a max observed value of 16 ppm.**
- **Observed values appeared to drop off by an order of magnitude within 10 km. If we use this as a rough scaling distance for the mixing and dilution of the oil droplet filaments or plume then we would expect to have total droplet concentrations reduced to the ppb level within about 40 km.**
- **Although this is a rough estimate it is consistent with the bulk of the available observations and by the time the droplets get 40 kilometers away numerous other physical and biological processes will start to alter the state and composition of the plume.**

Fate of the Oil: GOM spill

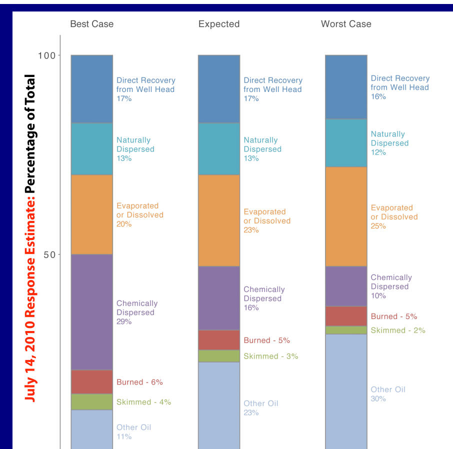
Response estimates expressed as % cumulative volume of oil discharged in the best, expected, and worst cases

Oil Budget Calculator

October 2010

NOAA (National Oceanic and Atmospheric Administration)

Other: Remaining oil is at the surface as light sheen or weathered tar balls, biodegraded, or already came ashore



Future of Dispersant Use

- The ability to effectively deploy and monitor an unprecedented dispersant response in the GoM was based on the past decades' improvements
- Misperceptions and knowledge gaps over their use remain. Areas for improvement include:
  - Need to be a common understanding of the risks and benefits of dispersant use, as well as the safety and effectiveness of dispersant products
  - Additional research is needed on the behavior and long term fate of dispersed oil in the water column when dispersants are applied at the sea floor
  - Conduct of field trials to advance and validate existing knowledge

National Energy Board — Office national de l'énergie

Response Planning Participation: ISR Communities, Industry and Government Agencies

July 26, 2011 Inuvik, NT
BREA Oil Spill Dispersant Workshop

John Korec, EP, P.Geol., Environmental Specialist
Robert LeMay, MEP, Emergency Management Specialist

Canada

DM # 533231

National Energy Board — Office national de l'énergie

Oil and Gas Regulator

The NEB

- Independent federal energy regulator, based in Calgary, Alberta
- Regulates federal energy projects, including
  - international and inter-provincial pipelines, and
  - oil and gas drilling and production operations in frontier areas such as the Arctic offshore
- Reports directly to the Parliament of Canada through the Minister of Natural Resources

Canada

National Energy Board — Office national de l'énergie

Working Together Booklet

Working Together - What Government and Other Agencies do if Canadian Arctic Waters are Threatened by a Spill

Find link at http://www.neb-one.gc.ca/ under "North / Offshore"

Canada

National Energy Board — Office national de l'énergie

Spills Working Agreement

NWT - Nunavut Spills Working Agreement

Applies to spills in the NWT, Nunavut and the Arctic offshore

Canada

National Energy Board | Office national de l'énergie

Spills Working Agreement

- Provides for cooperation and information sharing
- Identifies which agency is the Lead Agency, e.g., for offshore

Spill Source	Lead Agency
Ships and barges	Canadian Coast Guard
Oil and gas exploration and production facilities	National Energy Board
Facilities/operations licensed under INAC legislation	Indian and Northern Affairs Canada (INAC)

National Energy Board | Office national de l'énergie

Arctic Offshore Drilling Review

- NEB is examining best information available on the hazards, risks and safety measures of offshore drilling in the Canadian Arctic.
- Northern residents, scientists, regulators, environmental non-government organizations and industry, invited to share their information and knowledge
- The Board will consider the information gathered, the comments and suggestions provided and report on what it has heard and how that information will be incorporated in the examination, by the Board, of future applications for offshore drilling in the Arctic.

National Energy Board | Office national de l'énergie

Arctic Offshore Drilling Review

- The Inuvik Roundtable **September 12-16, 2011**
- The outcome of this review will be a public report clarifying the filing requirements for future applications for offshore drilling in the Canadian Arctic (expected in December 2011).
- Web site: http://www.neb-one.gc.ca/

National Energy Board | Office national de l'énergie

NEB Regulatory Authority

Offshore oil & gas activities are regulated under ***Canada Oil and Gas Operations Act***:

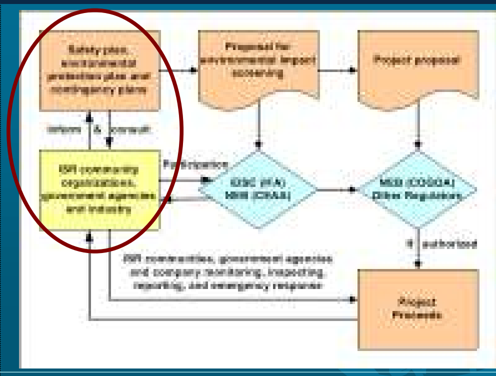
- Purpose of Act is to promote:
  - safety
  - protection of the environment
  - conservation of oil and gas resources

Examples of regulated offshore activities:

- marine seismic surveys
- exploration drilling

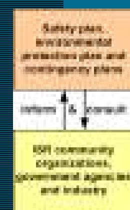
National Energy Board | Office national de l'énergie

Participation Overview



National Energy Board | Office national de l'énergie

Regulatory Requirements



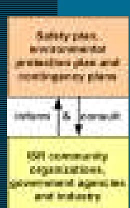
Canada Oil and Gas Drilling and Production Regulations (D&PR)

Contingency plans (s.6(e) D&PR) must

- provide coordination measures with relevant municipal, territorial or federal emergency response plans, and
- identifies the scope, and frequency of field practice exercises of oils spill counter measures

National Energy Board | Office national de l'énergie

Inuvialuit Response Role



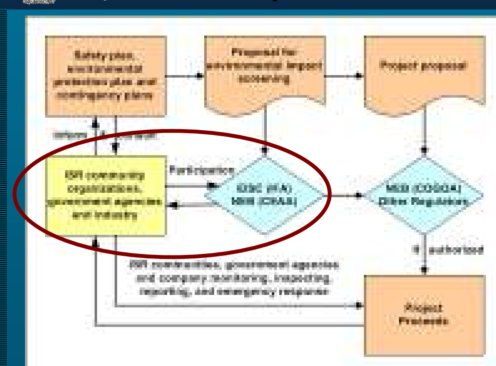
Coordinating with relevant municipal and territorial plans

The Inuvialuit and the Company (which has the primary responsibility to effectively respond to and mitigate effects of spills) may:

- Discuss opportunities for an Inuvialuit response role
- Discuss available Inuvialuit-based infrastructure and resources
- Discuss Inuvialuit training needs and training qualifications

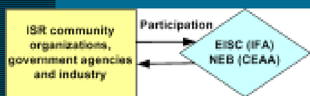
National Energy Board | Office national de l'énergie

Participation Overview



National Energy Board | Office national de l'énergie

Regulatory Requirements

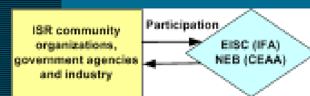


Environmental Impact Screening

- Proposals in the ISR are subject to environmental impact screening under:
  - *Inuvialuit Final Agreement* (IFA), and
  - *Canadian Environmental Assessment Act* (CEAA)

National Energy Board | Office national de l'énergie

Regulatory Requirements

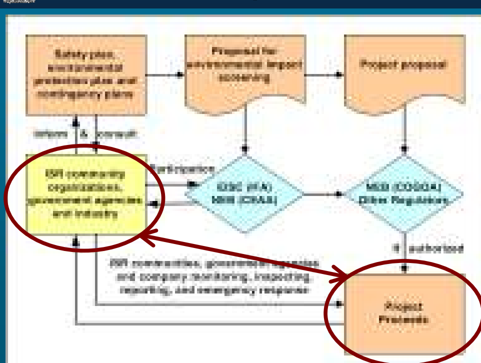


Environmental Impact Screening

- ISR community organizations and expert gov. agencies review the project description and provide comments to the EISC and NEB
- Screening determinations are then provided to the regulator(s) along with any "*environmental terms and conditions"* recommended by the EISC, or
- the project may be referred to the EIRB

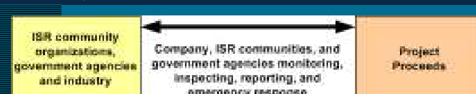
National Energy Board | Office national de l'énergie

Participation Overview



National Energy Board | Office national de l'énergie

Inuvialuit Participation



- ISR communities may be kept informed about the project by
  - Inuvialuit-based environmental monitors,
  - regular company monitoring reports,
- Acceptably trained and qualified Inuvialuit could provide spill response help, if authorized

Verifying Compliance

ISR community organizations, government agencies and industry	⟵ Company, ISR communities, and government agencies monitoring, inspecting, reporting, and emergency response ⟶	Project Proceeds

- NEB would
  - verify Company compliance with the Regulations and the terms and conditions of the project authorization,
  - would monitor and evaluate spill response exercises

NEB Presenters

Oil Spill Dispersants – Evaluation and Scientific Support

Carl E. Brown* and Ben Fieldhouse
Emergencies Science and Technology Section
Environment Canada
Ottawa, ON

Emergencies Science & Technology Section - Background

Environment Canada

- Science and Technology Branch
- Water Science and Technology Directorate
- Emergencies, Operational Analytical Laboratory and Research Support Division
- Emergencies Science and Technology Section (ESTS)

ESTS

- Undertakes Environmental Emergencies R&D and related scientific activities (RSA)
- Provides scientific and operational support to the Environmental Emergencies Program

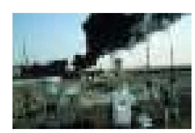
Environmental Emergencies Program

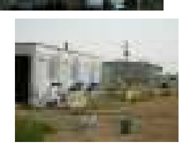
Mandate

- To prevent or reduce the frequency, severity and consequences of environmental emergencies
  - All hazard planning approach
- Four principal areas of activity:
  - Prevention
  - Preparedness
  - Response
  - Recovery
- Environmental Emergencies related Research and Development, carried out at the River Road Laboratories is fundamental to the Program

Environmental Emergencies Program - Legislative/Policy Framework

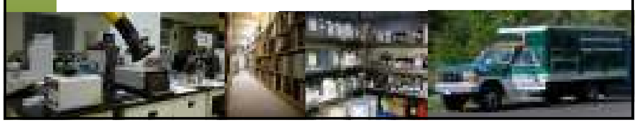
- Canadian Environmental Protection Act, Fisheries Act, Migratory Birds Convention Act, Species at Risk Act, Emergency Preparedness Act
- 1973 Cabinet Directive
  - Authority to develop a Government-wide Environmental Emergency program
  - Contingency plans
  - Response (technical advice/operational leadership)
  - 24/7 Spill notification systems
  - Regional Environmental Emergencies Teams (REETs)
- 1995 Updated Federal Policy for Emergencies
  EC Responsibilities:
  - Environmental hazards / Risks identification
  - Incident assessment / Mitigation
  - Response assistance as per International Treaty commitments
  - Migratory birds & habitats (assessment/effects mitigation)
  - Observations / Forecasts/ Warnings
  - Dispersion projection (air, water, land)
- Federal Emergency Response Plan (FERP)
  - Emergency Support Functions
- International Agreements
  - To provide mutual aid in the event of environmental emergencies
  - US Environmental Protection Agency (EPA)
  - United Nations Environment Programme (UNEP)
  - International Maritime Organization (IMO)





Emergencies Science & Technology Section

- Emergencies Science and Technology Section located in Ottawa at the EC River Road Facility
- Large laboratory facilities, response vehicles, mobile laboratories
- Large library of oil spill literature
- 18 staff plus post-docs & co-op students
- Unique inventory of oil samples from Canadian and International Sources



ESTS Operational Roles and Responsibilities

Response During an Incident

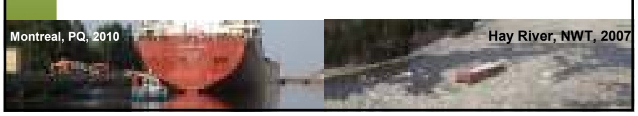
- Provide specialized scientific and technical advice on oil and chemical properties, fate and behaviour and spill countermeasures
- Assist during emergencies by providing trained personnel, specialized field analytical and sampling equipment, and mobile laboratory capabilities
- Oil/chemical spill modelling, air plume modelling (short-range), fire and explosion modelling
- Provide laboratory support for the forensic analysis of samples (petroleum products and chemicals)

Preparedness for Future Incidents

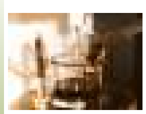
- Conduct basic and applied research into oil & chemical spill behaviour, fate and effects
- Test new products for oil & chemical spill response
- Test new petroleum, fuel oil-related products to provide needed data for modeling
- Level A Hazmat training/capacity
- Develop new standard guides, manuals, methods and techniques for oil spill response and remediation (e.g., ASTM, CCME, EC standard methods)

ESTS Research for Oil Spill Emergencies

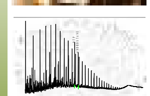
- Fate and Behaviour of Oil in the Environment
- Spill Modelling (trajectory and behaviour)
- Oil Physical and Chemical Properties (includes Biofuels)
- Laboratory and On-site Field Sample Analysis
- Forensic Analysis for legal purposes
- Field Work - Emergency Response
- Remote Sensing
- Oil Spill Countermeasures, Clean-up and Remediation
  - Mechanical Recovery
  - In-situ Burning
  - Spill Treating Agents (including Dispersants)
  - Natural Attenuation



Oil Spill Research

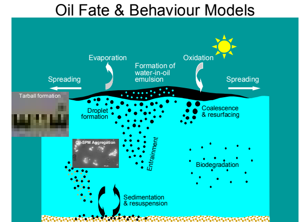


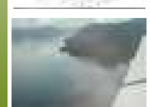
Oil Properties



Environmental Chemical Forensics

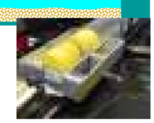
Oil Fate & Behaviour Models





Remote Sensing

Spill Countermeasures and Remediation

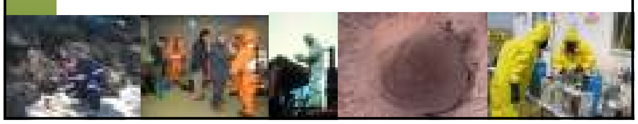


Workshop on Dispersants in the Beaufort Sea, Inuvik, NT – Page 8 – July 25-28, 2011

Canada

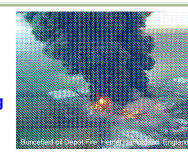
Field Work and Response

- Provide local and First Responders with the specialized knowledge needed to deal with spill emergencies
- Evaluate and develop new equipment and techniques to improve spill counter-measures
- On-site analysis and technology evaluation
- New techniques for site assessment (SCAT)
- Criteria for clean-up endpoints



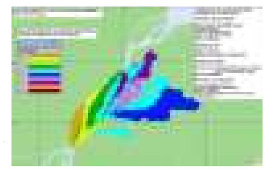
Spill Modelling

Oil Spill Modelling



Air Quality Modelling (Source & Plume)

Soil Quality Modelling



Chemical Spill Modelling (Water & Air)

ESTS Role during Oil Spill Incidents - Scientific & Operational Support

- ESTS provides scientific advice and operational support to the Environmental Emergencies Program and to the Regional Environmental Emergencies Team (REET) during oil spill incidents
- Oil chemical and physical properties (ESTS database) http://www.etc-cte.ec.gc.ca/databases/OilProperties/oil_prop_e.html
- Fate and behaviour including modelling
- Oil spill countermeasure advice
  - Mechanical recovery
  - In-situ burning
  - Spill treating agents including dispersant effectiveness
  - Natural attenuation
- Sampling and forensic analysis
- Remote sensing advice
- Shoreline Cleanup Assessment Technique (SCAT)

Oil Spill Response Countermeasures

- In all oil spill responses, there are a number of countermeasures that should be considered including;
  - Mechanical recovery
  - In-situ burning
  - Application of Spill Treating Agents (including dispersants)
  - Natural attenuation (with long-term monitoring)
- The pros and cons of each possible countermeasure should be evaluated through a Net Environmental Benefit Analysis (NEBA) to determine the applicability of the suggested countermeasure.
- In any given oil spill incident, one or more countermeasures may be applicable depending on the type and volume of oil spilled, environmental conditions, sensitivity of nearby resources, and human health concerns relevant to the specific incident.

Spill Treating Agents (STAs)

- During a major oil spill incident, the EC Regional Environmental Emergency Coordinator (REEC) will be a co-chair of the local Regional Environmental Emergencies Team and as such will give scientific advice in regard to STA use at the spill.
- At a spill scene, the federal oversight agency (lead) has the final decision with respect to the use of treating agents. The use of dispersants during an uncontrolled release of petroleum crude oil and/or products is prohibited by law, there is no implied exemption. The recommendation by REET on the outcome of a proposed course of action may support dispersant use, but EC does not have power of authorization.

Spill Treating Agents Use Decision Tree

There are many factors in the STA decision-making process as follows:

1. Selection of appropriate treatment option, accounting for alternatives, NEBA, resource allocation, failure risks (cost of ineffective treatment)
2. Selection of appropriate product to achieve treatment objectives
   - suitability of product for the application (oil type, salinity, environmental conditions)
   - available resources to implement treatment plan
   - sufficient study to support confidence in projected treatment outcome

Elements of a Dispersant Treatment Plan

Requirements:

- Treatment objective
- Justification
- Health & Safety considerations
- Effectiveness verification
- Water quality monitoring
- Treatment endpoint
- etc

Spill Treating Agent Evaluation

- Information on all new products (including STAs) in Canada must be submitted to the New Substances Program to ensure compliance with the New Substances Notification Regulations (Chemicals and Polymers) under the Canadian Environmental Protection Act (CEPA, 1999).
- Once the product has been confirmed to meet CEPA regulations, the product and supporting documentation may be submitted to ESTS for evaluation.
- The STA will be subjected to the effectiveness tests deemed appropriate by EC staff. If the effectiveness results merit consideration for approval, the product will be sent for aquatic toxicity testing using CALA accredited laboratories by the STA vendor/manufacturer. The results of the toxicity testing and the effectiveness testing will be considered in tandem when determining whether to include the product on the internal EC list of approved products*. An individual product must meet minimum standards. Products that do not meet the minimum standards for effectiveness and aquatic toxicity will not be considered for use.

** DISCLAIMER*

Inclusion on the ESTS/EC "approved" list does not authorize use of the product. The intent of the list is to act as a quick reference for EC staff when considering countermeasure options, providing the names of those products that have been evaluated and found to offer potential benefit to the clean-up of oil spills. All STAs should be used following the manufacturer's instructions, by qualified personnel and in accordance with treatment plans developed for the specific incident.

Spill Treating Agents (STAs)

- The Emergencies Science and Technology Section has an on-going program to evaluate STAs for use at oil spills.
- ESTS evaluates the effectiveness and toxicity of the following oil spill treating agents;
  - Dispersants
  - Surface Washing Agents
  - Solidifiers
  - Recovery Enhancers
  - Demulsifiers
- ESTS also screens products for behavioural modification, such as dispersant effects by bioremediation products.

Dispersant Use Guidelines

- Environment Canada has published 2 versions of the “Guidelines on the Use and Acceptability of Oil Spill Dispersants”
  - 1st Edition 1973 Report EPS 1-EE-73-1
  - 2nd Edition1984 Report EPS 1-EP-84-1
- There is general consensus that the 2nd Edition (1984) is in need of an update to address changed legal context
- New methodologies for the evaluation of dispersant effectiveness in the laboratory have been developed since the publication of the 1984 Guidelines. These newer methods have replaced those identified in the earlier guidelines

Dispersant Use Guidelines - continued

- Correlating laboratory results with real-world field results is difficult and the amount of testing done under actual spill conditions is limited.
- The construction of a small number of meso-scale test tanks to bridge the gap between laboratory and open water dispersant effectiveness has been beneficial.
- Environment Canada is currently consulting with other federal departments and stakeholders with the aim to develop a regulatory regime for spill treating agents and a policy for dispersant use in Canadian waters.

Bench-Scale Dispersant Effectiveness Laboratory Testing

- In the laboratory, dispersant effectiveness is estimated using a number of different tests. The most commonly used protocols around the world include the swirling flask test, the baffled flask test, the IFP test, the EXDET test, and the Warren Spring end-over-end flask test.
- All bench-scale tests share the common advantages that they are less expensive and the number of samples run is larger.
- Variables such as temperature, dispersant-to-oil ratio (DOR), salinity, and energy dispersion can be easily controlled, allowing for very specific and detailed testing.

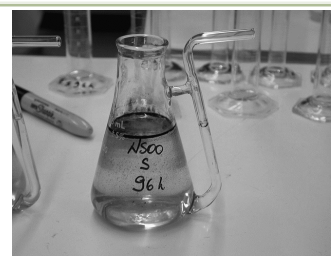
Bench-Scale Dispersant Effectiveness Laboratory Testing

- ESTS evaluates dispersants with the ASTM Standard Test Method for Laboratory Oil Spill Dispersant Effectiveness Using the Swirling Flask (ASTM F 2059 – 06). The Swirling Flask Test was developed by ESTS.

Summary of ASTM Test Method F 2059 – 06

- Dispersant is pre-mixed with oil and placed on water in a test vessel. The test vessel is agitated on a moving table shaker. At the end of the shaking period, a settling period is specified and then a sample of water taken. The oil in the water column is extracted from the water using a pentane/dichloromethane mixture and analyzed using gas chromatography.
- The extract is analyzed for oil using a gas chromatograph equipped with a flame ionization detector, (GC-FID). Quantification is by means of the internal standard method. Effectiveness values are derived by comparison with a calibrated set of effectiveness values obtained at the same time and by the same method.

Swirling Flask Test



- A swirling flask test vessel after a test. This particular oil-dispersant combination would not have been highly effective, yielding an effectiveness value of about 10%**.

** C.E. Brown, B. Fieldhouse, T.C. Lumley, P. Lambert, B.P. Hollebone, "*Environment Canada's Methods for Assessing Oil Spill Treating Agents*", in Oil Spill Science and Technology: Prevention, Response, and Clean Up, Ed. M. Fingas, Elsevier, Burlington, MA, USA, pp. 643-671, 2011.

Dispersant Toxicity Testing

- Toxicity test data are provided to Environment Canada by the STA vendor/manufacturer using CALA accredited laboratories using accepted standard methodologies;
  - EC Reference Method EPS 1/RM/9 "Acute Lethality Test Using Rainbow Trout"
  - EC reference method EPS 1/RM/11 "Acute Lethality Test Using Daphnia spp."
  - EC reference method EPS 1/RM/24 "Toxicity Test Using Luminescent Bacteria"

Funders / Research Partners

(not a complete list)

Funders

- Environment Canada
- Coastal Response Research Center (CRRC/NOAA)
- Renewable Fuels Strategy
- PERD
- US BOEMRE

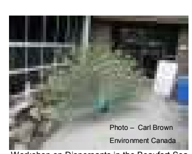


Photo – Carl Brown
Environment Canada

Research Partners

- TC, HC, NRCan (GSC), NRC
- US EPA, NOAA
- EC ALET, PYLET
- Universities
  - Waterloo, Ottawa, Queens, RMC, Leeds (UK)
- SAIC Canada, Allen-Vanguard, Husky Oil Operations Ltd.

AMOP Reminder

AMOP* Technical Seminar on Environmental Contamination and Response

October 4-6, 2011

Banff, Alberta

Contact: Natalie Jones at 613-991-1114 or Natalie.Jones@ec.gc.ca

*Arctic Marine Oilspill Program

Workshop on Dispersants in the Beaufort Sea, Inuvik, NT – Page 25 – July 25-28, 2011

Questions?

Workshop on Dispersants in the Beaufort Sea, Inuvik, NT – Page 26 – July 25-28, 2011

Overview of Dispersant Planning in Atlantic Canada

Inuvik Dispersant Workshop

Roger Percy July 25-28, 2011

Dispersant Issue

- Renewed Interest in dispersant use by Oil Industry following recent large scale spill incidents
- Evaluations underway in Canada relative to our current state of preparedness (NEB/Offshore Boards)
- Renewed Interest Within US & Canada in Offshore/Arctic related spill response R & D

Dispersant Issue

- Pre-planning activities/R&D are taking place in other countries also
- Issue of pre-approval for use of dispersants has always been controversial on east coast
- Perceived increased risk due to expanding vessel traffic & offshore exploration development activity in new areas/deeper waters

Regulating the Offshore

- Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) and Canada-Newfoundland & Labrador Offshore Petroleum Board (CNLOPB) the primary regulators on the east coast
- Both Boards have MOU's with other support agencies (DFO, CCG, EC, TC, Atlantic provinces)
- Spill response support/logistics provided by industry cooperative (ECRC) and CCG
- Atlantic REET is a principle environmental advisor

Historical Context

Nova Scotia Offshore (CNSOPB)

- Oil & gas exploration began offshore Nova Scotia in 1959
- First well drilled on Sable Island in 1967
- To date 204 wells drilled (130 exploration, 27 delineation, 47 production wells)
- Production of gas & oil liquids began in 1992
- In 2011 the Deep Panuke field will commence production

Historical Context

Offshore Newfoundland & Labrador (CNLOPB)

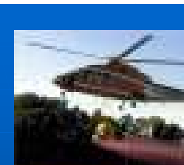
- First seismic investigations undertaken offshore NL in 1964
- First rig on the Grand Banks in 1996; earlier exploratory drilling in Labrador Sea
- Oil production now taking place at 4 fields on the Grand Banks

Hibernia platform during tow out

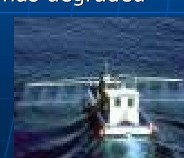
Historical Context

- A significant decrease in spill numbers over the last few years (from roughly 6000 to 3600 annually)
- Majority are land-based incidents
- Most marine spills on east coast related to shipping rather than offshore oil & gas activities
- There is a robust marine spill surveillance program (eyes in the sky) that has made a difference

Historical Context



- During 1970-80's oil industry maintained dispersant delivery equipment, stockpiles of dispersant and conducted testing/R&D on the east coast as did CCG
- Dispersant application capability has degraded over the years
- A need to re-evaluate the option



Dispersants

(Including other products like shoreline treating agents)

Currently are considered an option in Atlantic Region

Planning Requirements

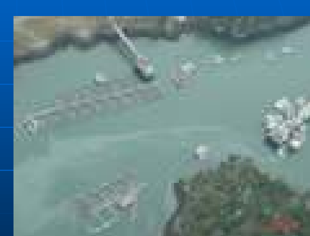
- Timely access to dispersants and Application equipment
- Plans for logistics and operations
- Prior testing with Specific Oil types
- Experienced and trained Staff
- Understand dispersion process
- Apply in timely manner (weathering)

Dispersants - the Advantages

- Ability to treat large slicks quickly
- Allows response in higher sea states/further offshore
- Removes some surface oil
- Enhances biodegradation
- Dilution (Water Depth & Currents)

Dispersant – the Disadvantages

- Potential toxicity in water column
- Effectiveness (proportion of oil dispersed)
- May reduce effectiveness of mechanical recovery.



Factors to Consider

- Guidance on dispersant use and net environmental benefits available through ASTM Standards
- Fisheries Act currently, prohibits deposit of "deleterious substances"
- "Guidelines on the Use and Acceptability of Oil Spill Dispersants" needs updating

Factors to Consider

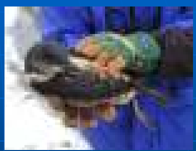
- Canadian Environmental Protection Act (Sec. 195) States – Despite sec. 36 (3) of the Fisheries Act…the Minister may examine and conduct research, including tests, respecting the cause, circumstances and effects of and remedial measures for an environmental emergency
- CEPA, Sec. 196 – The Minister may issue guidelines and codes of practice respecting prevention of, preparedness for and response to an environmental emergency and for restoring any part of the environment damaged by or during an emergency

Factors to Consider

Species At Risk Act, sec. 79 (2)

- "…must identify the adverse effects of the project on the listed species and its habitat…"

(includes measures, monitoring, recovery and action plans)



Background

Atlantic Region Environmental Emergency Team (REET) active on the issue

- Fosters exchange of technical and planning information among stakeholders during annual REET meetings - 2010 meeting highlighted Gulf of Mexico spill response initiatives including dispersant usage
- Sponsors workshops in Region to focus discussions on response/clean-up issues

Background

- Active participation in industry and government led regional spill response exercises where dispersant issue is explored
- Dispersant option regularly evaluated during Canada-US exercises on Canada's east coast; net environmental benefit is often recognized
- REET contingency plan documents government/ industry roles and responsibilities during a spill
- REET plan establishes a mechanism to evaluate response options

Atlantic REET 101

- Regional Environmental Emergency Team (REET) a flexible multi-agency, multi-disciplinary group
- Atlantic REET chaired by EC; active for past 39 years; established following the Arrow tanker spill off Nova Scotia in 1970
- Recognized as principal environmental advisor to CCG/TC/Offshore Boards during marine incidents
- Provides coordinated/consolidated advice to lead agency

REET

- Coordinates delivery of Canadian environmental advice during international incidents/exercise
- Active in both civil and pollution emergencies
- Operates in two modes
  -planning (annual meetings among agency/industry representatives)
  -response (meetings as required/required expertise)

Benefits of REET

- Focuses advice provided to lead agency/OSC
- Forum for discussion and conflict resolution
- Develop consensus on environmental protection and clean-up priorities and techniques
- Minimizes environmental damage through pre-planning
- Maximizes use of limited regional resources

Environmental advice

- spill protection and cleanup priorities
- spill containment and recovery strategies
- use and acceptability of spill treating agents/in situ burning – info on spill behavior, fate and effects
- impacts of hazardous materials on people and the environment – waste storage and disposal
- wildlife, fisheries and other natural resources protection and rehabilitation strategies

Spill response planning

- promotion and preparation of contingency plans
- provision of sensitivity maps and information on sensitive resources
- training on shoreline assessment, protection and cleanup – guidance on contingency planning
- participation in spill responses/exercises

Spill response operations

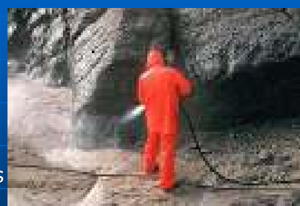
- alerting and notification of REET members
- provision of spill report information to relevant experts/advisors
- monitoring impacts on wildlife and fisheries resources
- provision of information on priorities for spill protection and clean-up
- spill trajectory modeling
- spill sampling and analysis
- weather/sea state forecasts and warnings – evaluation of clean-up activities
- damage assessment
- debriefing the REET response

Use Requirements

- Convene REET for thorough discussion of pros and cons of various options for response
- REET consensus on "Net Environmental Benefits"
- Endorse or reject use request
- If appropriate, further lab & field tests (by proponent or REET)
- Ongoing monitoring, evaluation, documentation (by proponent and REET)

Regional Experience

- Very few requests for dispersant use
- Mainly requests for shoreline cleaning
- Often inappropriate requests for use on heavier bunker type spills



- Currently lack of equipment & dispersants in region
- Inadequate field monitoring capacity

Regional Experience

- Current ship spill regulatory regime does not give credit to Response Organizations for having dispersant capacity
- Important to consider both environmental and economic benefits
- Further evaluation required on effectiveness of dispersants in protecting wildlife

Known Cases

- Sea Camel (used without approval, applied with a bucket)
- Katsheshuk (approval discussed but not requested, diesel, high energy, birds vs crabs, potential liability considerations)
- Dartmouth Cove (approved for fresh bunker, spot cleaning on shoreline, Corexit 9580, lifted oil for recovery by sorbents
- J. R. Gray (requested for bunker spill in Bay of Fundy, aerial application, unable to find oil in fog
- Lucien Paquin (requested for bunker, spot cleaning, Corexit 9527 vs 9580, applied with back packs and tree sprayers, large volumes applied)

Known Cases

- IOL McNab's Island (requested for heavy oil, spot cleaning on shoreline, Corexit 9580); approved following tes
- Tufts Cove (approved for fresh oil, spot cleaning around riprap, Corexit 9580, lifted oil for recovery by sorbents)
- King Darwin (2008) incident in Dalhousie, NB – received permission to use shoreline cleaner on shoreline and dock but steam cleaning proved more effective
- MT Jasmine Knutsen (2008) shuttle tanker oiled with crude successfully cleaned in Argentia with Corexit 9580

Next Steps

"No planning without approval; No approval without planning"

- Evaluate/resolve current regulatory impediments to the approval of dispersants

- If dispersants accepted as legitimate option in response toolbox then solid planning and streamlined mechanisms need to be in place

- Update dispersant use guidelines and ensure their applicability to Arctic situations

- Oil properties, behaviour and dispersability of local oils needs to be thoroughly documented

Next Steps

- Closely follow studies underway in Gulf of Mexico spill response as they shed light on effectiveness/ impact of dispersant use

- Implement findings relevant to Canada particularly as they relate to use in deep water releases

- Broaden discussion to include shipping industry - need to ensure industry response organizations credited for dispersant capabilities under spill response regime

Dispersants in Other Jurisdictions

BREA Dispersant Workshop

Inuvik, NT

July 25-28, 2011

Introduction

- Many plans and policies in place
- Address pre-spill planning and spill-time
- International models (e.g, EMSA, IMO, IMO/UNEP(Northwest Pac)
- BREA Workshop
  - Dispersant policies
  - Guidelines
  - Decision-trees

Original IMO Guidelines (1995)

- Generic Oceanography-based guidelines
  - acceptable in waters > 30 feet deep
  - not acceptable in waters < 30 feet deep
  - not acceptable < 1 mile from land
  - not acceptable < 3 miles from coral reefs

National Policies

- Dispersants pre-approved
- Dispersants preapproved for some, case-by-case for others
- Dispersants case-by-case
- Dispersants prohibited

Survey of Government Policies

Nation	Role of Dispersants In Response	Lead in Response
United Kingdom	Primary – Dispersants Pre-approved for offshore Secondary – Mechanical, shore cleanup	Gov't
New Zealand	Dispersants, mechanical co-equal Dispersants pre-approved	Gov't
France	Mechanical is primary. Dispersant use preapproved	Gov't
United States	Mechanical is primary. Dispersants secondary; pre-approved in most areas	Industry/ Gov't
	Continued	

Survey of Government Policies

Nation	Role of Dispersants In Response	Lead in Response
Norway	Mechanical primary, dispersant use supplementary, Approval- hybrid.Pre-approval for some; Otherwise case by case.	Gov't/ Industry
Japan	Mechanical is primary. Dispersants possible Approval case-by-vase; Consultation with local fishermen's assoc'n required.	Industry/ Gov't
Canada	Primary – Mechanical Secondary – Dispersants Dispersants – case-by-case	Industry/ Gov't
Greenland	Primary – Mechanical Dispersants – Case-by-case	Government

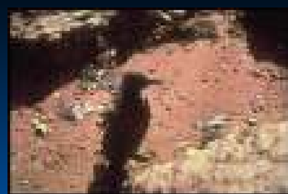
Dispersant-Use Guidelines

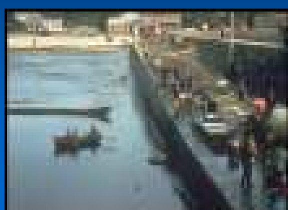
- Many, many national, regional (e.g., New Zealand, U.S. RRT 6, below)
- May involve pre-approval or not
- Generally specify at least:
  - Approval/pre-approval protocol permissions & restrictions
  - Who can authorize dispersants (e.g., FOSC)
  - Approved decision-tree
  - Notification protocol
  - Dispersant product restrictions
  - Daylight ops only
  - Contract with sprayer in place pre-spill
  - Types of platforms and equipment to be used
  - Standards (e.g., ASTM) for equipment and operations
  - Must have trained, experienced operators
  - Must have effectiveness monitoring (SMART)

Dispersant Decision-Tree

- Many, many
- For example (New Zealand)
  - 1- Spill reported?
  - 2- Sensitive resources threatened
  - 3- Dispersants being considered?
  - 4- Is there Net Environmental Benefit?
  - 5- Oil dispersible?
  - 6- Suitable dispersant available?
  - 7- Dispersant application safe?
  - 8- Trial application feasible? Successful?
  - 9- Operation continues to be safe?
  - Others include – Ocean conditions suitable for effectiveness?

Environmental Considerations and Net Environmental Benefit Assessment





NEBA - Introduction

- Compares environmental risks from untreated spills vs chemically dispersed spills
- Identifies the environmental benefits of using dispersants AND the environmental losses
- Applied on a typical spill scenario
- Quantifies risks to typical local resources
- Allows stakeholders to consider risks and make trade-offs

NEBA - Introduction

- Method:
  - For a specific local scenario

Method

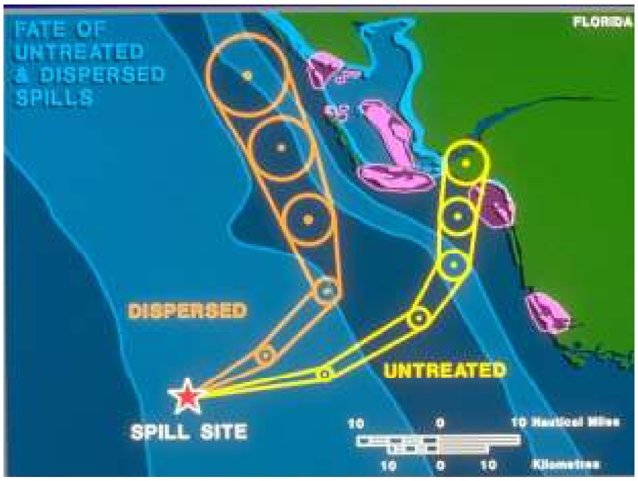
Oil Spill

Untreated Spill	Dispersed Spill
↓	↓
Fate/Movement of Oil	Fate/Movement of Oil
↓	↓
Identify Resources at Risk	Identify Resources at Risk
↓	↓
Assess Impact	Assess Impact

Compare Impacts

↓

Assess NEB



Summary of Impacts of Dispersed and Untreated Spill: Charlotte, Florida

Resources (Stocks)	Impact, %	
	Untreated	Dispersed
Pink Shrimp (E. Gulf)	0.1 (0.5)	0.4 (1)
Blue Crab (E. Gulf)	0.2 (0.2)	0 (0)
Spotted Seatrout (Charlotte)	0.8 (3)	0.5 (3)
Least Tern (W. Florida)	5	0
Br. Pelican (E. Gulf)	3	0
Mangrove (Charlotte)	10	0
Marinas	8	0
Beach, non-amenity	8 km	0
Mangrove shoreline	39 km	0

NEBA - Introduction

- Background:
  - Developed as training tool under Environment Canada (1980s)
  - Computerized as dispersant planning tool in Gulf of Mexico 1980s
  - Assessed feasibility of dispersants for platform spills in GOM and California
  - U.S. version called “Environmental Risk Assessment Consensus Approach” used for pre-approval planning in many regionsd spills vs chemically dispersed spill
  - Expanded to apply to all cleanup methods

NEBA - Method

- Approach
  - Select spill scenario
  - Compute oil fate and trajectory for **untreated** spill
  - Compute **areas-of-impact** using oil fate data and:
    - Toxicity criteria
    - Impact assessment algorithm
  - Identify resources at risk (environmental and human use)
  - Assign protection **priorities** for each
  - Prepare spill **vulnerability profiles** for populations (e.g., South Beaufort Sea population of polar bears)
    - Spatial distribution of population
    - Aggregation features
    - Habitat use and habits
    - Seasonality

NEBA - Method

- Approach (cont'd)
  - Compute impacts on each for untreated spill
  - Repeat for chemically dispersed spill
  - Compare risks from untreated and dispersed spills
  - Decide whether dispersants reduce the overall impact of spill
  - Document

Summary of Impacts of Dispersed and Untreated Spill: Charlotte, Florida

	Impact, %	
Resources (Stocks)	Untreated	Dispersed
Pink Shrimp (E. Gulf)	0.1 (0.5)	0.4 (1)
Blue Crab (E. Gulf)	0.2 (0.2)	0 (0)
Spotted Seatrout (Charlotte)	0.8 (3)	0.5 (3)
Least Tern (W. Florida)	5	0
Br. Pelican (E. Gulf)	3	0
Mangrove (Charlotte)	10	0
Marinas	8	0
Beach, non-amenity	8 km	0
Mangrove shoreline	39 km	0

Environmental Considerations and Net Environmental Benefit Assessment