ARCTIC RESPONSE TECHNOLOGY
OIL SPILL PREPAREDNESS

# THE ARCTIC OIL SPILL RESPONSE TECHNOLOGY

## JOINT INDUSTRY PROGRAM

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# COLLABORATION AMONG TEN COMPANIES

- International research programme
- Builds upon decades of R&D in arctic oil spill response
- Brings together experts across industry, academia and independent research centres
- Research integrity through technical review and public dissemination of results

## Six areas of research:

- Dispersants
- Environmental Effects
- In Situ Burning (ISB)
- Mechanical Recovery
- Trajectory Modelling
- Remote Sensing

# ACHIEVEMENTS TO DATE

## 9 reports now completed:

### In Situ Burning (ISB)

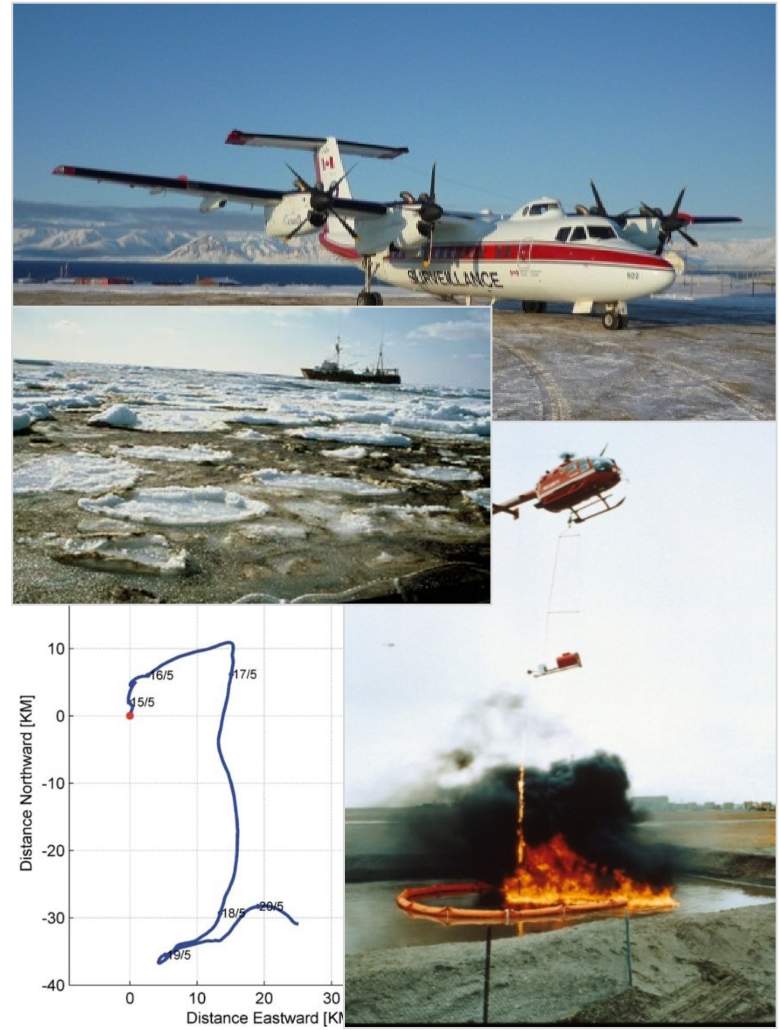
- **State of Knowledge**
- **Technology Summary and Lessons from Key Experiments**
- **Status of Regulation in Arctic and Sub-arctic Countries**

### Dispersants

- **Fate of Dispersed Oil Under Ice**
- **State of Knowledge of Dispersant Testing Under Realistic Conditions**
- **Status of Regulations and Outreach Opportunities**
- **Inter-Basin Calibration**

### Remote Sensing

- **Surface Remote Sensing**
- **Subsea Remote Sensing**



Photos: J. Mullin; Transport Canada; DF Dickins

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# CURRENT RESULT STATUS

- **Results to-date demonstrate the potential viability of multiple oil spill response technologies in arctic conditions beyond mechanical recovery – although limitations exist with each of them and more research needs to be done**
- **The release of three new reports, in addition to the six released in 2013, continues to build a comprehensive picture of arctic oil spill response technologies**
- **New research phase will see JIP commence laboratory and basin testing of specific technologies**

# A CLOSER LOOK AT THE PROJECTS

## Dispersants

### 1) Fate of dispersed oil under ice

- **AIM: To create a numerical modelling tool to predict the potential for a dispersed oil plume to resurface under the ice**
    - **SINTEF is the contract for this project**
    - **Phase 1 is complete and the final report is on JIP website**
    - **Planning for Phase 2 field work is underway**
    - **JIP exploring options to collect under-ice turbulence data during cruises in 2014 and 2015**

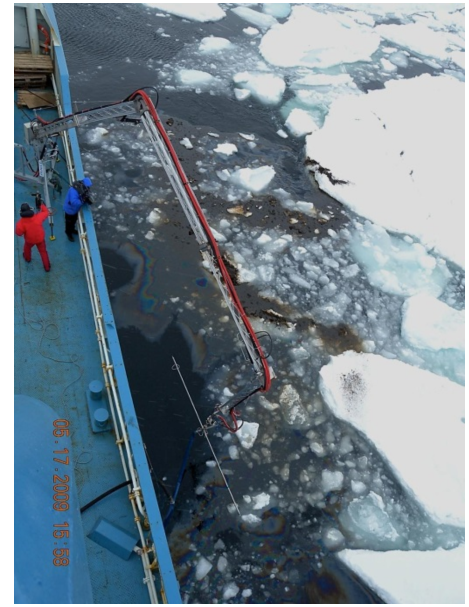


**Photo: DFO Canada**

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# A CLOSER LOOK AT THE PROJECTS

## Dispersants

### 2) Dispersant testing under realistic conditions

- **AIM: To define the operational limits of chemical dispersants and mineral fines in arctic marine waters**

  - **State of Knowledge, Summary of Existing Regulations, and Inter Basin Calibration tasks are complete and reports on JIP website**

  - **Weathering protocol and test matrix for laboratory and meso-scale basin experiments is finalized**

  - **Dispersant effectiveness experiments will be initiated at research facilities in Canada, France and Norway by end of 2Q/2014**

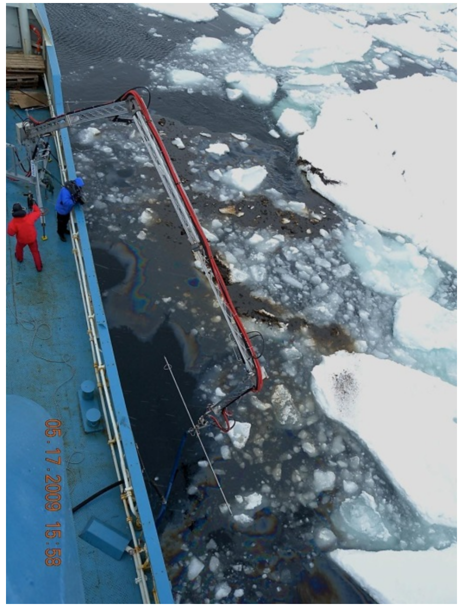


Photo: DFO Canada

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# A CLOSER LOOK AT THE PROJECTS

## Remote sensing

**AIM: To advance oil spill remote sensing and mapping capabilities to locate oil on, encapsulated in and under ice**

- **Phase 1 complete is complete and the surface/subsea reports are available on the JIP website**
- **Prince William Sound Oil Spill Recovery Institute is the contractor to conduct phase 2 research program**
- **Phase 2 experiments will be conducted at the U.S. Army Corps of Engineers-Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, NH**


**Photo: Transport Canada**

# A CLOSER LOOK AT THE PROJECTS

## In situ burning

### 1) State of knowledge

**AIM: To prepare informational materials on all aspects of in situ burning as an arctic oil spill response tool**

- **This project is complete and three reports are available on JIP website**
- **State of Knowledge**
- **Technology Summary and Lessons from Key Experiments**
- **Summary of Existing Regulations**


ISB with 90% efficiency after herding

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# A CLOSER LOOK AT THE PROJECTS

## In situ burning continued

### 2) Chemical herders

**AIM: To advance the knowledge of chemical herder fate, effects and performance to expand the operational utility of in situ burning as an arctic oil spill response tool**

- **Request for proposal was issued for solicitation**
- **Tasks include fate and effects studies and research to extend the window-of-opportunity for herder use**
- **Proposals currently under review by the technical working group and work will commence in 2Q/2014**


**ISB with 90% efficiency after herding**

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# A CLOSER LOOK AT THE PROJECTS

## In situ burning continued

### 3) Aerial ignition systems

**AIM: To improve aerial ignition systems for using in situ burning as an arctic oil spill response tool**

- **Technical working group reviewing/selecting concepts to develop statement of work**
- **Request for proposals will be issued in 2Q-3Q/2014**

Photo: J. Mullin



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# A CLOSER LOOK AT THE PROJECTS

## Environmental impacts

**AIM: To improve the knowledge base for conducting arctic Net Environmental Benefit Analysis (NEBA)**

- **The comprehensive Phase 1 review is complete**
- **Web-based presentation of these materials for use as an education and resource tool for NEBA practitioners, stakeholders and the public in development**
- **Phase 2 research will address research activities to improve and advance Arctic NEBA's**
- **Projects initiation meeting will be conducted later this month**

Photo: Caspian International Seal Survey

Photo: SINTEF

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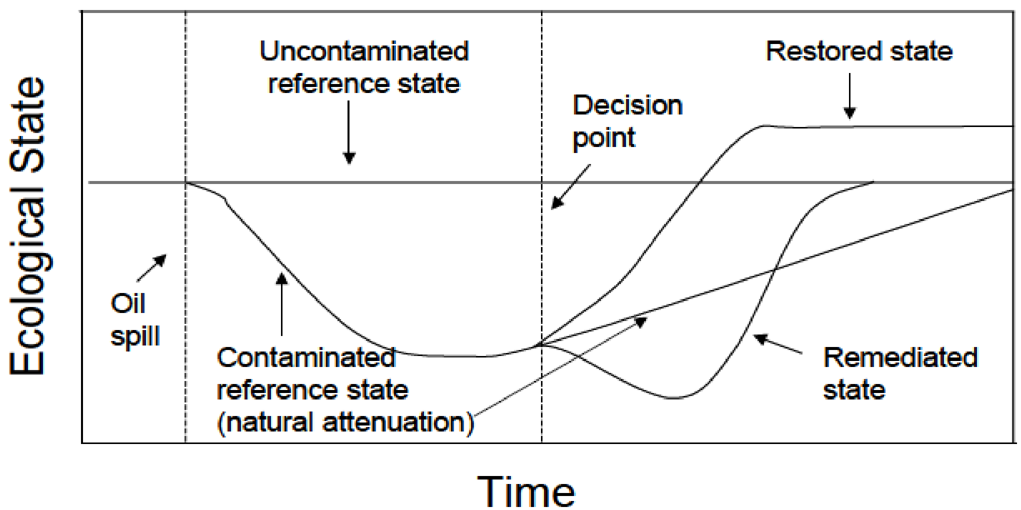
# PRIMARY PROJECT OBJECTIVE

**To produce data that will contribute to the expansion of the science base that will be used to develop a Net Environmental Benefit Analysis for the Arctic region**

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Main Project coordinator

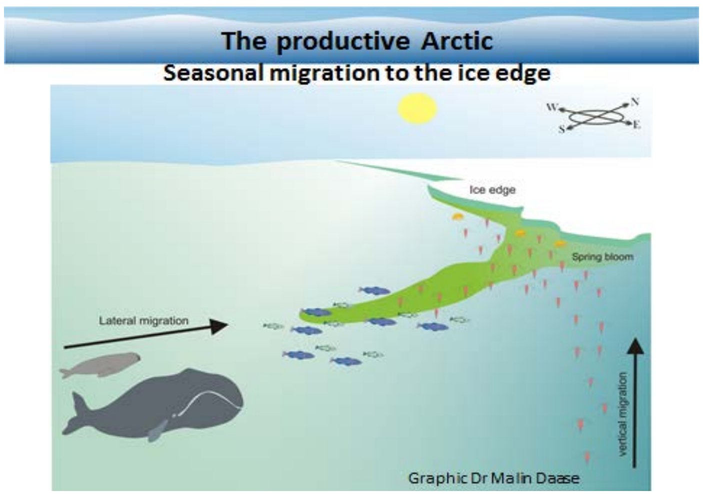
**Project A:**
Resilience and sensitivity of Arctic species

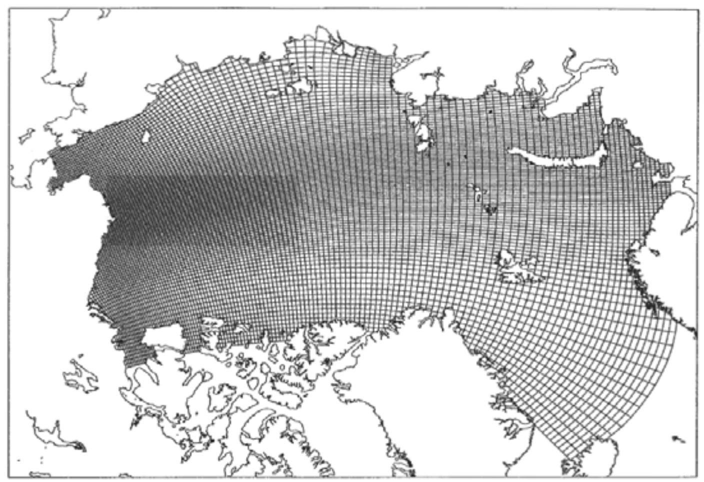
**Project B:**
Oil weathering and biodegradation

**Project C**
Population consequences, acute vs. chronic effects

# OBJECTIVES OF PROJECT A

1. To understand the importance of ecology associated with sea ice and the sea surface micro layer in the light of oil spill scenarios during modelling exercise
2. To perform field studies using in situ mesocosm to measure the exposure potential, the sensitivity and resiliency of sea ice and sea surface micro layer



Oil spill modelling

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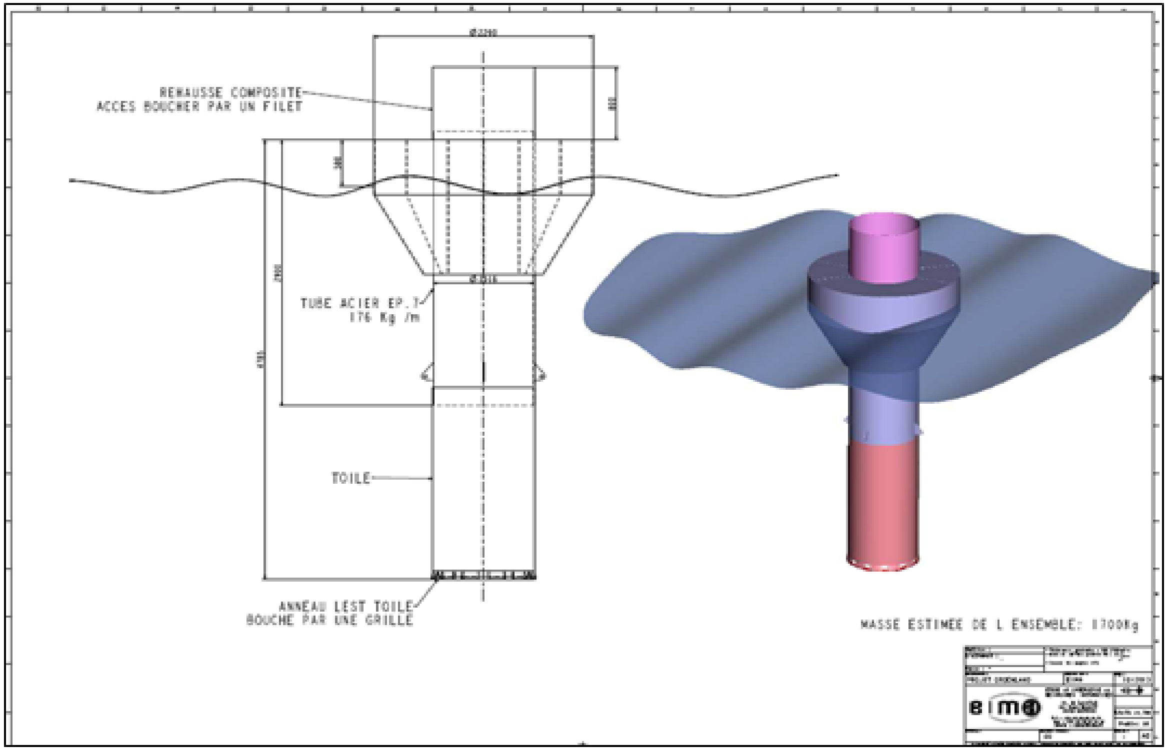
# IN SITU MESOCOSMS

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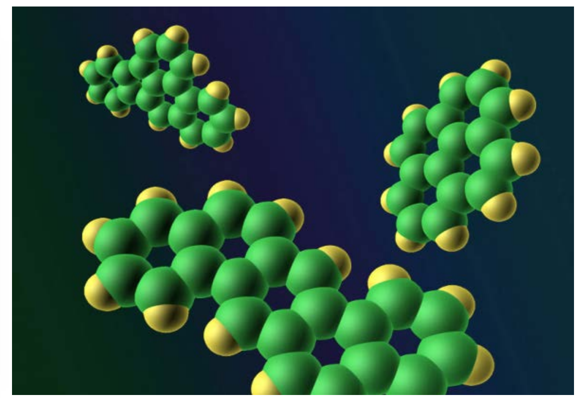
# OBJECTIVES OF PROJECT B

1. To characterize oil weathering in sea ice, sediment and rocky bottom
2. To characterize biodegradation processes by identifying microbial communities



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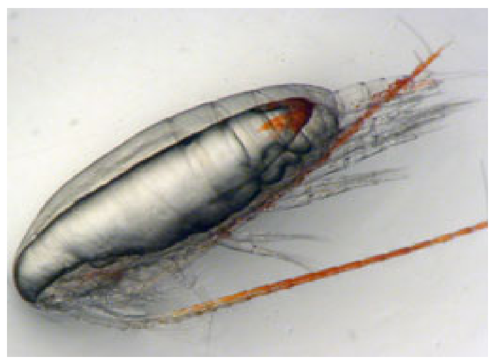
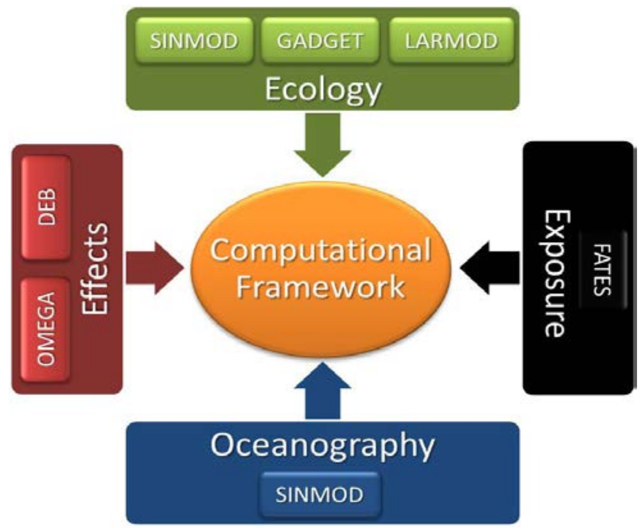
# OBJECTIVES OF PROJECT C

## 1. Impact on fish and copepod populations using population models

- Acute effects on populations
- Combined acute and chronic effects on populations



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# OSR Environmental Consequences Matrix for Dispersant Usage

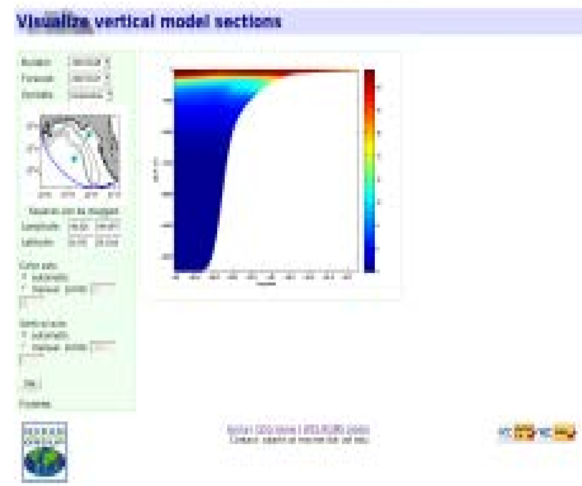
| Ecosystem Compartments | | Compartment Attributes | | | | Dispersant Applied | Dispersant Not Applied – Physical Recovery |
|---|---|---|---|---|---|---|---|
| | | Resiliency | Sensitivity | Exposure Potential | Biodegradation Potential | | |
| Atmosphere | Mammals and Birds | Reproductive potential is relatively low | Sensitive to volatiles | Behavioral avoidance or attracted to slicks | Volatilizes and rapid dilution by winds | Removal of surfaced oil and reduction of volatile exposure | Release of volatiles until oil concentrations are exhausted |
| Surface Water (upper mm) | Mammals and Birds | | Generally less sensitive | Maximum contaminant concentrations avoided by behavioral responses | Low potential biodegradation based on lowest surface area to volume ratio exposed to microbial use | Rapid removal of surfaced oil to subsurface | < 10% recovery; lowest surface area/volume ratio of oil reduces microbial degradation efficiency; more oil is transported to convergence zone compartments |
| Surface Water (upper mm) | Neuston, larvae & juveniles | Reproductive potential is high | Generally most sensitive stages | Maximum exposure; unable to avoid fouling or exposure | | | |
| Pelagic | upper 10m plankton, larval & juvenile fish | High reproductive potential | Generally among the more sensitive groups | Small potential for exposure to high concentrations of petroleum unless treated by dispersants or OMA | Biodegradation is rapid with the small amount of oil compounds diffused into the water | High surface area to volume increases microbial biodegradation efficiency; exposure to pelagic organisms increased | Oil compounds diffuse into the upper layers of water (~1m) but at relatively small rates; less impact on pelagic species; intermediate to large sized droplets with less surface area to volume than dispersed oil → less efficient biodegradation |
| Pelagic | >10m | High reproductive potential but concentrated abundances are on pycnoclines | Generally among the more sensitive groups | | | Chemically dispersed oil generally remains within the upper 10m of water; > 10m are not expected to have significant effects | Physical dispersion and diffusion of soluble components do not generally attain these depths at significant effects based concentrations |
| Subtidal | >10m | Moderate reproductive potential | Moderate sensitivity but, some very old age classes (deep water corals), unknown sensitivity | Limited exposure potential for surface oils impacting deep subtidal environments | Limited biodegradation potential for surfaced oils in deep water subtidal environments | | |
| Subtidal | <10m | Moderate reproductive potential (may be interfered with by oil contact with spawning or feeding aggregates) | Wider range of sensitivity | Exposure increases when wind and waves introduce oil to shallower subtidal sediments | Limited to moderate biodegradation; smaller surface area to volume ratio's and emulsification | Nearshore habitats have low potential of impact because of continued dilution and enhanced microbial degradation that occurs from during transport from offshore | Potential impacts from unrecovered oil contacting shallow subtidal |
| Intertidal Sand | Infauna/fish and invertebrates | Wide range of reproductive potential | | Stranding on intertidal sands re-concentrates surface oil and maximizes exposure | Surface of stranded oil may undergo further weathering, minor biodegradation | | Unrecovered oil can strand on the surface of beach sands where it can be recovered |
| Intertidal Cobbles/ Boulders | Epifauna & burrowing | | | Longer term exposure to residual oil and reintroduction of 'lingering oil' to surface compartment | Poor in storage areas between cobbles and boulders or when weathered and on rock surfaces | | Unrecovered oil can strand on rock surfaces, within cobble / boulders. Long term storage with minimum degradation & potential for continued physical fouling, chemical release and exposure. |

# A CLOSER LOOK AT THE PROJECTS

## Trajectory modelling

**AIM: To conduct research investigations in ice modelling and integrate the results into established industry oil spill trajectory models**

- **Project recently initiated**
- **The Nansen Environmental and Remote Sensing Centre (NERSC), Bergen, Norway is the contractor for this project**
- **Develop a new sea regional scale ice model as well as a new very-high resolution model to simulate sea ice dynamics in the Marginal Ice Zone.**
- **NERSC outputs will be coupled into existing oil spill trajectory models**




Map: USF

# A CLOSER LOOK AT THE PROJECTS

## Mechanical recovery

**AIM: To improve mechanical recovery of oil spills in arctic conditions**

- **Assessing the results of feasibility studies**
- **Alaska Clean Seas will summarize project findings and put them into operational perspective**
- **Report is expected 4Q/2014**
- **A new recovery device project is being evaluated.**
- **RFP expected to be issued for solicitation in 2Q/2014**


Photo: SINTEF

# WHAT'S NEXT?

- **Basin calibration of three test tanks have been completed and over the next year, laboratory and further basin testing of dispersant effectiveness will be conducted at different test facilities (SL Ross, SINTEF, and Cedre)**
- **Research experiments will be conducted at the CRREL facility to test and evaluate the performance of various surface and subsea remote sensing technologies**
- **Research has been initiated to develop a new sea ice model that will be tested, evaluated and validated. Results will be integrated into established oil spill trajectory models**
- **Research is being initiated to improve our knowledge of herder fate, effects, and performance in ice affected waters**

# JIP CONTACT INFORMATION

- **Joseph Mullin – Programme Manager**
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- **John Campbell – JIP Administrator**
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- **Jennifer Wyatt – JIP Executive Committee Chair**
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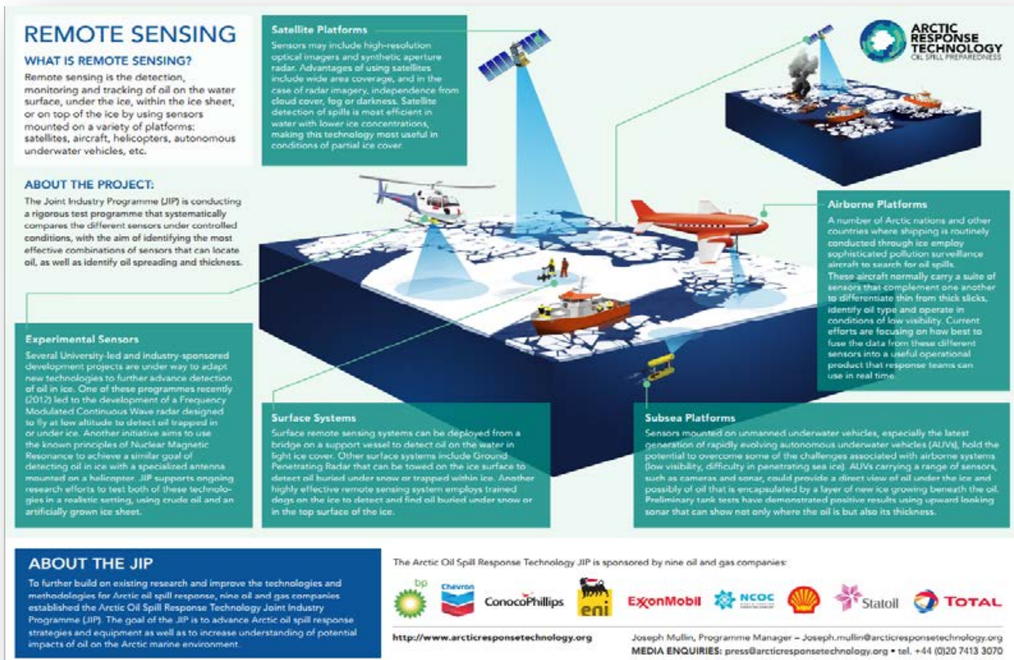
**Visit the programme website at: www.arcticresponsetechnology.org**

# CURRENT UNDERSTANDING – REMOTE SENSING




**The industry has a range of airborne and surface imaging systems utilised from helicopters, fixed-wing aircraft, vessels and drilling platforms that can be used for ice conditions**



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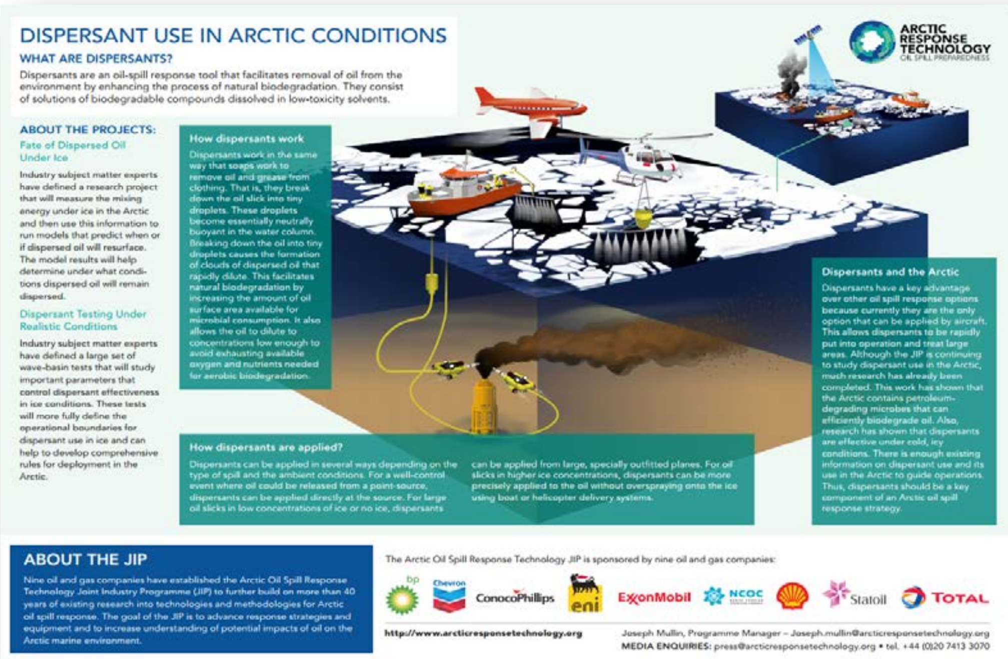
# CURRENT UNDERSTANDING - DISPERSANTS

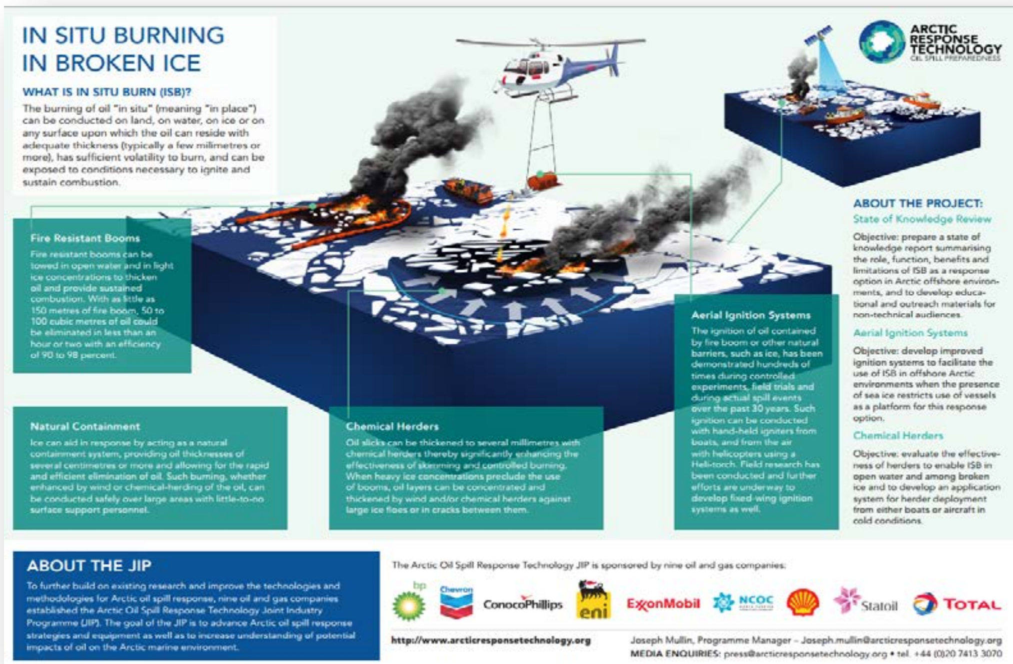



**Dispersants can work in the Arctic and will, under certain conditions, be more effective in the presence of ice than in open water**

**The presence of ice can increase the time window within which dispersants can be used effectively**

**There is need for a discussion around potential obstacles to achieving permission to conduct dispersant operation in ice-prone regions**

# CURRENT UNDERSTANDING – IN SITU BURN (ISB)




**Technology exists to conduct controlled ISB of oil spilled in a wide variety of ice conditions**

**ISB is one of the response techniques with the highest potential for oil spill removal in arctic conditions and the industry should consider regulation that will support its use**

**Most of the perceived risks associated with burning oil are able to be mitigated**



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