

State-of-the-Science of Dispersants and Dispersed Oil (DDO) in U.S. Arctic Waters:



***Doug Helton,
NOAA Emergency Response Division
ARRT, May 16, 2019***



University of New Hampshire

Coastal Response Research Center and Center for Spills and Environmental Hazards

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The Coastal Response Research Center (CRRC) was established as a partnership between the National Oceanic Atmospheric Administration (NOAA), through the Office of Response and Restoration (OR&R) and the University of New Hampshire (UNH) in 2004.



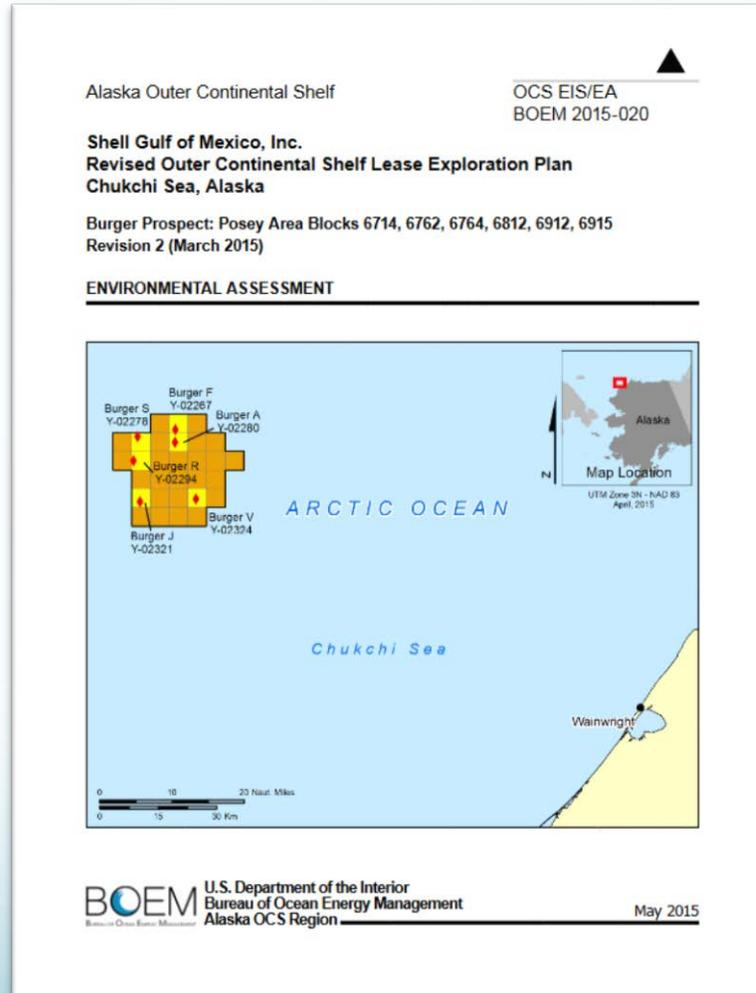
The Center for Spills and Environmental Hazards (CSE) is a University center that expands the scope of interaction and cooperation with the private sector, other government agencies and universities.

The Centers are administered by, and located at, the UNH campus in Durham, NH. Both centers are affiliated with the UNH School of Marine Science and Ocean Engineering (SMSOE). [Center one-pager here](#)>> 

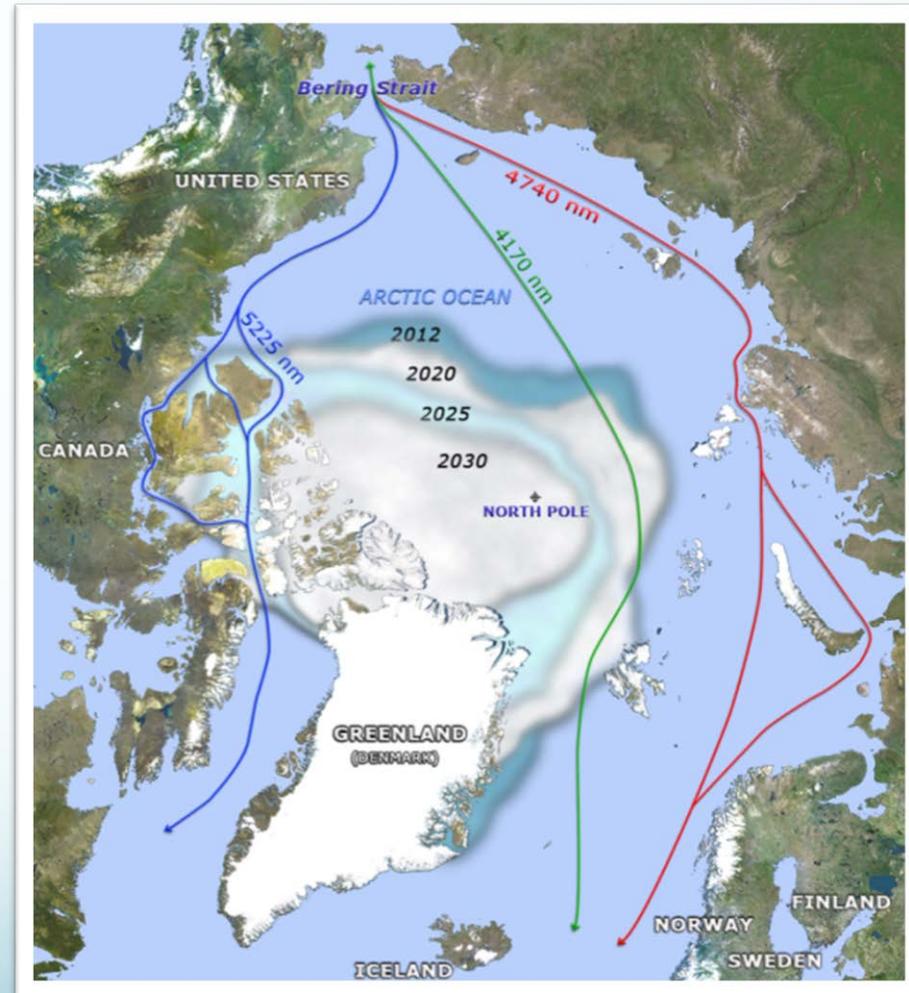
Origins of the Project



Deepwater Horizon



Shell Exploration in the Chukchi



Increased Arctic Vessel Traffic



13 Executive Seminar
EXERCISE SCENARIO (September 20th, 2014)
Oil Location on September 26, 2014 1700hr

Mr. David Kennedy
National Oceanic & Atmospheric Administration

Mr. Larry Hartig
State of Alaska

Ambassador David Balton
Department of State

Mr. Bruce Gelber
Department of Justice

Mr. Bruce Salerno

Mr. [Name]

Mr. [Name]

Mr. [Name]

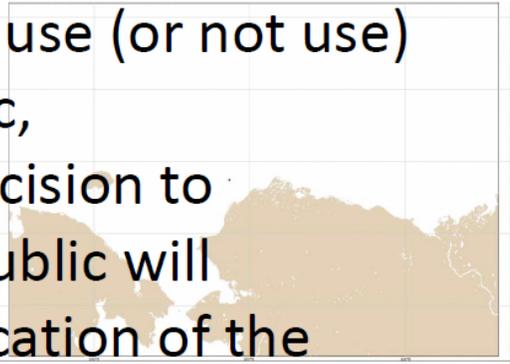
Mandate from the Arctic SONS Executive Seminar

2013 Lesson Learned

2013 Late Summer Scenario

2014 Late Summer Scenario

If a decision is made to use (or not use) dispersants in the Arctic, communicating that decision to stakeholders and the public will require clear communication of the science contributing to that decision.



Corrective Action

- Develop Summary of the State of Dispersant Science
 - 1) What we know
 - 2) What we don't know
 - 3) Key issues of which senior leadership should be aware
- Collaborate with ongoing efforts in Alaska

Key Questions

1. Efficacy and Effectiveness; 
 - Will they work in ice and cold water?
2. Physical Transport and Chemical Behavior; 
 - Where will the dispersed oil go?
3. Degradation and Fate; 
 - How long will it take for the oil and dispersants to degrade?
4. Eco-Toxicity and Sublethal Impacts; and 
 - What are the impacts on food webs and animals?
5. Public Health and Food Safety. 
 - What are the risks for workers, public, and subsistence users?

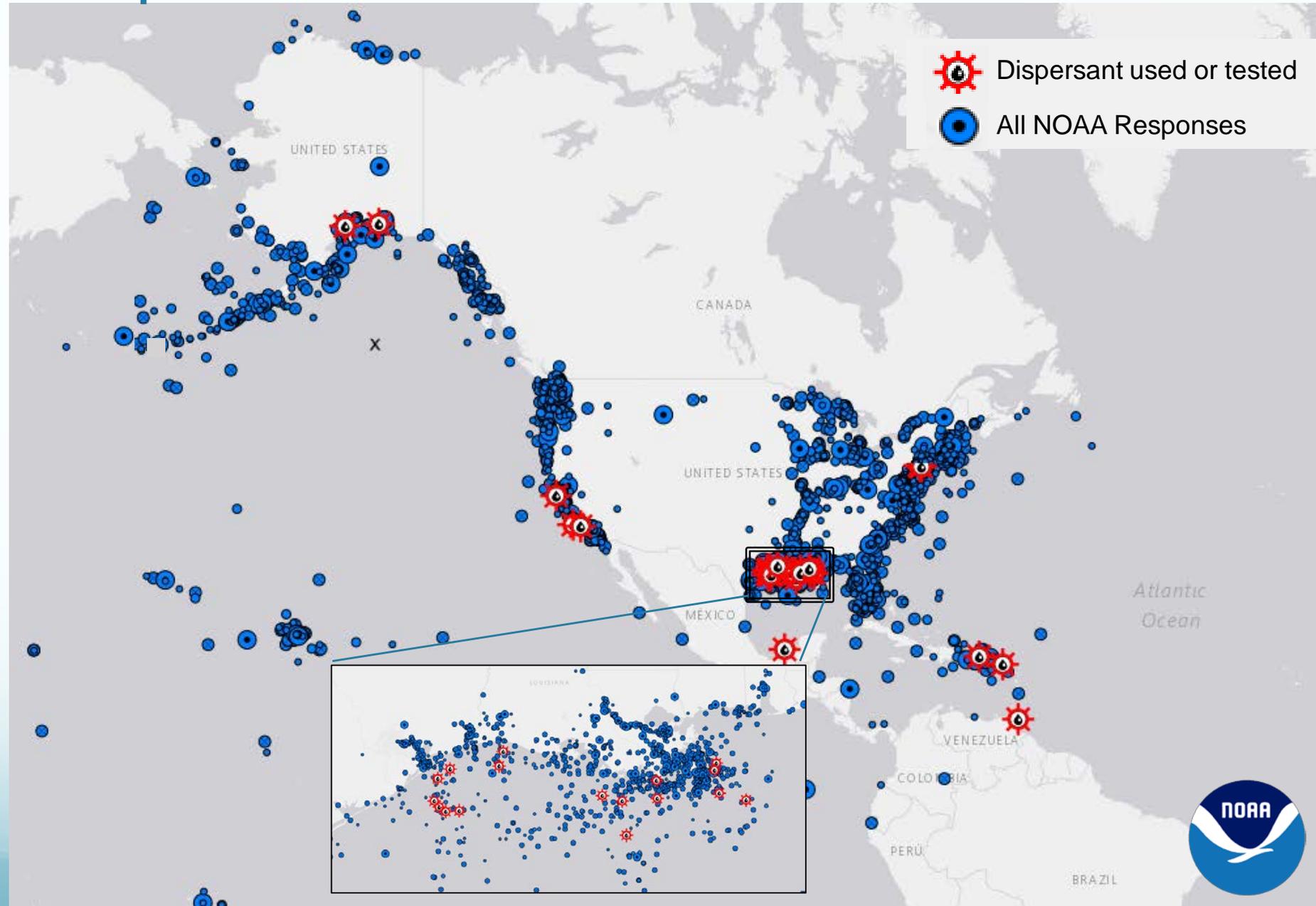
Why even consider dispersants?

- Conventional response equipment challenged by
 - Weather and Ice
 - Logistics and Infrastructure
 - Time and distance



Dispersant Use 1968-2018

- Rarely used in the U.S
- None in Arctic
- 27 incidents in or near U.S. Waters
- Mostly in the Gulf of Mexico
- Many were small scale tests and not operationally significant
- no use since the 2010 (DWH)



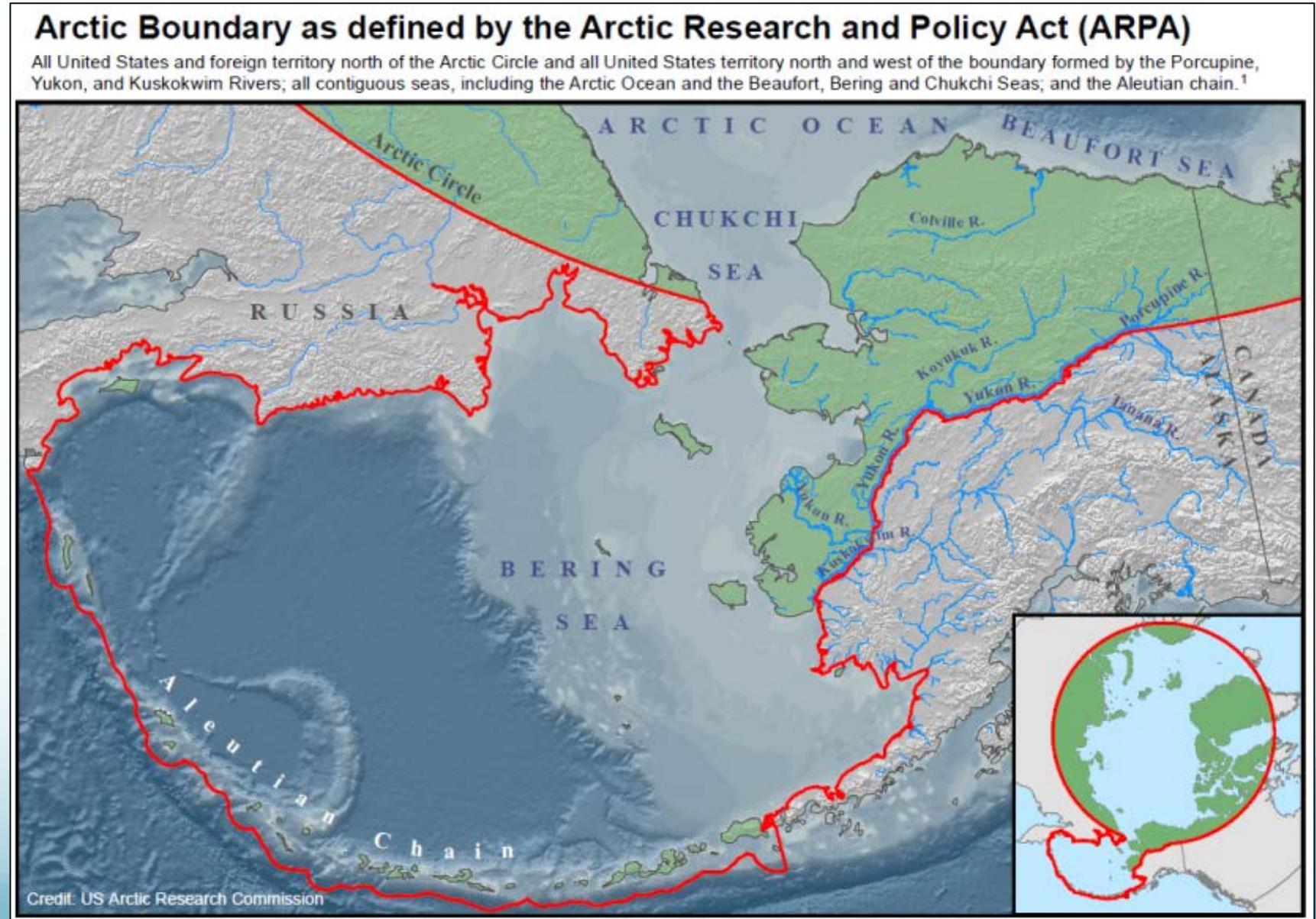
Caveats, Omissions and Limitations

- Peer reviewed literature
- Mostly focused on surface application
- Mostly focused on Corexit products in U.S. and post-DWH research
- December 2015 publication cutoff date for consideration of material
- Recent DWH studies including several recent health assessments were not considered but are reviewed elsewhere (e.g., PWSRCAC)
- Does not consider logistical or operational issues, which also will be significant in the Arctic



More Caveats

- Not focused on future research priorities
- Broad definition of the Arctic
- Summary conclusions are ours....



#1: Efficacy and Effectiveness



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6-2017

2017 State-of-the-Science of Dispersants and
Dispersed Oil (DDO) in U.S. Arctic Waters:
Efficacy & Effectiveness

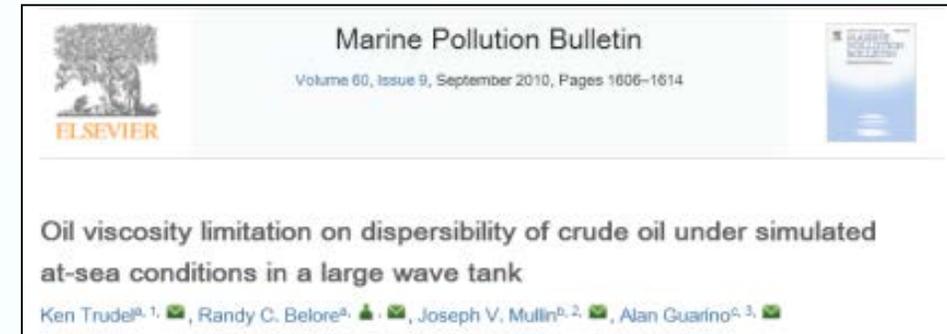
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Will they work in Arctic conditions?

Efficacy and Effectiveness

- Dispersants will work in cold marine water, but oils become more viscous in cold temperatures.
- Oils that disperse in temperate conditions will generally disperse in cold water if they remain fluid.
- Wave energy is needed to mix the dispersants and promote the dispersion process.
- Ice cover and low temperatures may increase the length of time favorable for dispersant use.



#2: Physical Transport and Chemical Behavior



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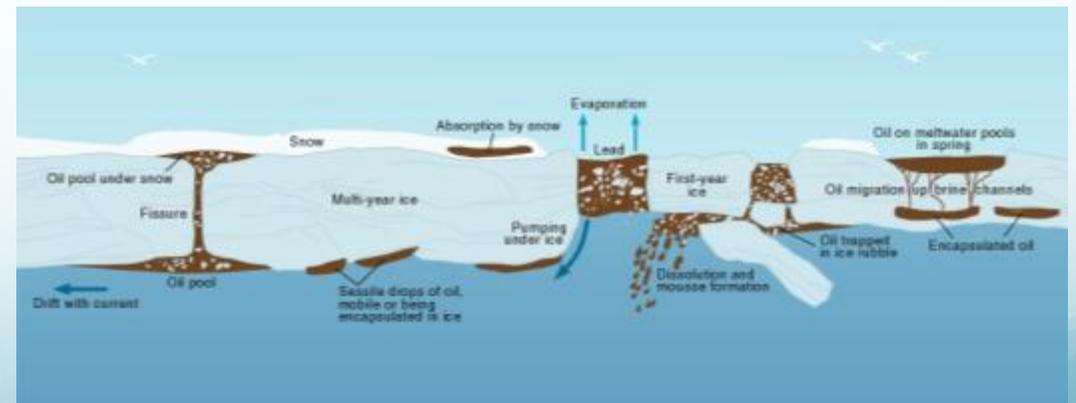
2017 State-of-the Science of Dispersants and Dispersed Oil (DDO) in U.S. Arctic Waters: Physical Transport and Chemical Behavior

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Where will the dispersed oil go?

Physical Transport and Chemical Behavior

- Dispersants increase the amount of oil in the water column.
- There are many forms and stages of sea ice and all forms of ice affect oil movement and behavior.
- Oil and dispersant frozen into ice can move long distances and then be released during melting and breakup
- Seasonal freshwater inputs and transitional conditions during ice formation and break-up, make oil transport modeling difficult.



#3: Degradation and Fate



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2017 State-of-the Science of Dispersants and
Dispersed Oil (DDO) in U.S. Arctic Waters:
Degradation and Fate

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How long will it take to degrade?

Degradation and Fate

- Dispersants can enhance biodegradation of oil by increasing interfacial area.
- Dispersants create smaller oil droplets than those from physical dispersion.
- Chemically-dispersed oil is frequently (but not always) observed to degrade faster than physically-dispersed oil.
- Oil degrading bacteria are present and can degrade crude oil in cold Arctic waters, but this process will occur more slowly than in temperate waters.
- Some oil compounds degrade rapidly while others are very slow to degrade.



PLoS One. 2014; 9(1): e84297.

Published online 2014 Jan 8. doi: [10.1371/journal.pone.0084297](https://doi.org/10.1371/journal.pone.0084297)

Biodegradation of Dispersed Oil in Arctic Seawater at -1°C

[Kelly M. McFarlin](#),^{1,*} [Roger C. Prince](#),² [Robert Perkins](#),³ and [Mary Beth Leigh](#)¹

Jonathan H. Badger, Editor

#4 Eco-Toxicity and Sublethal Impacts



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5-2018

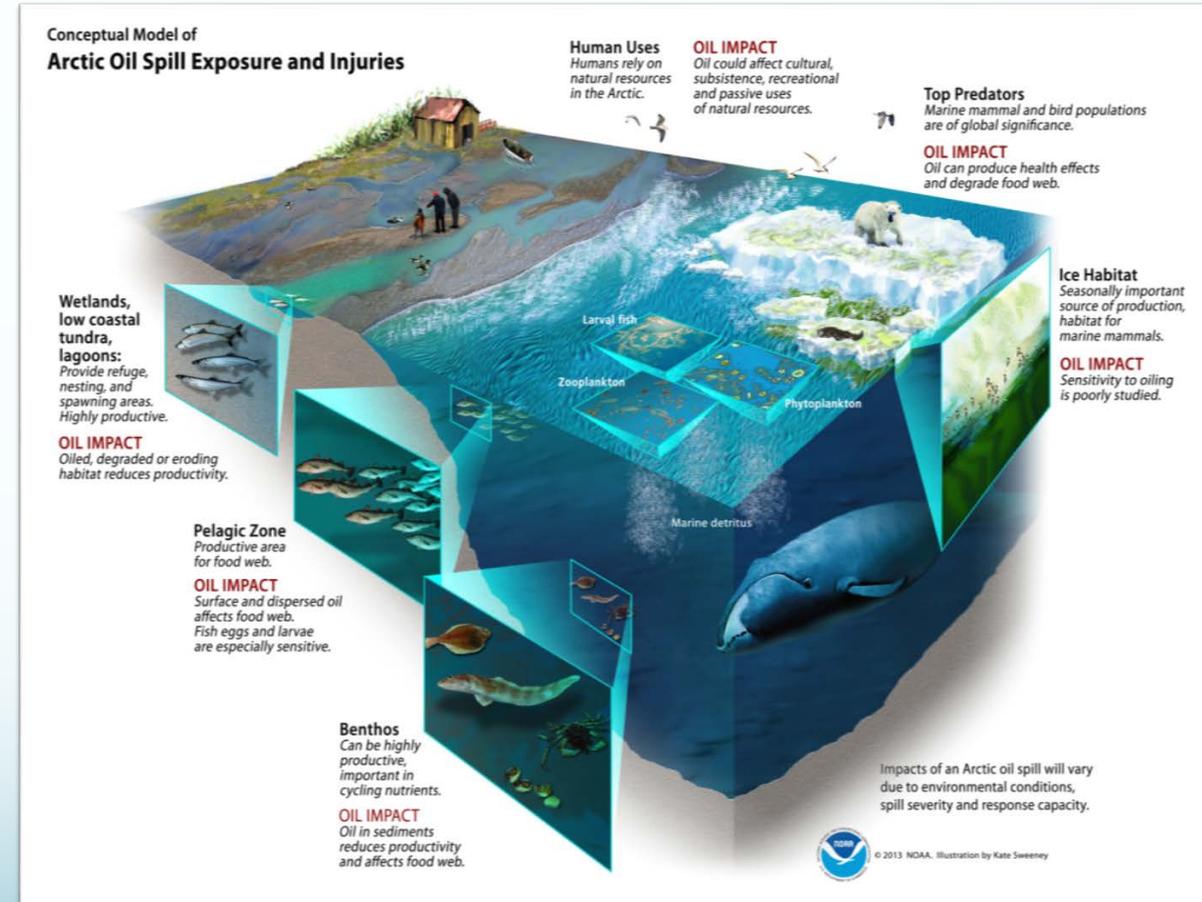
2018 State-of-the Science of Dispersants and Dispersed Oil (DDO) in U.S. Arctic Waters: Eco-Toxicity and Sublethal Impacts

Coastal Response Research Center (CRRC)

What are the impacts on food webs and animals?

Eco-Toxicity and Sublethal Impacts

- Dispersants reduce exposure to surface and intertidal species and increase exposure to species in the water column.
- Toxicity data are very limited for Arctic species but some fish species and life stages appear to be very sensitive to oil.
- Dispersants do not change the toxicity of the oil but increase the exposure to the oil
- Many laboratory studies and standard toxicity tests can miss ecologically important endpoints.



What are the impacts on food webs and animals?

Eco-Toxicity and Sublethal Impacts (2)

- Sea ice is a unique habitat
- Under-ice communities are unique in their concentration and composition of species, some of which exist nowhere else. This habitat could be exposed to particulate, floating and dissolved contaminants.
- Oil can concentrate in the leads between ice floes and in breathing holes. Mammals and birds using these areas would be vulnerable to surface (undispersed) oil.



Environ Toxicol Chem. Oct 2013; 32(10): 2284–2300.

PMCID: PMC4282318

Published online Aug 14, 2013. doi: [10.1002/etc.2307](https://doi.org/10.1002/etc.2307)

The acute toxicity of chemically and physically dispersed crude oil to key arctic species under arctic conditions during the open water season

[William W Gardiner](#),[†] [Jack Q Word](#),^{*†} [Jack D Word](#),[†] [Robert A Perkins](#),[‡] [Kelly M McFarlin](#),[‡] [Brian W Hester](#),[†] [Lucinda S Word](#),[†] and [Collin M Ray](#)[†]

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#5 Public Health and Food Safety



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2019 State-of-the-Science of Dispersants and
Dispersed Oil (DDO) in U.S. Arctic Waters: Public
Health and Food Safety

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What are the risks for workers, public, and subsistence users?

Public Health and Food Safety

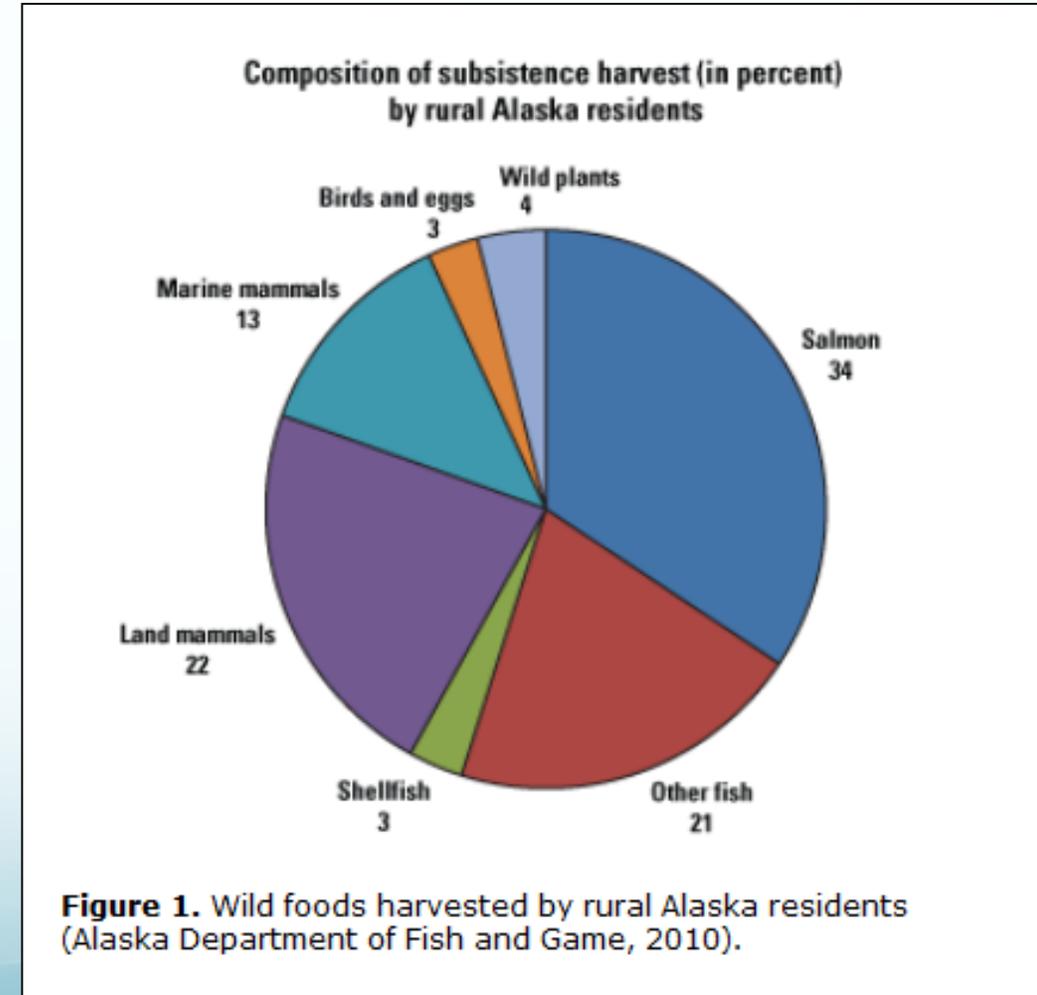
- Limited studies have been conducted to assess human health impacts of oil and dispersants.
- It is difficult to disentangle health effects of oil alone, dispersant alone, dispersed oil, stress, or any combination.
- Responders are at greater risk than public. Responders directly handling oil and dispersants are at greatest risk.
- Symptoms such as throat irritation, eye irritation, nausea, headache and cough were commonly observed.



What are the risks for workers, public, and subsistence users?

Public Health and Food Safety (2)

- National seafood consumption rates are not representative of consumption by local populations in the Arctic
- Baseline health information of Arctic populations at potential risk from exposure to oil and dispersants are lacking.
- Dispersant constituents did not accumulate in edible tissues of Gulf crab and finfish following DWH.
- Poor risk communication regarding seafood safety may have negative public health consequences.



This is a summary prepared by NOAA's Office of Response and Restoration

- Interested readers should review the full reports at https://crrc.unh.edu/dispersant_science
- Efficacy and Effectiveness;
 - <https://scholars.unh.edu/crrc/1/>
- Physical Transport and Chemical Behavior;
 - <https://scholars.unh.edu/crrc/4/>
- Degradation and Fate;
 - <https://scholars.unh.edu/crrc/3/>
- Eco-Toxicity and Sublethal Impacts;
 - <https://scholars.unh.edu/crrc/2/>
- Public Health and Food Safety.
 - <https://scholars.unh.edu/crrc/22/>



Office of Response and Restoration

OIL AND CHEMICAL SPILLS

ENVIRONMENTAL RESTORATION

MARINE DEBRIS

DISASTER PREPAREDNESS

