The Value of Dispersants for Oil Spill Response

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Dispersant Workshop
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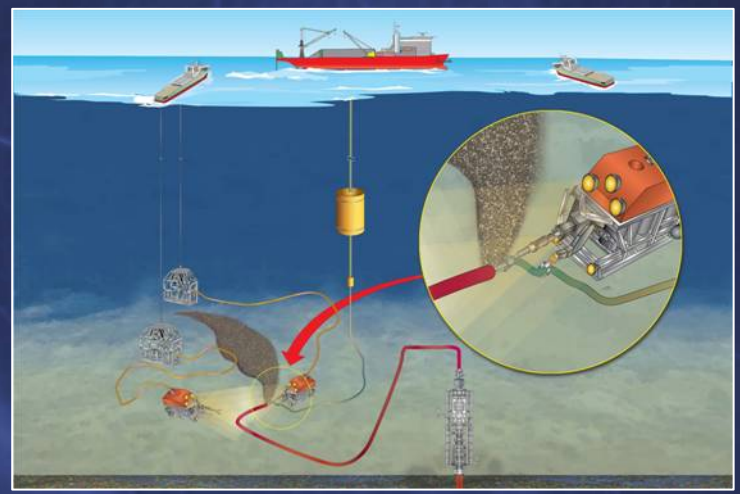
ExxonMobil

Introduction

Topics of Discussion

- Oil spill response options
- Background on dispersants
- Deepwater Horizon Incident
- Summary

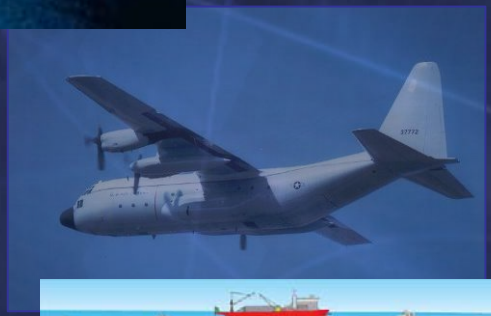


Spill Response Options: *The Toolbox*

Mechanical Recovery: Booms & Skimmers

Monitor & Evaluate

In-Situ Burning

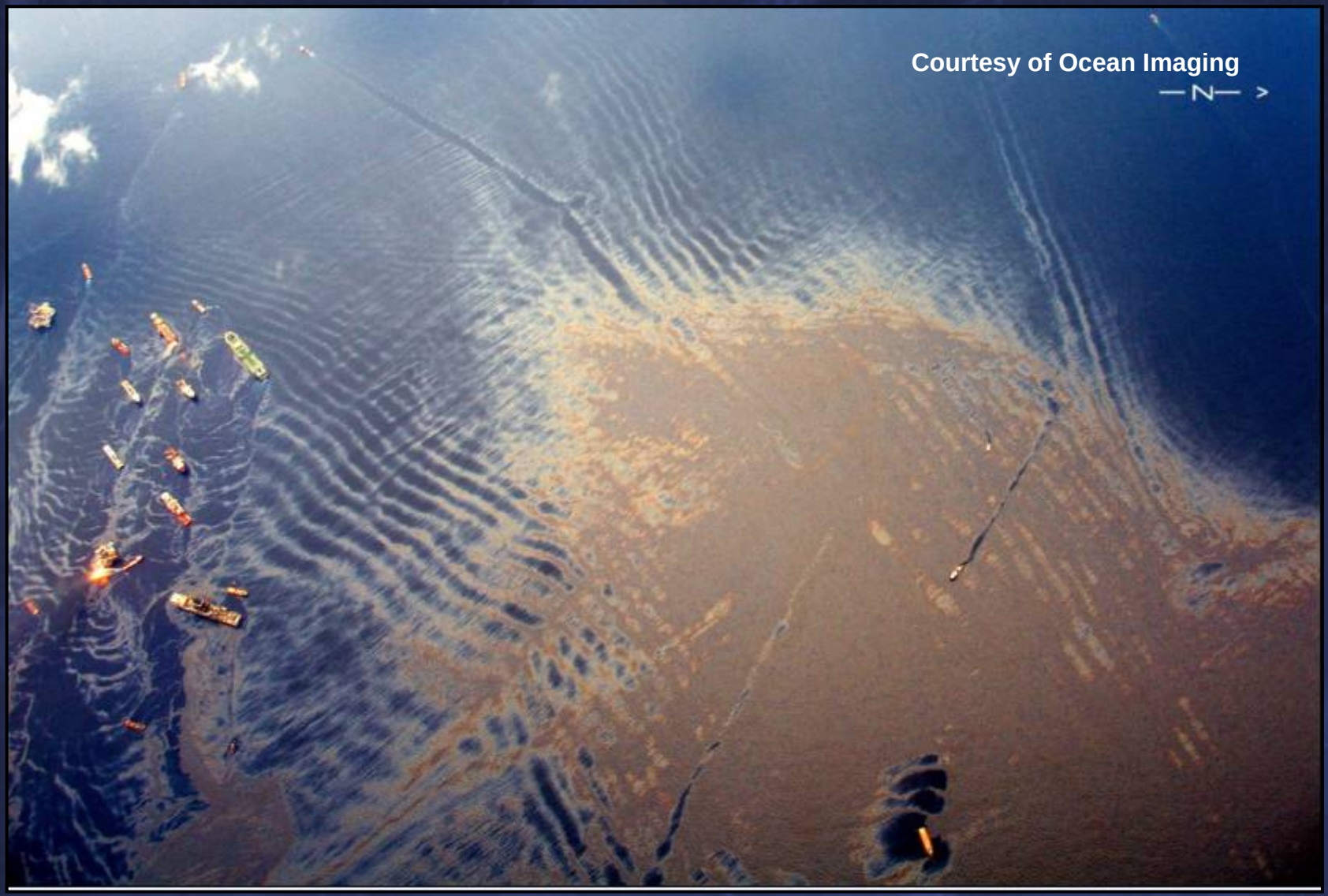


Aerial Dispersants

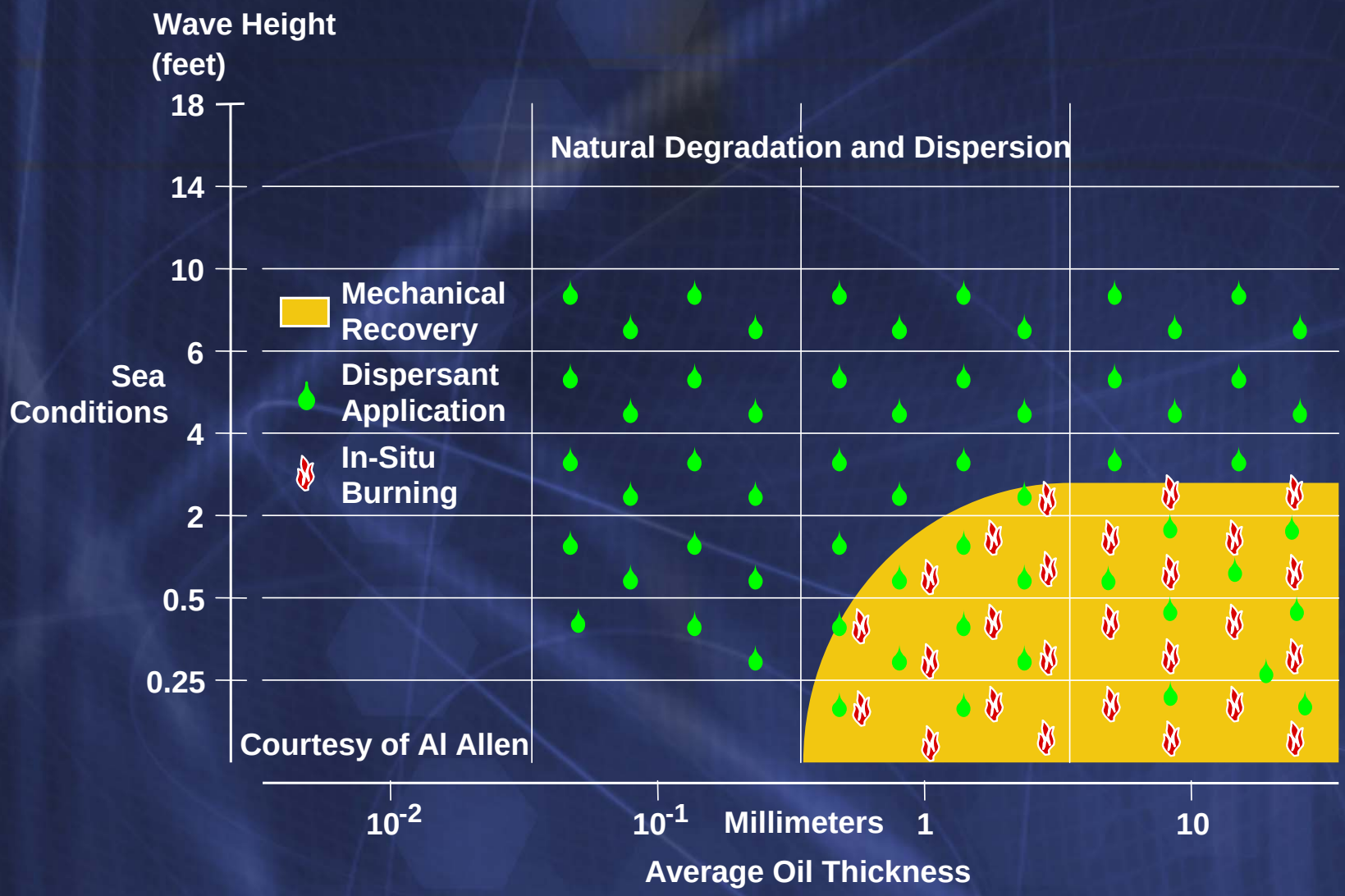
Subsea Dispersants

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

Encounter Rate is Key to Offshore Response

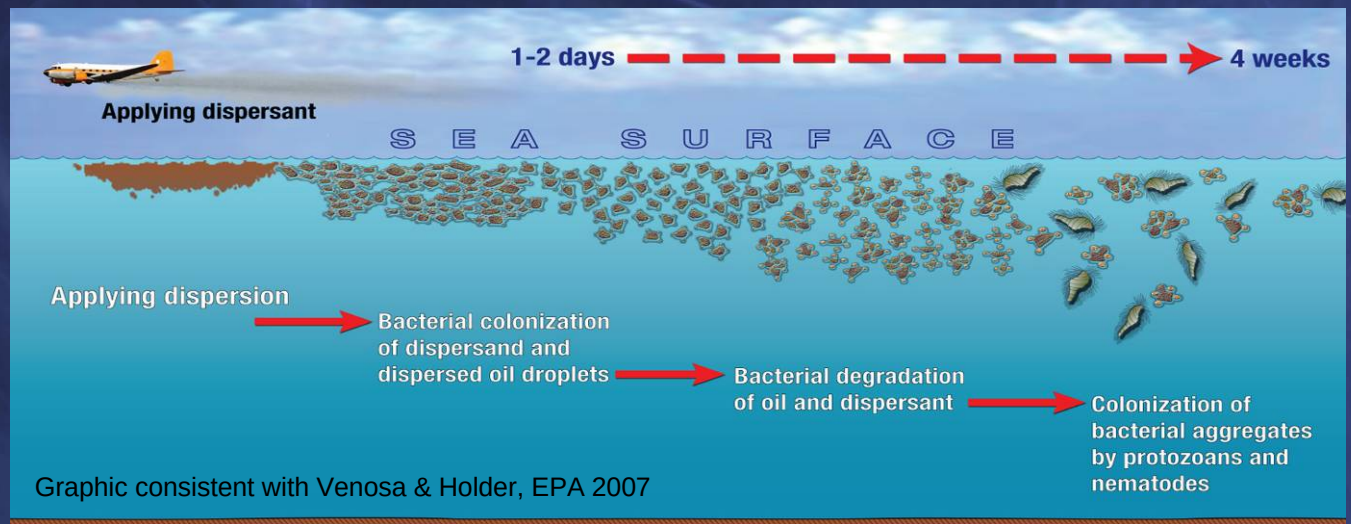


Spill Conditions Limit Response Options



Dispersants – What are they?

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



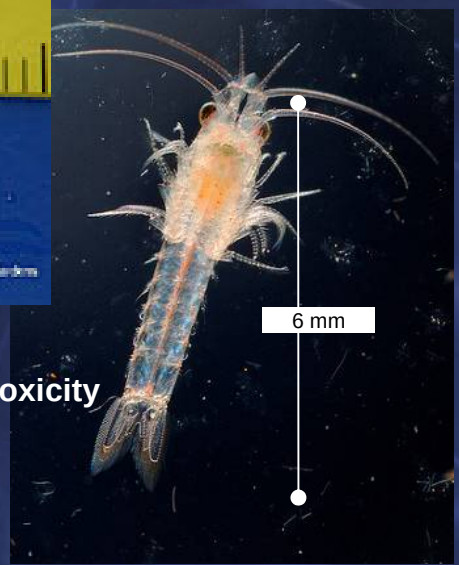
Graphic consistent with Venosa & Holder, EPA 2007

Rapid dilution limits environmental impacts

- A simple calculation illustrates how rapidly dispersed oil dilutes
  - A low-viscosity oil spreads to an average thickness of 0.1 mm
  - 1-m waves rapidly mixes dispersed oil into the top 1 – 1.5 m of the water column
  - Dilution by a factor of 10,000 to an average hydrocarbon concentration of 100 ppm.
- Wave tank studies found rapid dilution
  - Li et al. (2009) found concentrations of 12 to 2 ppm within 60 minutes 10 m downstream
  - Belore et al. (2009) found concentrations from 5 ppm to 147 ppm
- Wave-tank data is confirmed by field tests (McAuliffe et al.,1980; Cormack and Nichols, 1977; Daling and Indrebo, 1996)
- We expect dispersed oil concentration below 10 ppm in 24 hours and likely below 1 ppm
- All prior research on dispersed oil biodegradation failed to recognize rapid dilution
  - Lindstrom and Braddock [2002] used concentrations of 1400 - 4500 ppm
  - Swannell and Daniel [1999] used concentrations of 266 ppm
  - Davies et al. [2001] used 250 ppm
  - Yoshida et al. [2006] used 227 ppm
  - Zahed et al. [2010] used concentrations ranging from 100 - 2000 ppm
  - Venosa and Holder [2007] used 830 and 83 ppm
- Recent publications continue to use unrealistically high concentrations
  - Milinkovitch et al., 2011 / Luna-Acosta, 2011

Environmental Impacts

- Toxicity of oil > toxicity of the dispersant
- Modern dispersants use ingredients found in household products



Organisms used in EPA's toxicity tests

Other Uses of Corexit 9500 Ingredients (from Nalco website)

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

ExxonMobil's Role in Dispersant Development

1967 – Corexit 7664
Developed the first low-toxicity dispersant for use in the marine environment

1972 – Corexit 9527
Developed a self-mixing dispersant

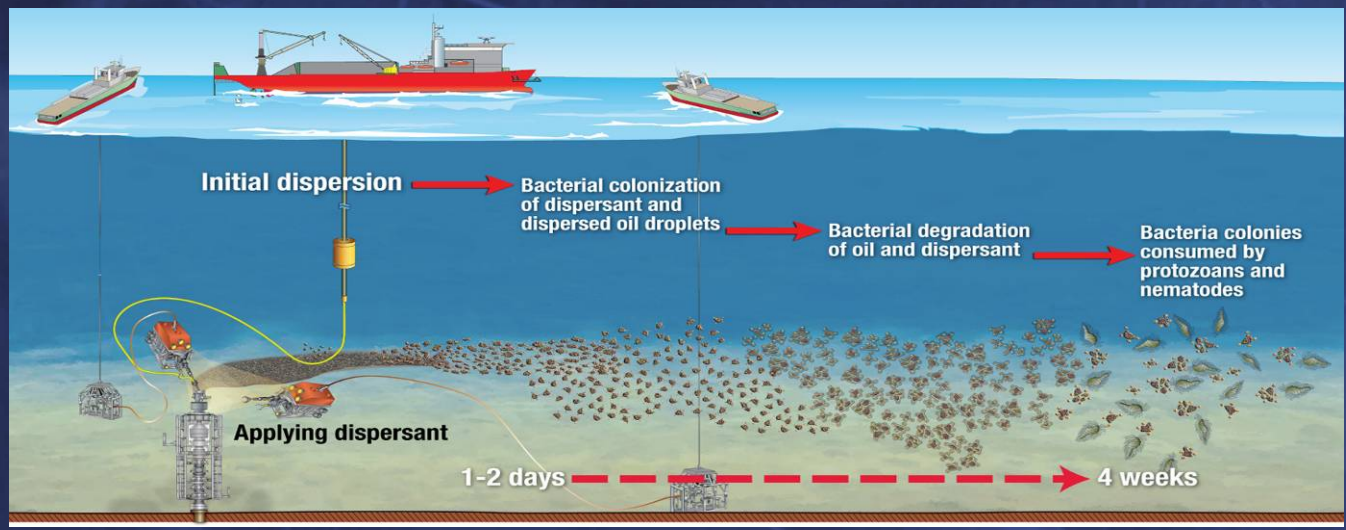
1994 – Corexit 9500
Developed dispersant effective on heavy oil

2002 to 2010
- *Developed a dispersant that requires 3 x less product (yet to be commercialized)*

Beyond 2010
- *Next generation dispersants*

Subsea Injection of Dispersants

- Preliminary observations of DWH experience
- Benefits of subsea injection
- Long-term fate and effects

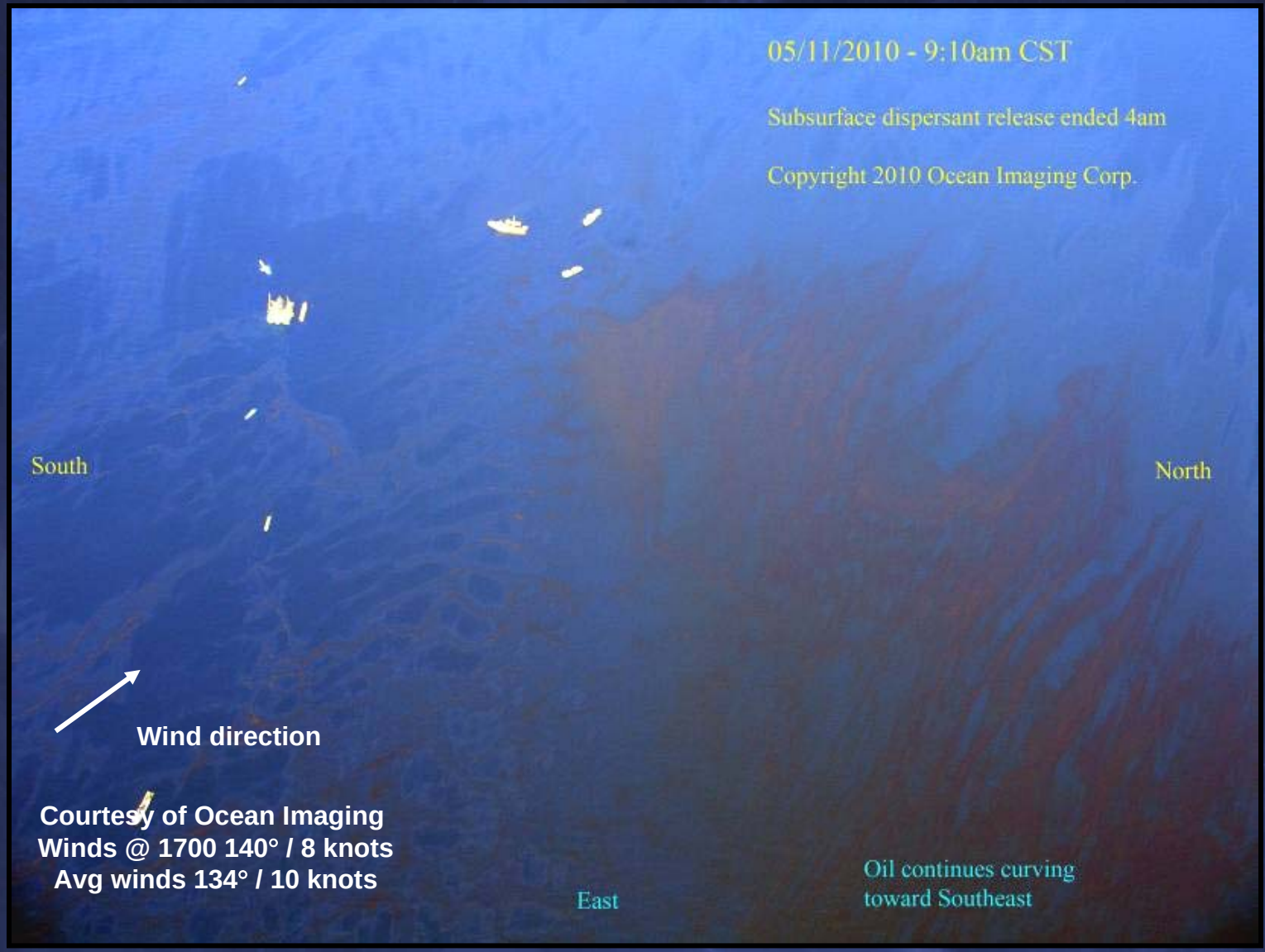


Release Site May 9 Prior to Injection

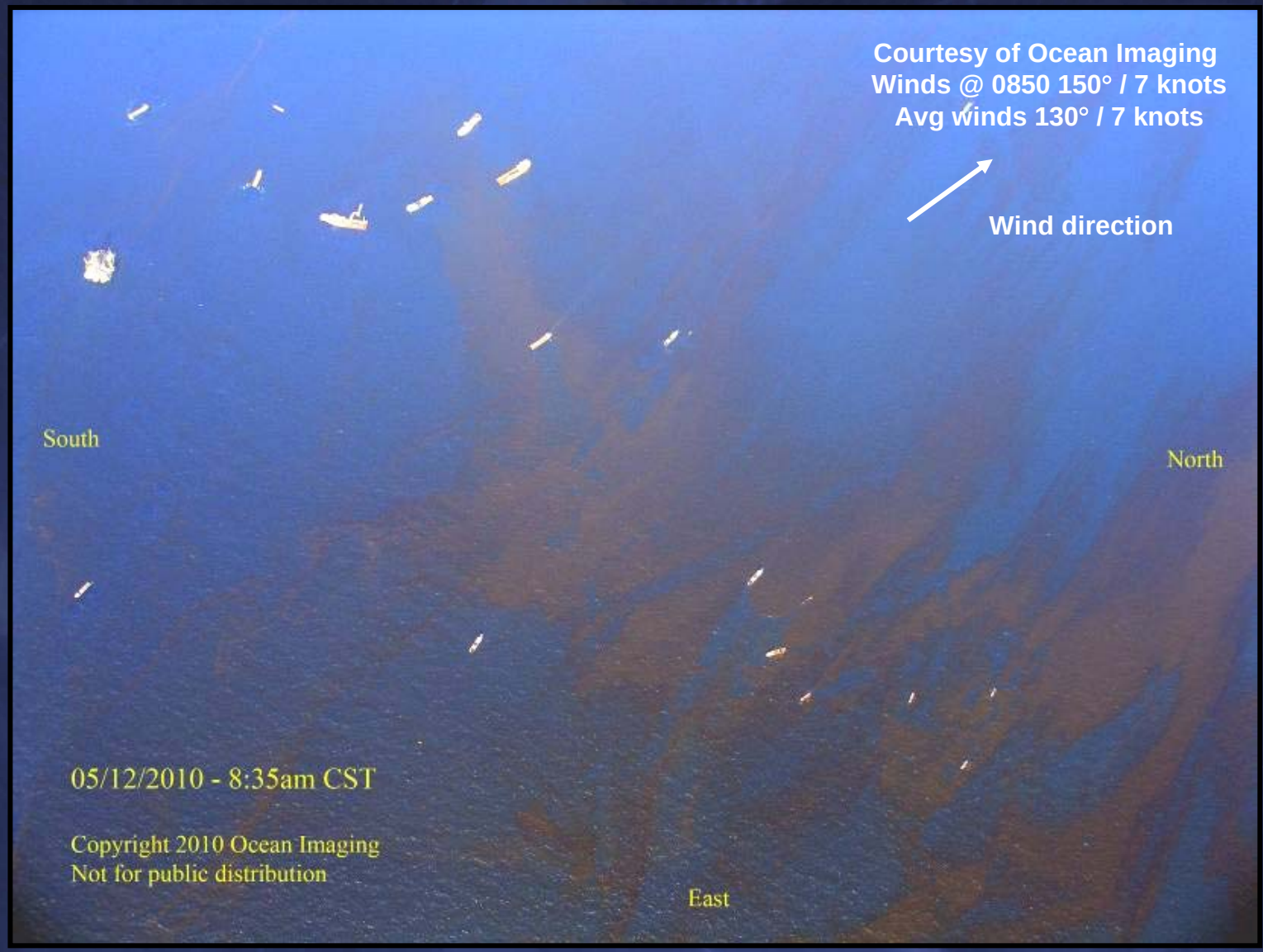
Release Site May 10: 3 hrs of Injection

Release Site May 10: 11 hrs of Injection

Release Site May 11 5 hrs after Injection Ended



Release Site May 12 28 hrs After Injection Ended

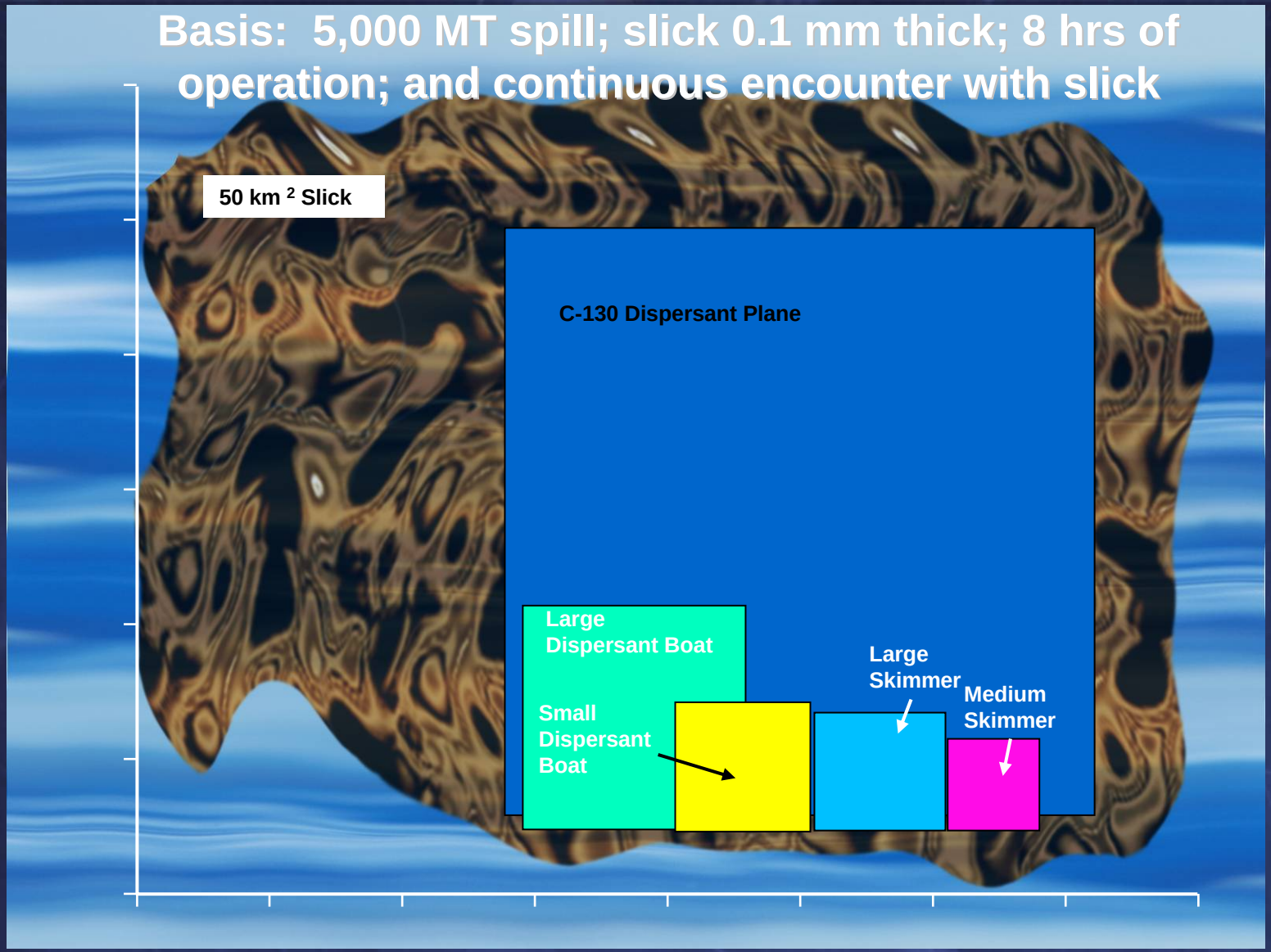


Summary

- Along with prevention, robust oil spill response (OSR) is critical
- Highest priority in emergency response is human health and safety
- Basic strategy for addressing oil spilled from an offshore well
  - Respond as close to the source as possible
  - Utilize all appropriate tools to keep oil from reaching shorelines
- Dispersant use presents a necessary tradeoff given the limitations of mechanical recovery and should be a primary response option
- Subsea injection is a step-change advance that may reduce spill impacts by an order of magnitude
- More research is needed to optimize subsea injection and better understand the long term effects of dispersed oil in deep waters

The End

Encounter Rate is Key to Offshore Response



Advantages of Dispersants

- Accelerates the natural biodegradation process, which removes oil from the environment
- Can minimize safety risks associated with surface collection in rough seas and exposure of personnel to volatile organic vapors
- Rapidly remove surface oil and dilute it into the water column
  - Dispersed plume quickly dissipates in open water by wave action and currents
  - Minimal localized risk to fish populations
  - Affected plankton quickly re-establish
- Reduce the impact on shorelines, sensitive habitats, birds, wildlife, etc.
- Allow rapid treatment of large areas and large volumes of oil - high efficiency response technique, especially when applied subsea
- Offset the formation of emulsions
- Can be used in rough seas, high currents