health & environmental sciences • failure analysis & prevention

# Exponent®

# Dispersants Overview

Presentation to:

NOAA Regional Preparedness Training Session

Galveston TX          May 25 2016

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# Exponent®   NEBA Tradeoffs:                                2

1. **Oil on Water Surface**
2. **Oil on Shoreline**
3. **Oil in Water Column**

*Source: NOAA*

Waterfowl and seabirds are vulnerable to surface oil
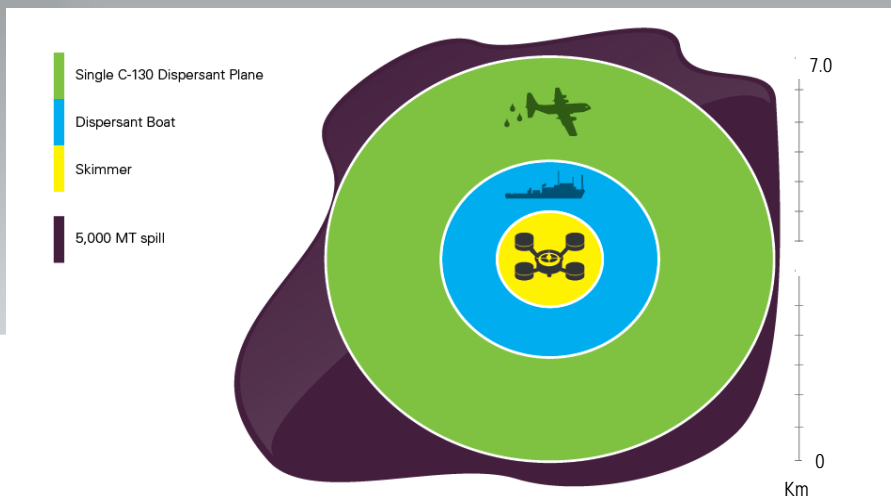
*Source: HDR*

Oil reaching shorelines threaten ecologically valuable nearshore habitats and coastal marshes.

*Source: USGS*

Oil dispersed into the water column may increase exposures of fisheries resources.
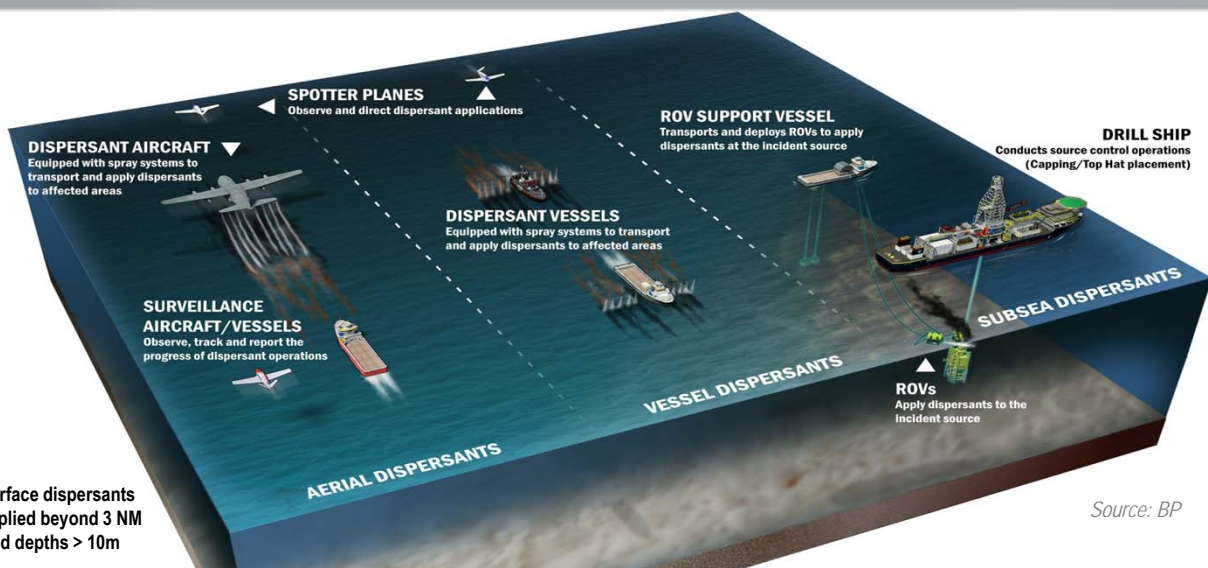
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# And Response Method Strengths Vary

Single C-130 Dispersant Plane

Dispersant Boat

Skimmer

5,000 MT spill

7.0

0

Km

*Source: BP*

**Relative Area Coverage in 2 Days of Operation**



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# Oil Spill Dispersants Response Methods

SPOTTER PLANES
Observe and direct dispersant applications

ROV SUPPORT VESSEL
Transports and deploys ROVs to apply
dispersants at the incident source

DRILL SHIP
Conducts source control operations
(Capping/Top Hat placement)

DISPERSANT AIRCRAFT
Equipped with spray systems to
transport and apply dispersants
to affected areas

DISPERSANT VESSELS
Equipped with spray systems to transport
and apply dispersants to affected areas

SURVEILLANCE
AIRCRAFT/VESSELS
Observe, track and report the
progress of dispersant operations

SUBSEA DISPERSANTS

ROVs
Apply dispersants to the
incident source

VESSEL DISPERSANTS

AERIAL DISPERSANTS

Surface dispersants
applied beyond 3 NM
And depths > 10m

*Source: BP*

**More than 11,500 Whole Water Samples were Collected for DWH between April 20 and August 3, 2010**



**Total PAH Concentrations Between April 20 and August 3, 2010 by Depth**



TPAH (ppb)

| Depth | TPAH |
|---|---|
| 0-1 m n=609 | 0.087 |
| 1-10 m n=712 | 0.091 |
| 10-200 m n=1067 | 0.011 |
| 200-950 m | 0.011 |
| | 0.027 |
| 463 | 0.012 |

- Geometric means were calculated to represent the central tendency of the data

**O-1 max 105000ug/l    1-10 max 44.9 ug/L**

From Morrison, Murray, Cook & Boehm, GoMRI Conference 2016

## Slide 9

E⁴ponent 9
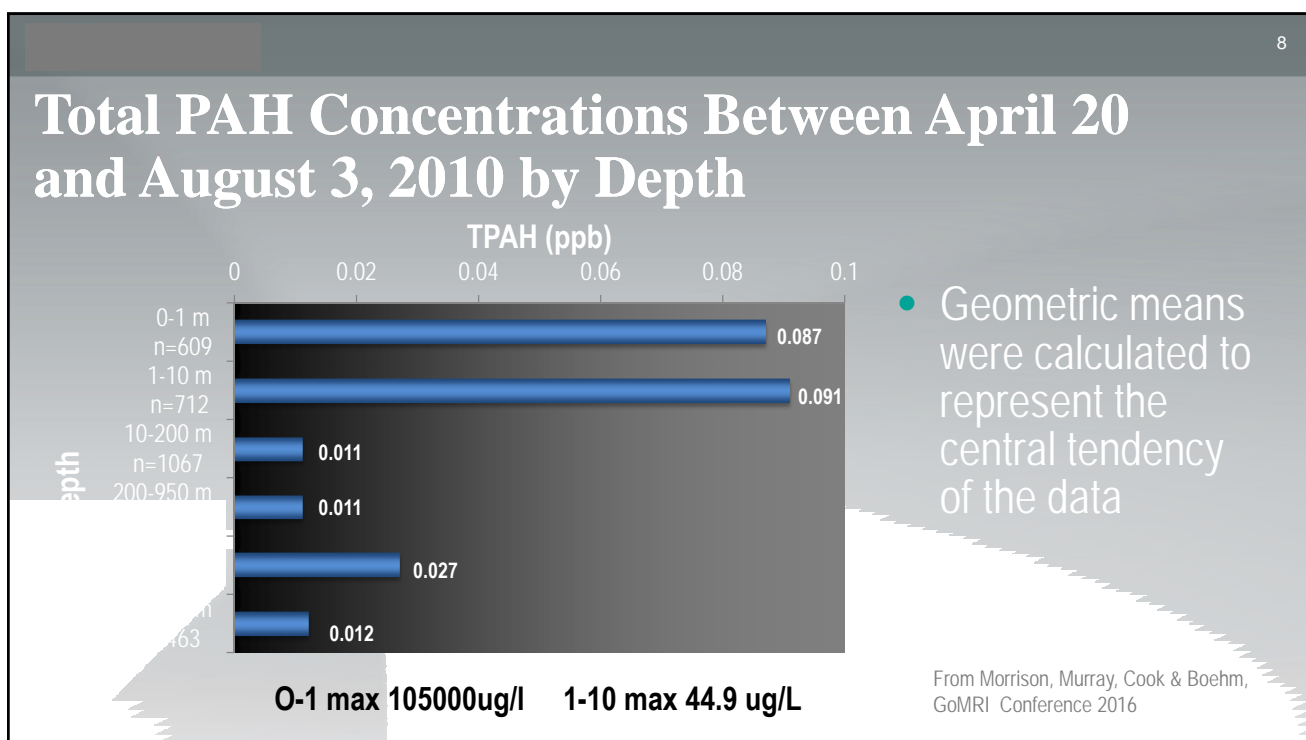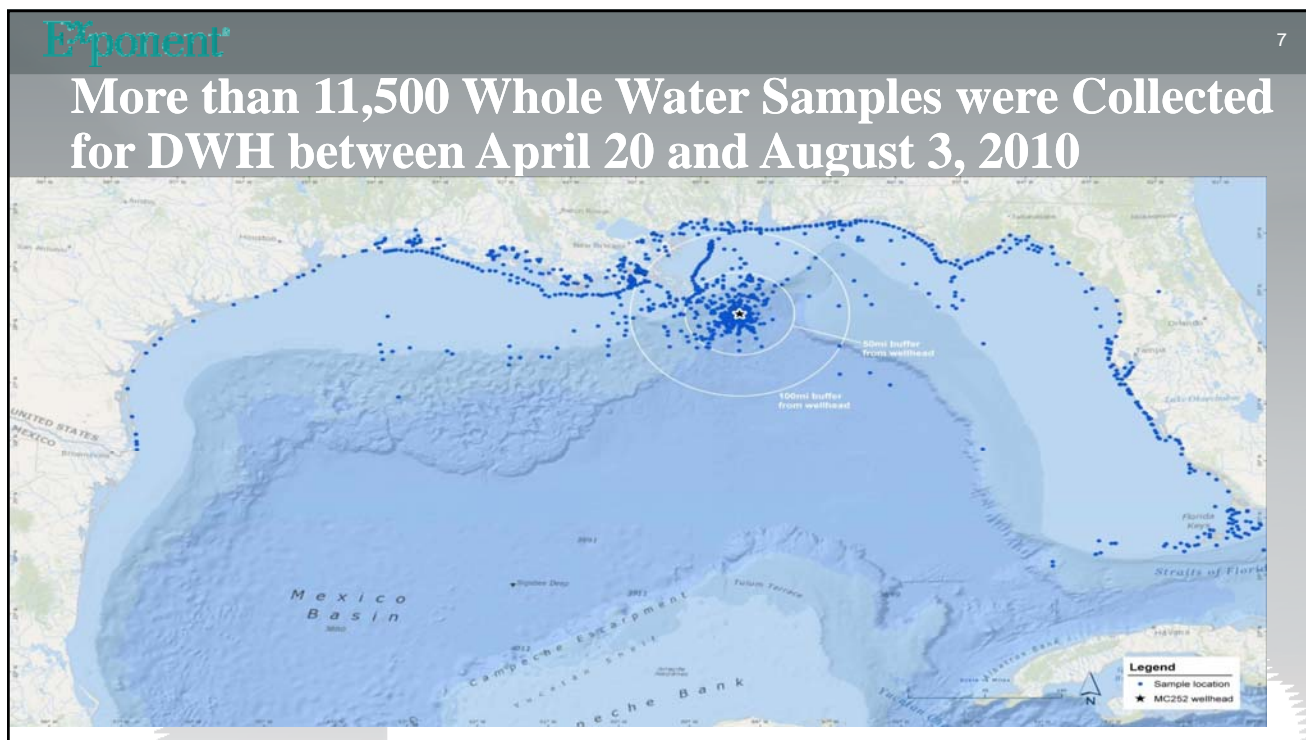
# Depth of Entrainment Can Be Determined By Evaluating Photodegradation of PAHs

**Depletion Difference C1-Chrysene–C4-Chrysene**
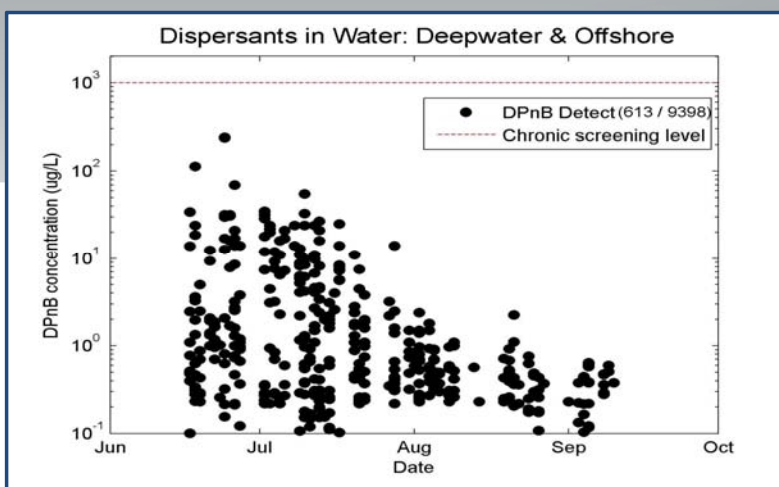
Evidence of Photodegraded Oil · No Evidence of Photodegradation
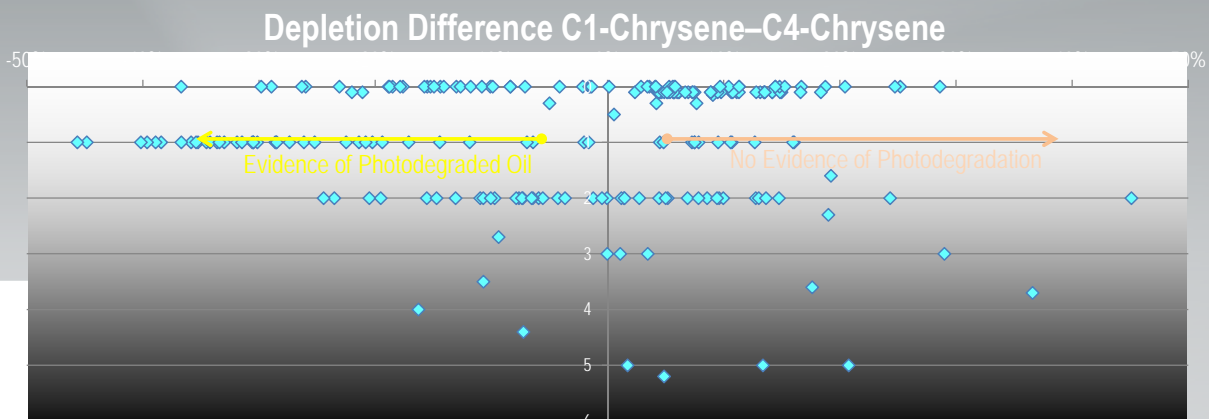
- **No evidence of photodegraded Macondo oil was found at depths below 4.5 meters in the water column**

From Morrison, Murray, Cook & Boehm

## Slide 10

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# Offshore and Deep-water Sampling Zones
## Dispersant Related Chemicals

- **No exceedances of benchmarks for dispersant related chemicals (1mg/L)**

- **Detects for DPnB (one of the more persistent dispersant related chemicals) indicates a decreasing trend in concentrations over time**

Dispersants in Water: Deepwater & Offshore

DPnB concentration (ug/L) vs Date (Jun–Oct)

- DPnB Detect (613 / 9398)
- Chronic screening level

From *Deepwater Horizon MC 252 Operational Science Advisory Team Report* Dec. 2010

## Slide 11

# DWH SMART Tier III Dispersant Application M/V International Peace Study

- **Sampling before and after surface dispersant at 1 ad 10 M depth**

- **TPAH and TPH concentrations variable TPAH <0.01–77.33 µg/L TPH   <0.01–5.1 mg/L)**

- **DPnB concentration <003ug/L to 100 ug/L**

- **94% of data below TPH 5% hazard concentration**

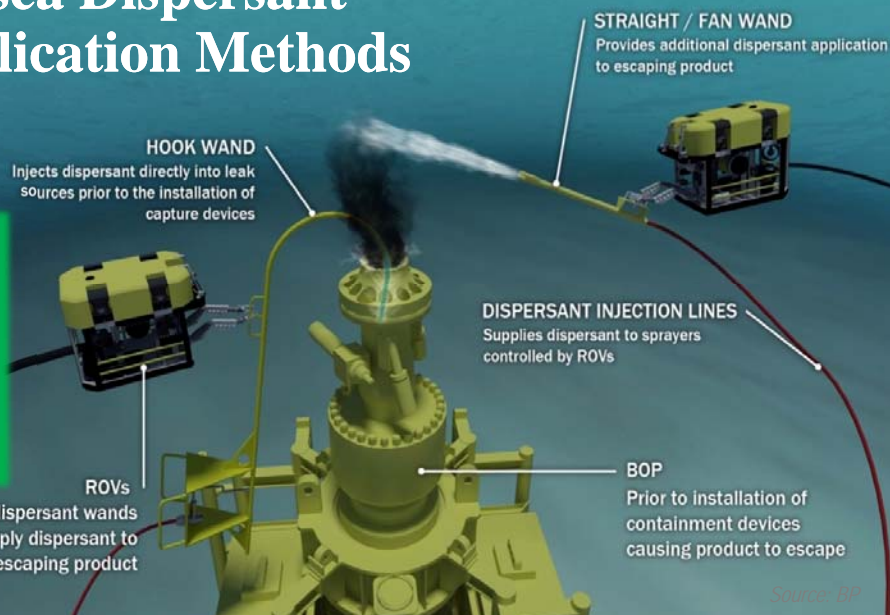Data from Bejarano, Levine & Mearns 2013



## Slide 12
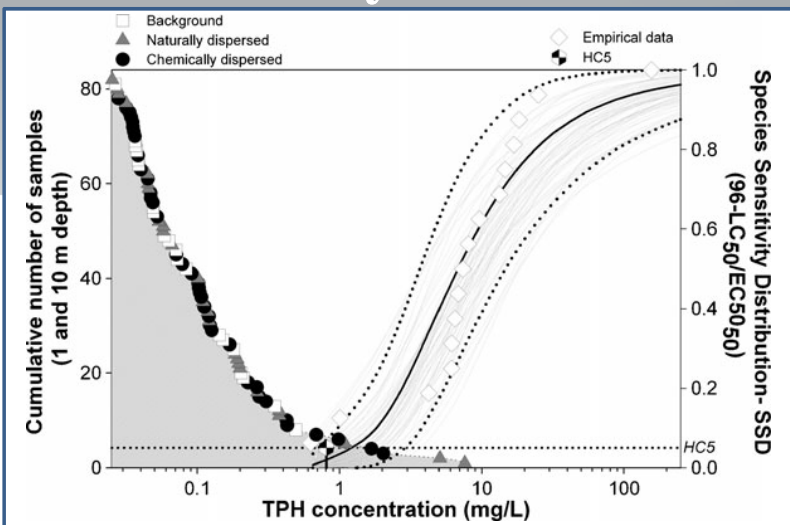
# Subsea Dispersant Application Methods

**Advantages**
- On 24/7 once deployed
- Best encounter rate
- Biggest window of opportunity
- Surface VOC reduction
- Enhances Biodegradation



STRAIGHT / FAN WAND
Provides additional dispersant application to escaping product

HOOK WAND
Injects dispersant directly into leak sources prior to the installation of capture devices

DISPERSANT INJECTION LINES
Supplies dispersant to sprayers controlled by ROVs

BOP
Prior to installation of containment devices causing product to escape

ROVs
Utilize various dispersant wands to inject / apply dispersant to escaping product

Source: BP

**Subsurface release – WITH dispersant injection**

Multiple 100 micron oil droplets?

*Plume of entrained water, oil and hydrate/gas*

*Dispersant* *Outflow of oil and gas*

Large oil droplets will give a more vertical stream of oil resulting in a thick surface oil slick directly above the release point

From SPE 2016 HSSE Conference Paper 179401 • Subsea Dispersant Injection • Brandvik
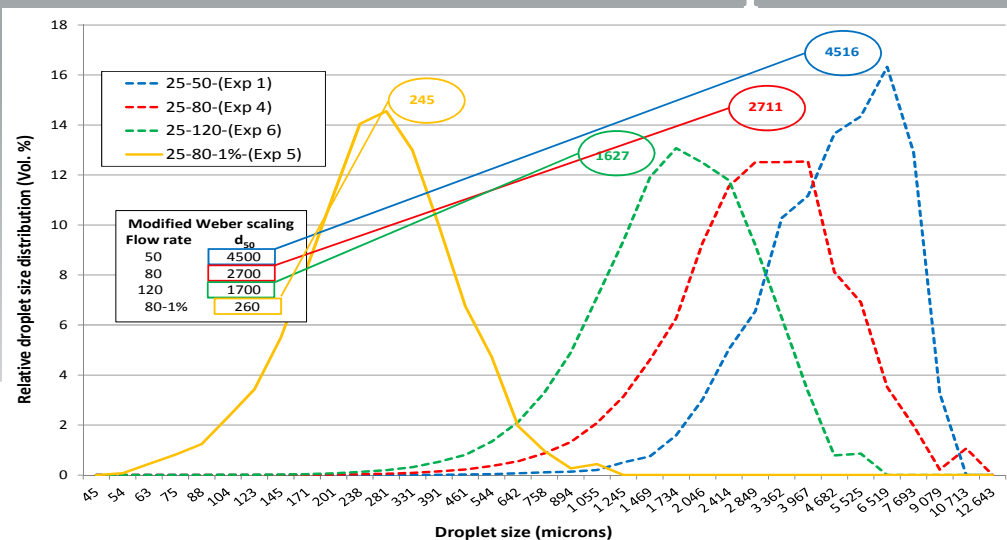


**Large-scale Subsea Dispersant Injection Tests**

**Large-scale testing at Ohmsett, NJ**
**US Bureau of Safety and Environmental Enforcement (BSEE) Facility**

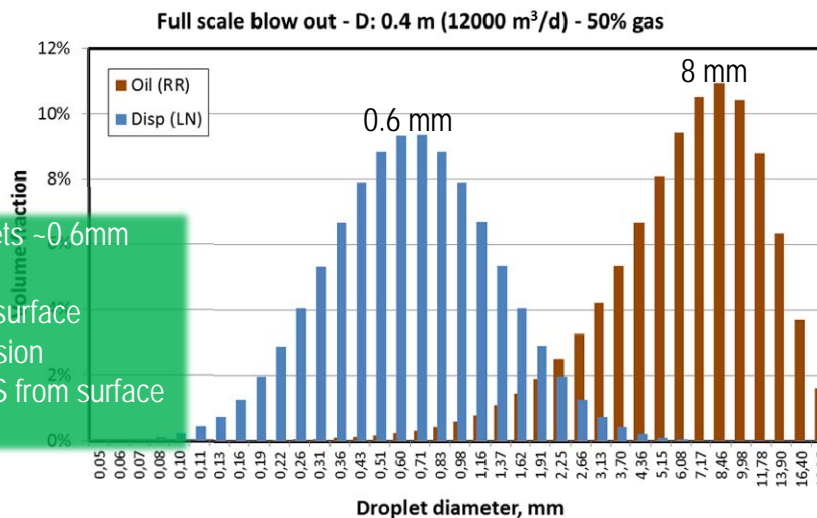From SPE 2016 HSSE Conference Paper 179401 • Subsea Dispersant Injection • Brandvik

Oil droplet sizes (mm) as a function of nozzle size, flow rate and dispersant injection

From SPE 2016 HSSE Conference Paper 179401 • Subsea Dispersant Injection • Brandvik



From Johansen, Brandvik, Farooq 2013

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# Summary

- **FGBNMS Scenarios could involve surface or subsea dispersants**

- **Subsurface dispersants not likely to create direct exposures**

- **Surface oil entrainment with or without dispersants possible concern**
  - DWH data suggests concentrations
    - Total PAH geomean of large data set ~ 0.1 ug/L in 0 to10 M
    - Dispersant range - 0.1 to 300 ug/L
    - TPH can be in ppm range 1 M short term below dispersant application
    - Surface entrainment of oil observed during DWH was less than 5M

- **Much new research on subsurface dispersant**

*Closing Comment: review new dispersant research for realistic conditions*