



Acquisition Directorate

Research & Development Center

Suspended Oil Containment/Protection Techniques

Distribution Statement A: Approved for public release; distribution is unlimited.

**RDC | Kurt Hansen | UNCLAS
OSPR Informational Meeting
Submerged and Sunken Oil
November 15, 2017**



Outline

Define Problem

- **Droplets versus dissolved oil**

Potential Response

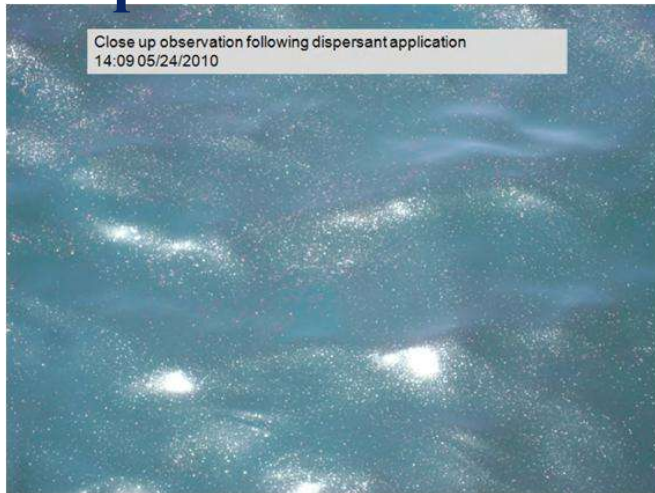
- **Detection**
 - Sonar
 - Fluorescence
 - Wide-Angle Scattering
- **Mitigation**
 - Sorbents
 - Air Bubbles
 - Netting
- **Data Gaps**

Special thanks to Steve Lehmann and Alex Balsley and USGS

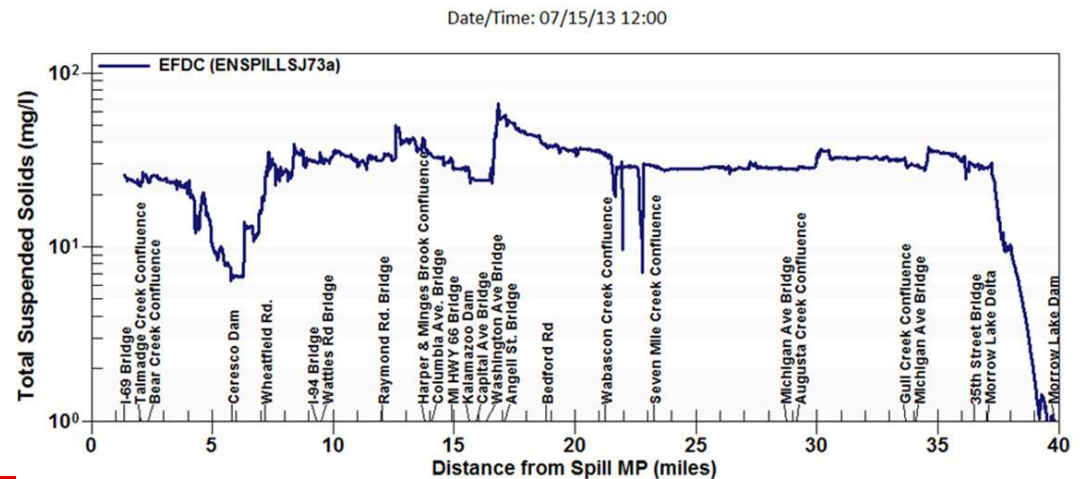
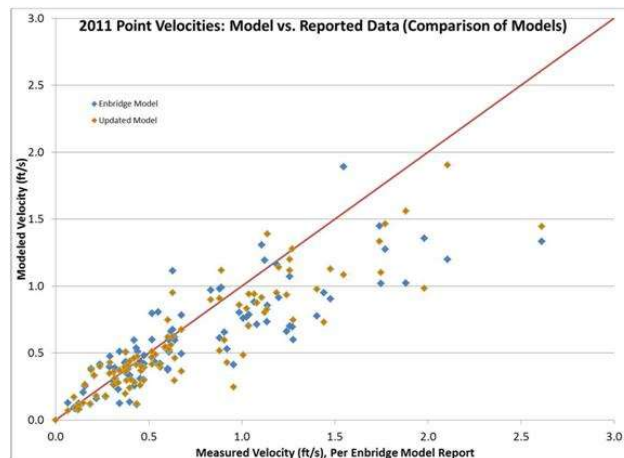


Oil in the Water Column (droplets and/or dissolved oil?)

Dispersed Oil

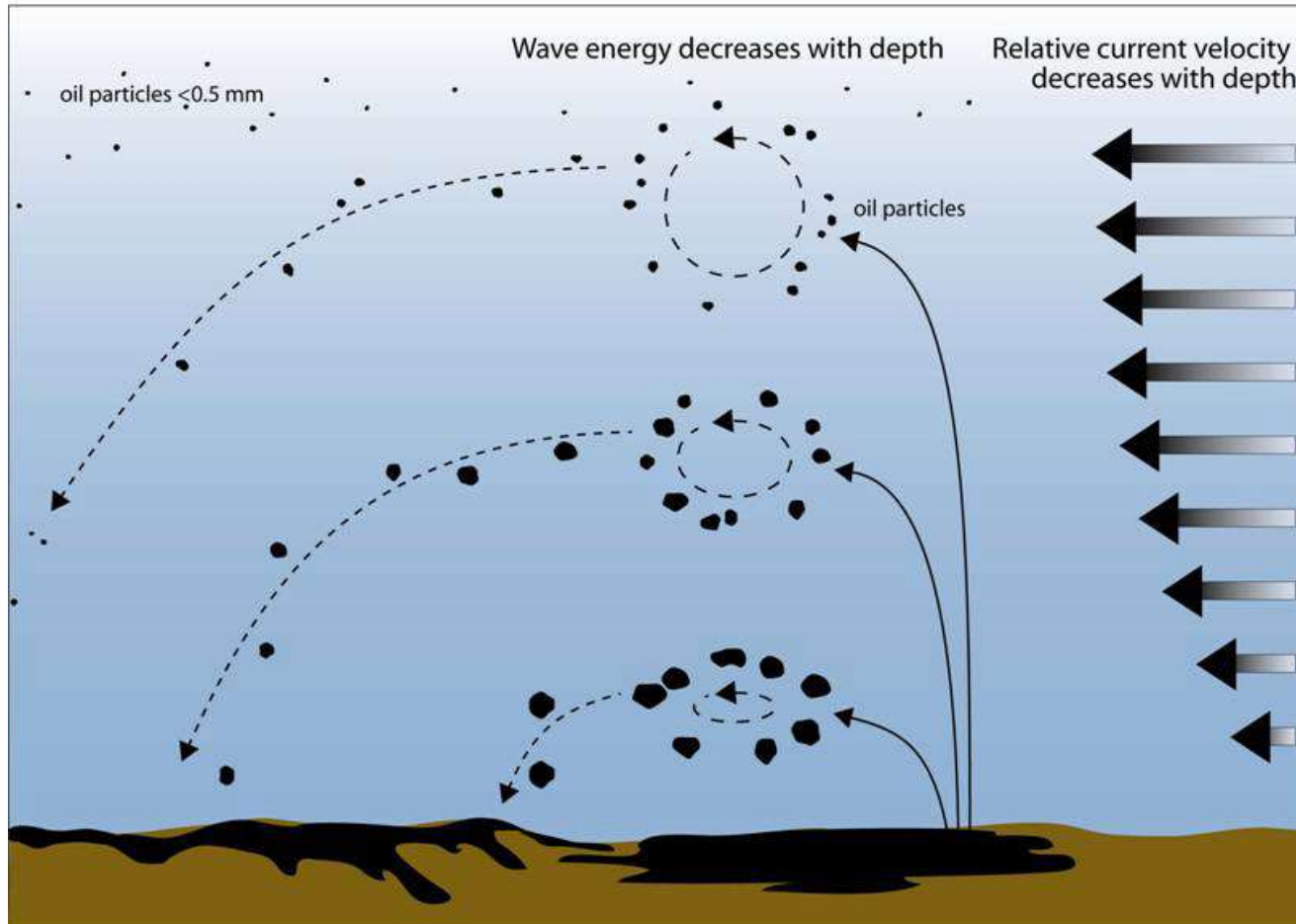


Data From Enbridge Pipeline Spill (Combined Hindcast/prediction)



Transport Modeling Offshore

Re-suspension and Transport of T/B /DBL-152/ Oil



Can you find oil after it moves for either case?



Past Attempts (Snare and Fence)



Cage Snares



Silt Fence

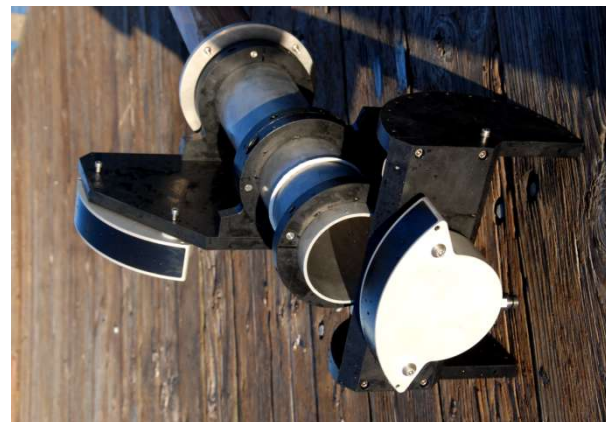
Anchored Snare



Sonar Detection Tests (NORBIT Multibeam)

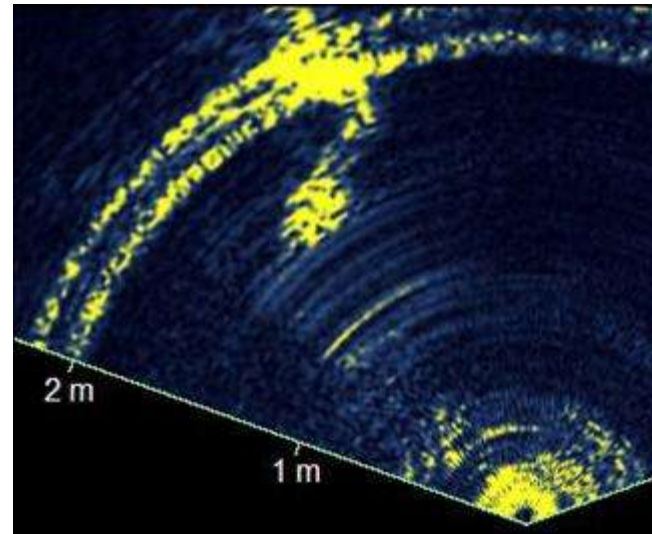
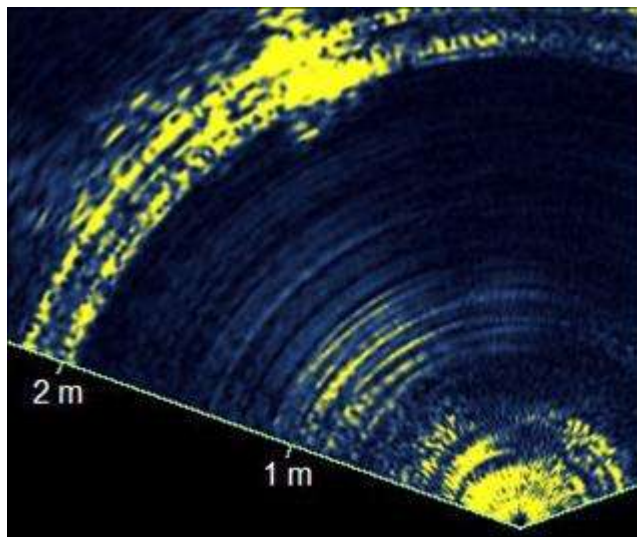
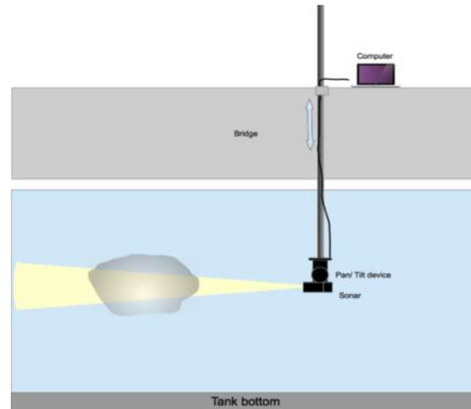


Views of Sonar



Sonar Detection

Test Setup



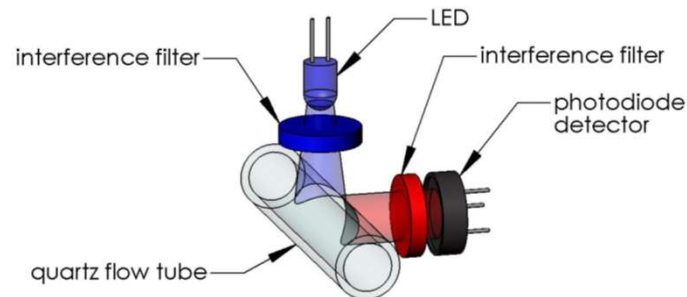
WBMS test #32/233 before (left) and after (right) plume was discharged.

Issue: Air and sediment and other biologics also have acoustic signal

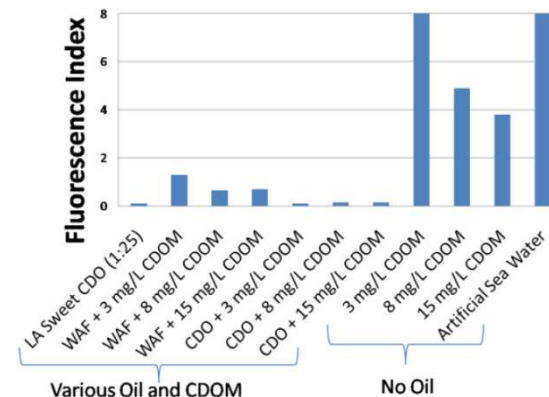


Enhanced Fluorescence (WET Labs)

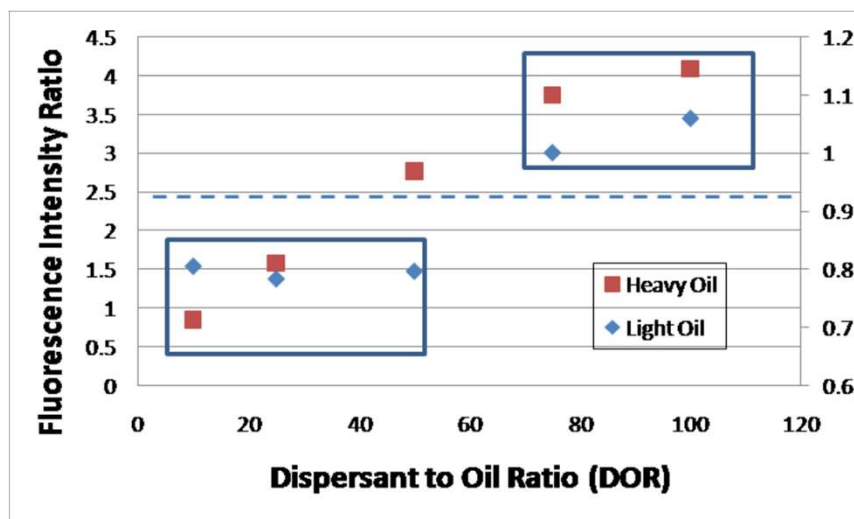
Fluorescent IN-situ Detection System for OIL (FINDS OIL)



Concept design



Initial Data



Different Oil Data

Similar to multi-spectral approach



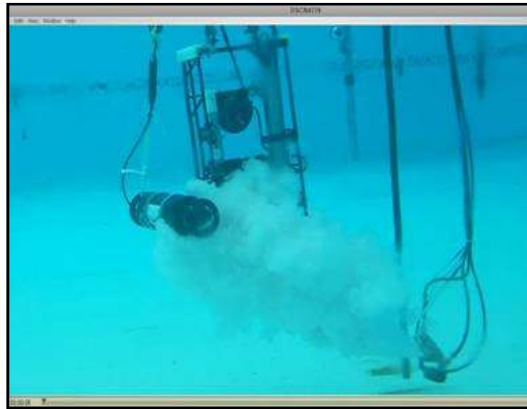
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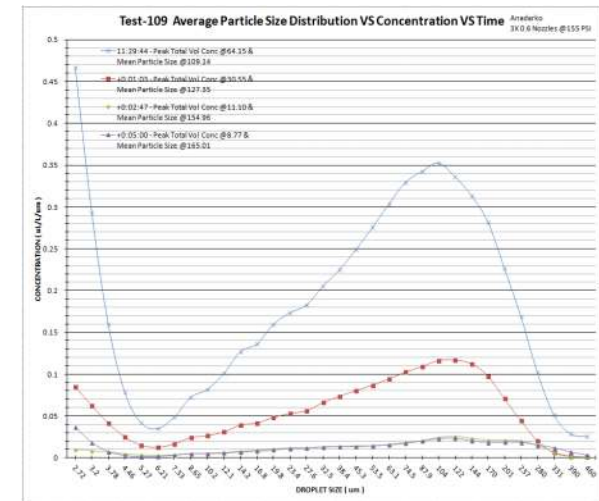
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Multi-Angle Light Scatter Tests (WET Labs)

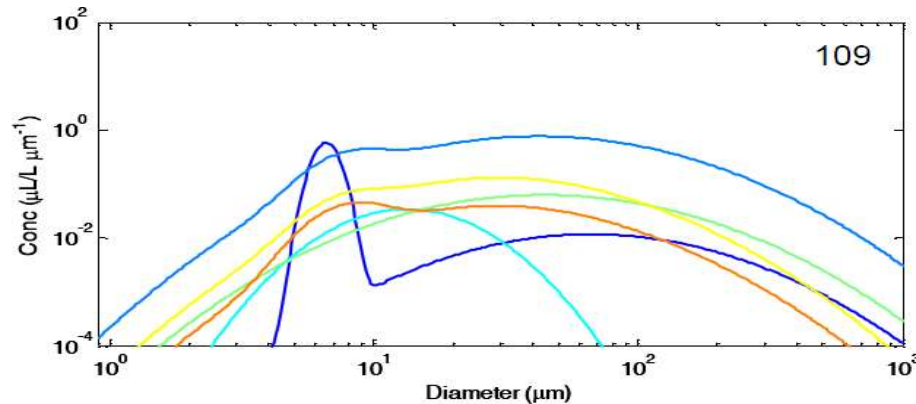
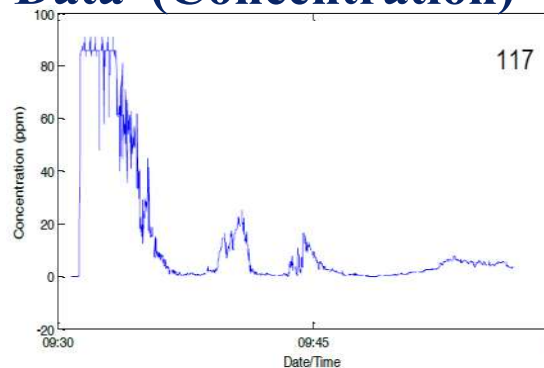
Instrument Package (CTD, DO, VSF)



LISST Data



Data (Concentration)



Mitigation Requirements

Extent of oil mitigation or removal rates and quantities;
Types of oil mitigated (e.g., droplets, tarballs, dissolved oil);
Minimization of environmental impacts with a focus on wildlife and plant life;
Effective limits in terms of depth of oil and deployment;
Effective limits in terms of environmental conditions such as current, wave height, winds, day/night, inclement weather, etc.;
Ease of use to include deployability and recovery of equipment;
Transportability;
Operability in fresh/seawater;
Ability to observe and monitor subsurface oil collection;
Reusability; and
Safety to personnel deploying and recovering

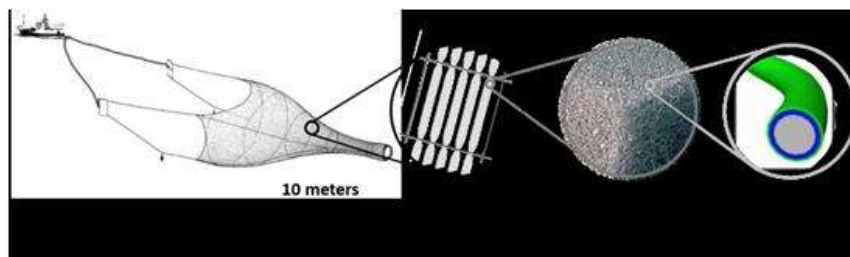
Problem is test setup. For Ohmsett, equipment moves through the water.



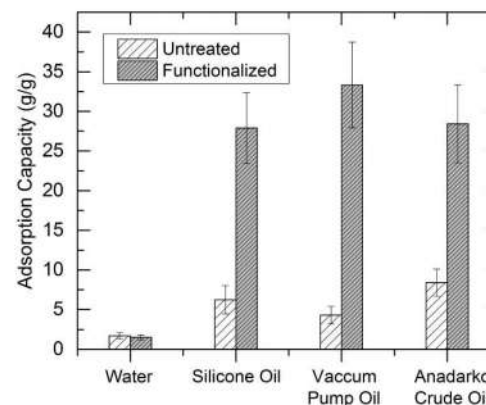
Mitigation within Water Column

Argonne National Lab: Reusable, Environmentally Benign Absorbent Foams for Oil Spill
Pollution Mitigation uses patented process to develop better hydrophobic/oleophilic materials

Concept



Initial Data



Testing at Ohmsett
Setup



In Tank



Recovering Oil



Sorbent Collection data

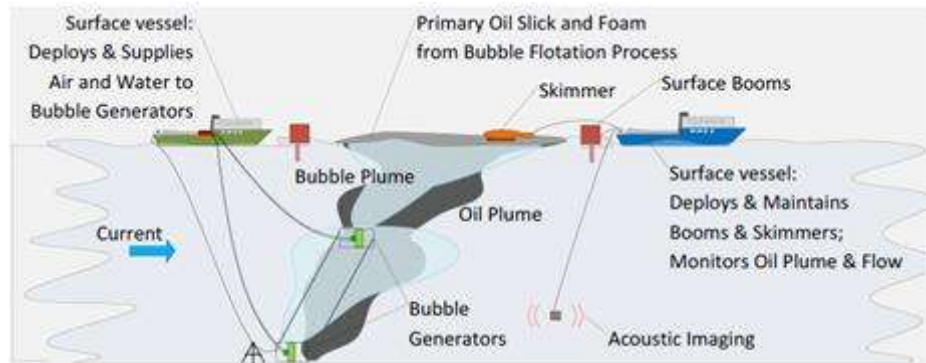
Test #	Oil Type	Oil Volume Distributed (gallons)	Oil Volume Distributed (mL)	Estimated Oil Volume Actually Encountered (mL)	Total Oil Volume Collected (mL)	Percent Oil Collected
8	HOOPS	5.4	20,441	10,221	1,306	12.8%
9	HOOPS	12.0	45,425	22,712	737	3.2%
10	HOOPS	12.1	45,803	22,902	1,169	5.1%
12	HOOPS	12.6	47,696	23,848	683	2.9%
13	HOOPS	12.0	45,425	22,712	946	4.2%
14	HOOPS	12.7	48,075	24,037	1,839	7.7%
15	Diesel	12.2	46,182	23,091	584	2.5%
16	ANS	8.7	32,933	16,467	1,294	7.9%
17	ANS	14.0	52,996	26,498	1,197	4.5%
18	ANS	11.7	44,289	22,145	524	2.4%
19	ANS	12.7	48,075	24,037	348	1.4%



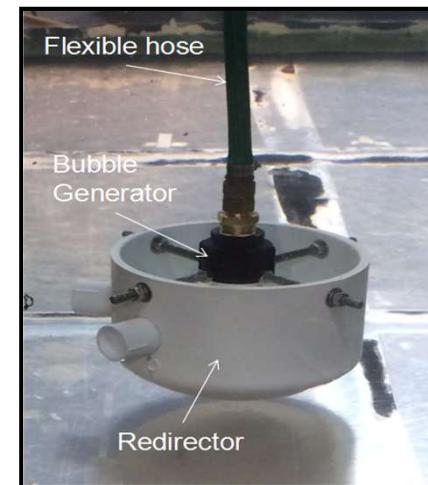
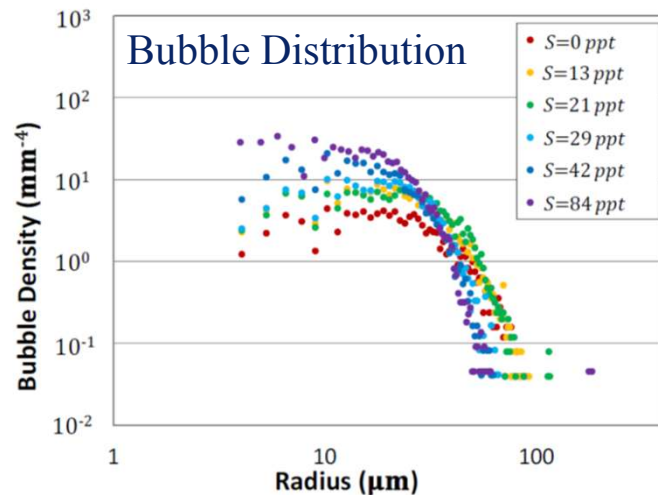
Mitigation within Water Column

Dynaflow, Inc: Subsurface Oil Recovery Using Microbubble Floatation uses cavitation and acoustics to create bubble field that could bring oil to surface

Concept



Design



Air Bubbles at Ohmsett

Setup



Testing



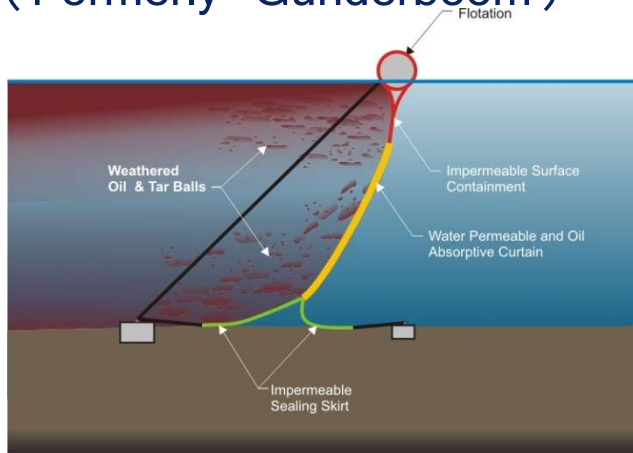
Sorbent Recovery Data

Ohmsett Test Number	Test	Oil Added, (gallons)	No. of Bubble Generators	Pump (psi)	Air Injection Rate, (L/min)	Conditions	Amount Oil Recovered, (gallons)	Recovered Oil, 30 minutes	Recovered Oil, 60 minutes	Recovered Oil, 90 minutes
22	Baseline	27	0	0	0	Circulation in tank	7.43	18.8%	27.5%	
23	Baseline	27	0	0	0	Circulation in tank	11.41	29.1%	42.3%	
24	Micro-bubble	27	8	13	2.0	moving, circulation	7.43	19.3%	27.5%	
25	Micro-bubble	27	8	13	2.0	moving, circulation	7.38	20.4%	27.3%	
32	Baseline	27	0	0	0	No circulation	11.18	24.9%	40.8%	
26	Micro-bubble	27	7	18	2.5	moving, no circulation	6.57	17.5%	24.7%	
27	Micro-bubble	27	6	22	2.5	Semi-stationary, no circulation	7.27	24.0%	26.9%	
33	Baseline	45	0	0	0	No Circulation	21.2	23.5%	40.2%	47.1%
29	Micro-bubble	45	6	22	2.5	Semi-stationary, no circulation	17.46	22.9%	32.7%	38.8%
30	Micro-bubble	45	6	20	3.5	moving , no circulation	17.17	21.9%	32.4%	38.2%



Other Approaches with Netting

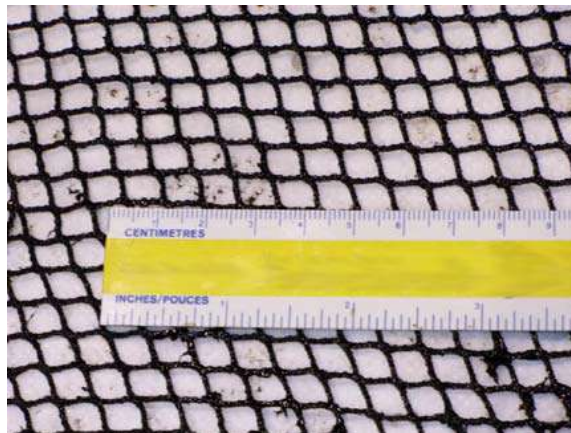
Mackworth Aquatic Environmental (Formerly Gunderboom)



Parachute Skimmer



Environment Canada (SAIC) Tests



Data Gaps

Finding the droplets

- Entrained with and without air or silt

Handling dissolved/dispersed oil

Lack of mitigation techniques

- Practicality of approaches
- Efficacy of sorbents

How to test at full-scale



Questions?

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Extra pictures

<http://www.heavyoilrecovery.ca/results.html>



Refloating system designed for Orimulsion

University of NH Circular Flume

