14TH CO-OPERATION FORUM (SESSION 6: OIL SPILL MANAGEMENT)

LATEST SOLUTIONS/ TECHNIQUES AVAILABLE TO MANAGE OIL SPILLS - AN INSIGHT INTO HERDERS

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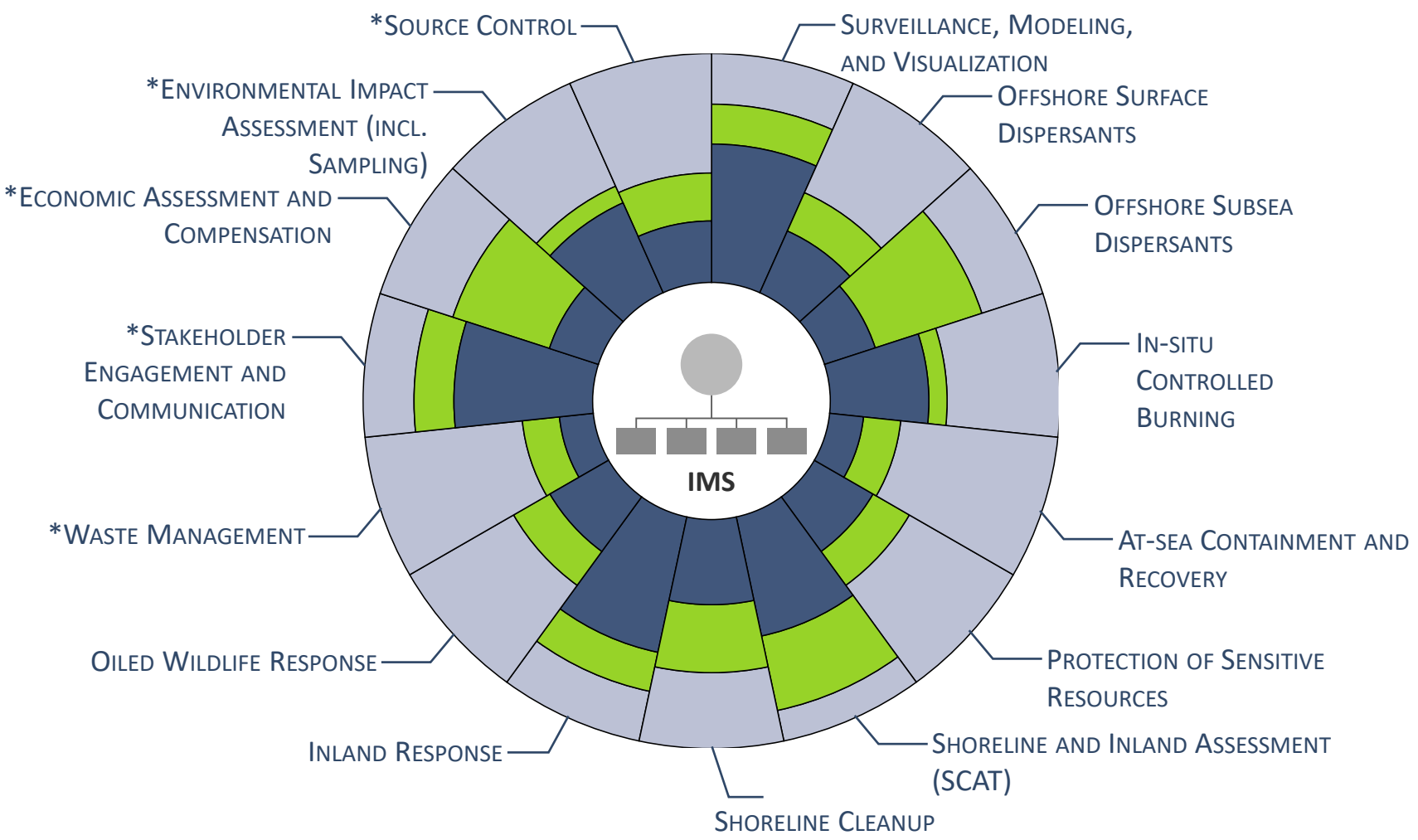
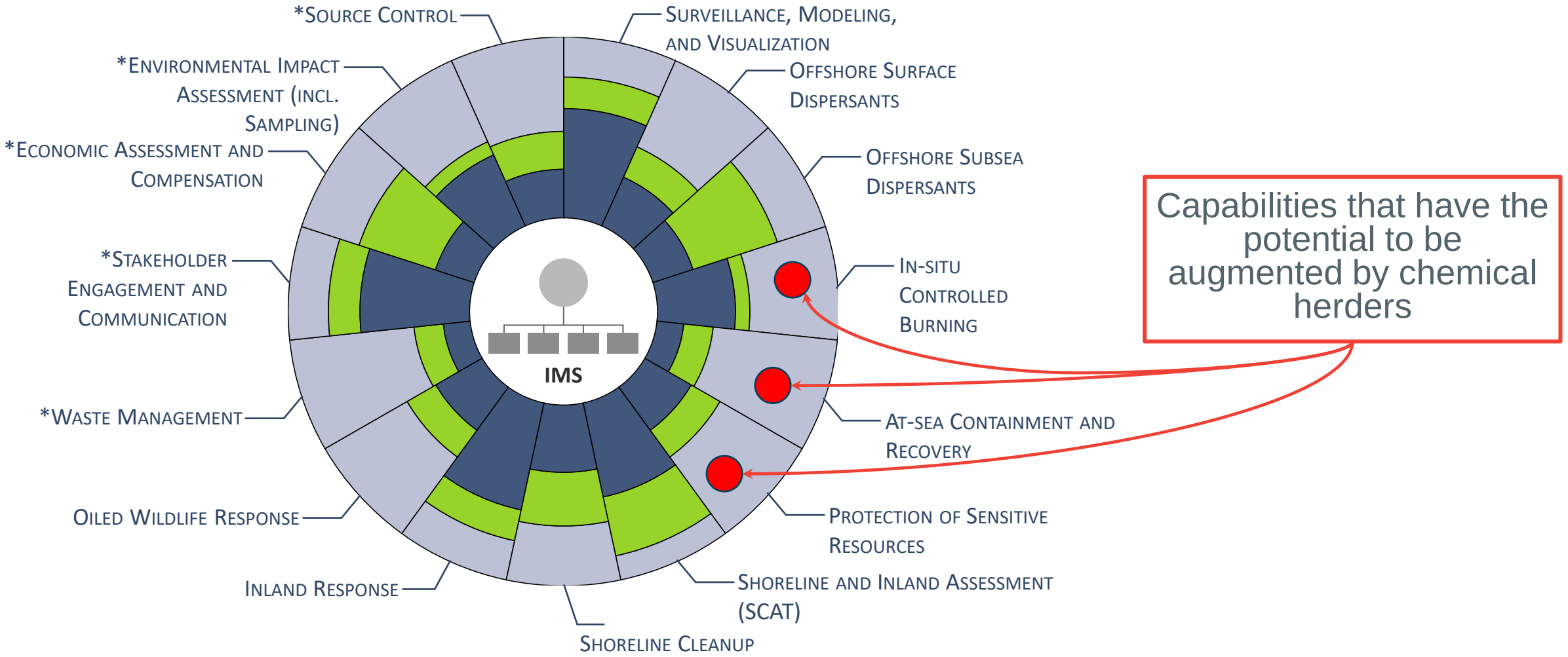
Oil Spill Response

Capabilities Required To Deal With A Full Range Of Oil Spills



- Oil spill responses are still dealt with using a selection of the same 16 response capabilities.
- However, developments continue to improve and augment the application of these capabilities.
- Developments such as;
  - Technology integration
  - Autonomous vehicles
  - AI
  - Enhanced techniques
  - Improved equipment

One Development That Has The Potential To Augment Existing Capabilities Is The Use Of Herders



What are herders?

A chemical product that contains a surface-active agent which acts on the water surrounding an oil slick and causes the oil to thicken.

Herder technology originally developed for open water in 2000's research focused on marine applications with ice; but more recent research has again concentrated on open water.

The goal is to have another tool that can be used to support response options (IBS, skim, deflect).

Why is OSRL looking at herders?

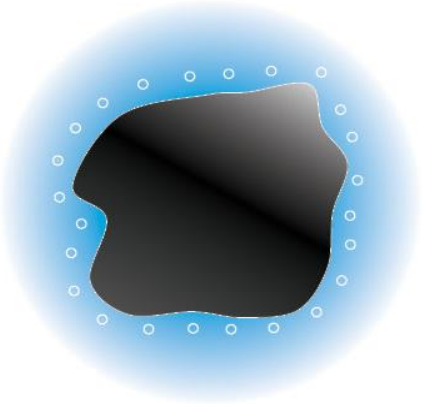
Oil Spill Response

OSRL currently employ a wide range of proven, tested spill response techniques that can be selected to deal with a multitude of scenarios on a NEBA-based approach.

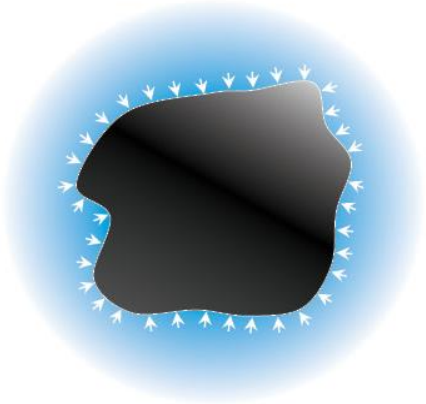
Exploring additional tools remains at the core of OSRL's technical development activity.

Adding chemical herder technology into our capability would be via a combination of regulatory approval processes, procurement, training and deployment capability

Technology Description



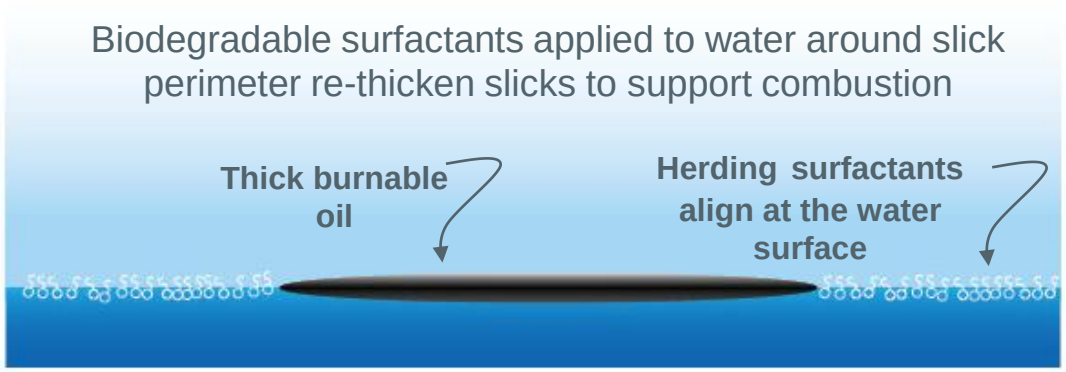
Herders sprayed on water around perimeter of slick via aircraft, boat, USV

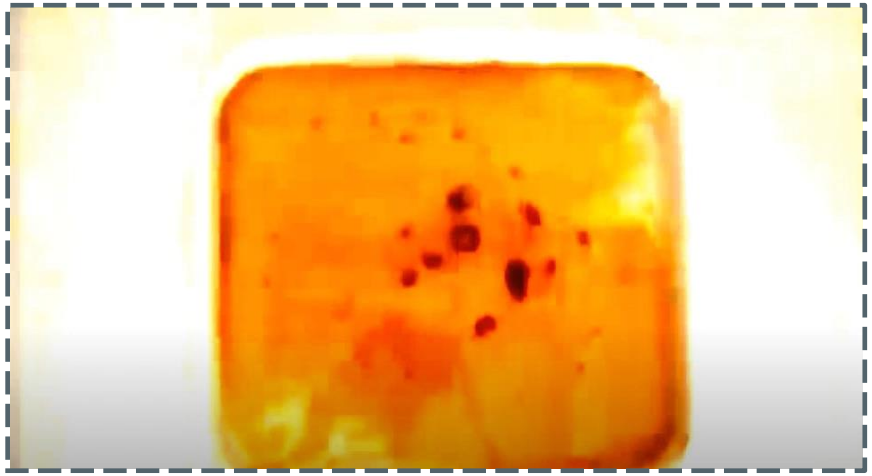


Herders rapidly spread to form monolayer of surfactant on water surface

Herders change surface tension of water forcing slick into smaller area

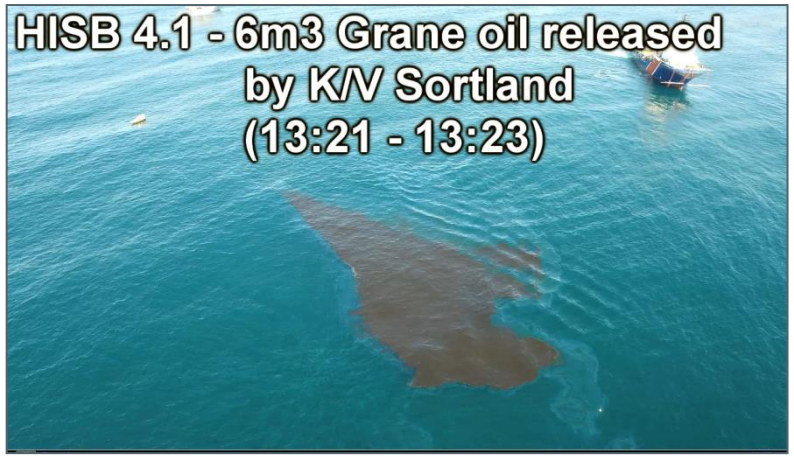
- Key points;
  - Forms a “surfactant boom”
  - Very low dosage concentrations (5L/km^2)
  - Low toxicity
  - Highly biodegradable
  - Rapid application
  - Oil viscosity and met-ocean condition limitations





Test Tank Demonstration

Field Testing – Offshore Norway 2016 (Cooper, 2017)



Control slick with no herder application 50 minutes after release

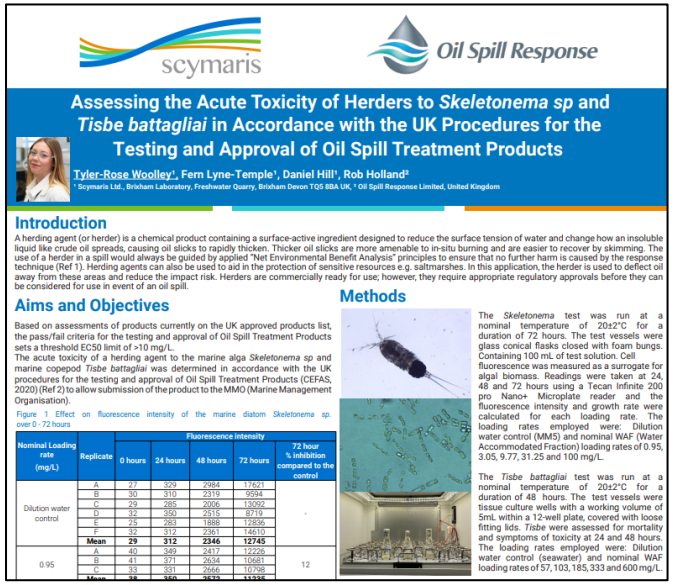
Slick after Herder application / before burn

- Field test conducted June 14, 2016
- First known study to successfully burn free-floating marine oil slicks in open water
- Herded slick burned for total of ~30 min.
- Control slick (no herder) burned for ~12 min.

Prior Research

- Over 15 years of research has proven that herder for ISB works
  - Most development performed under temperate, open-water conditions = not just Arctic!!!
- Herders have been formulated to be low toxicity and rapidly biodegradable, example;
  - *Thickslick biodegradation test result = 15% by day 1 and >99% by day 20
  - *Thickslick toxicity results = minnow 96 hr LC_{50}, 138 ppm (practically non-toxic¥), Shrimp 48hr LC_{50}, 286 ppm (practically non-toxic¥)
- Herders may work in sea states greater than booms as the surfactants reduce wave cresting – Garrett & Barger (1972) kept a slick herded for 2.5 hours in 6-foot seas with numerous white caps
- Two herders are listed on the USA EPA NCP schedule for potential use in US waters
- Thickslick 6535 passed UK toxicity test commissioned by OSRL
  - Application for use in UK waters with Marine Management Organisation (MMO) now in progress

….2023 poster at SETAC



scymaris

Oil Spill Response

Assessing the Acute Toxicity of Herders to *Skeletonema sp* and *Tisbe battagliai* in Accordance with the UK Procedures for the Testing and Approval of Oil Spill Treatment Products

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Introduction

A herding agent (or herder) is a chemical product containing a surface-active ingredient designed to reduce the surface tension of water and change how an insoluble liquid like crude oil spreads, causing oil slicks to rapidly thicken. Thicker oil slicks are more amenable to in-situ burning and are easier to recover by skimming. The use of a herder in a spill would always be guided by applied "Net Environmental Benefit Analysis" principles to ensure that no further harm is caused by the response technique (Ref 1). Herding agents can also be used to aid in the protection of sensitive resources e.g. saltmarshes. In this application, the herder is used to deflect oil away from these areas and reduce the impact risk. Herders are commercially ready for use; however, they require appropriate regulatory approvals before they can be considered for use in event of an oil spill.

Aims and Objectives

Based on assessments of products currently on the UK approved products list, the pass/fail criteria for the testing and approval of Oil Spill Treatment Products sets a threshold EC50 limit of >10 mg/L.
The acute toxicity of a herding agent to the marine alga *Skeletonema sp* and marine copepod *Tisbe battagliai* was determined in accordance with the UK procedures for the testing and approval of Oil Spill Treatment Products (CEFAS, 2020) (Ref 2) to allow submission of the product to the MMO (Marine Management Organisation).

Figure 1 Effect on fluorescence intensity of the marine diatom *Skeletonema sp.* over 0 - 72 hours

Nominal Loading rate (mg/L)	Replicate	Fluorescence Intensity 0 hours	24 hours	48 hours	72 hours	72 hour % inhibition compared to the control
Dilution water control	A	27	329	2984	17621	
	B	30	310	2319	9594	
	C	29	285	2006	13092	
	D	32	350	2515	8719	-
	E	25	283	1888	12836	
	F	32	312	2361	14610	
	Mean	**29**	**312**	**2346**	**12745**	
0.95	A	40	349	2417	12226	
	B	41	371	2634	10681	
	C	33	331	2666	10798	12
	Mean	**38**	**350**	**2572**	**11235**	

Methods

The *Skeletonema* test was run at a nominal temperature of 20±2°C for a duration of 72 hours. The test vessels were glass conical flasks closed with foam bungs. Containing 100 mL of test solution. Cell fluorescence was measured as a surrogate for algal biomass. Readings were taken at 24, 48 and 72 hours using a Tecan Infinite 200 pro Nano+ Microplate reader and the fluorescence intensity and growth rate were calculated for each loading rate. The loading rates employed were: Dilution water control (MM5) and nominal WAF (Water Accommodated Fraction) loading rates of 0.95, 3.05, 9.77, 31.25 and 100 mg/L.

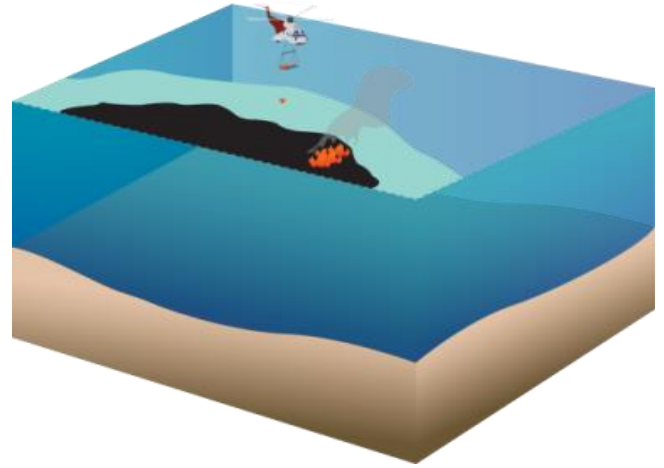
The *Tisbe battagliai* test was run at a nominal temperature of 20±2°C for a duration of 48 hours. The test vessels were tissue culture wells with a working volume of 5mL within a 12-well plate, covered with loose fitting lids. *Tisbe* were assessed for mortality and symptoms of toxicity at 24 and 48 hours. The loading rates employed were: Dilution water control (seawater) and nominal WAF loading rates of 57, 103, 185, 333 and 600 mg/L.

*Results of EPA Required Toxicity Testing for NCP Listing - ¥as defined by the US EPA aquatic toxicity ranking system (http://www.epa.gov/espp/litstatus/effects/redleg-frog/naled/appendix-i.pdf)

Garrett, W.D. and Barger, W.R., 1972. Control and Confinement of Oil Pollution on Water with Monomolecular Surface Films, Naval Research Laboratory, Washington, D.C., NRL Memorandum Report 2451.

Potential Use Case Scenarios

- In Situ Burning = "*Herd & Burn*"
- Recovery = "*Herd & Skim*"
- Chemical boom = "*Herd & Deflect*"
- Example:
  - Norther Caspian shallow water areas, reed beds
    - 2018 trial in Damba basin to test
    - Herders approved for use by Kaz regulator
    - NEBA driven use
      - Too shallow for dispersants
      - Speed of application



686904 2020 INTERNATIONAL OIL SPILL CONFERENCE

TEST OF HERDER AND CONTROLLED BURNING OF SPILLED OIL IN KAZAKHSTAN

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ABSTRACT

Recent years have seen renewed interest in the viability of using herding chemicals in conjunction with in-situ burning. NCOC, an operator in the shallow north Caspian Sea, undertook herder research as an extension to studies performed under the Arctic Response Technology Joint Industry Programme (JIP). The purpose was to investigate the feasibility of using herders as part of their response toolkit.

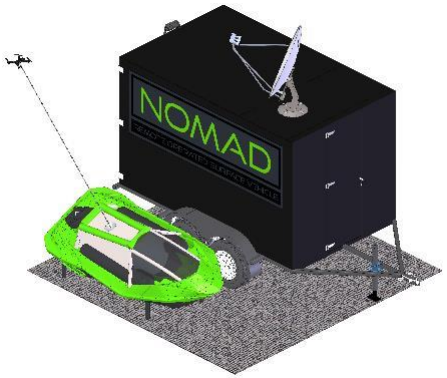
Laboratory tests were performed in Kazakhstan on weathered Kashagan export crude oil, using two herders listed on the US NCP Product Schedule. Results were positive and it was considered that a reasonable size test spill under realistic conditions was required to verify laboratory work.

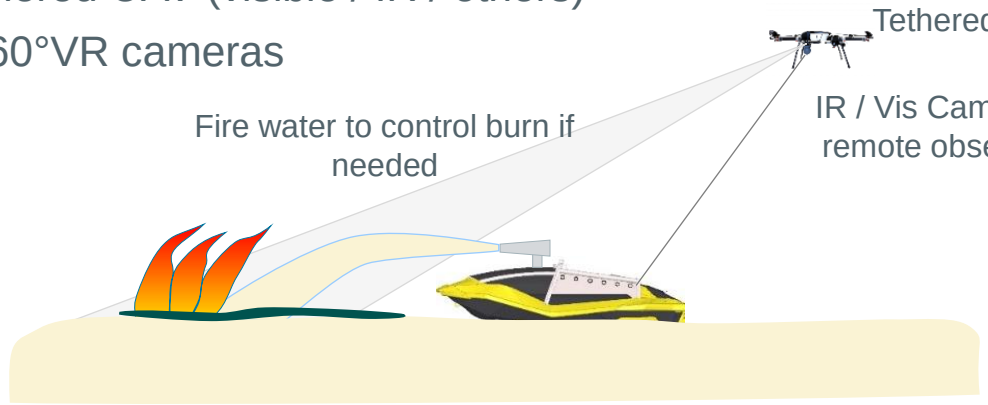
In November 2018 a field trial was undertaken in the boat basin at Damba in western Kazakhstan. A volume of 400 litres of artificially weathered Kashagan crude was pumped onto the water surface and allowed to spread. Air and water temperatures were just above freezing and a small amount of ice was present due to overnight low temperatures. The test was recorded by an unmanned aerial vehicle, using thermal IR and 4K video.

After the oil had been allowed to spread out to be <1 mm, i.e. too thin to sustain combustion, a small boat was used to spray Siltech OP-40 herder around the periphery of the

Joint Industry Project - Jet-Ski ROSV Project

- Rapidly deployable system that combines herder application and ignitors on a single platform for ISB
- Deployable from ship, helicopter, airplane
- Autonomous operation or remote (virtual reality) operator
  - GPS / long range radio / satellite communications
- Speeds up to 65 mph / 500-mile range / 12+hrs operation
  - Herder application / slick ignition
  - VOC monitoring
  - Aerial remote sensing with tethered UAV (visible / IR / others)
  - 4 surface / 2 underwater / 1 360°VR cameras
  - Oil sampling
- Underwater lighting
- Modular sensor platform
- Fire control using jet pumps
- June 2023 trial…





ROSV Testing of ISB Support Capability, June 2023

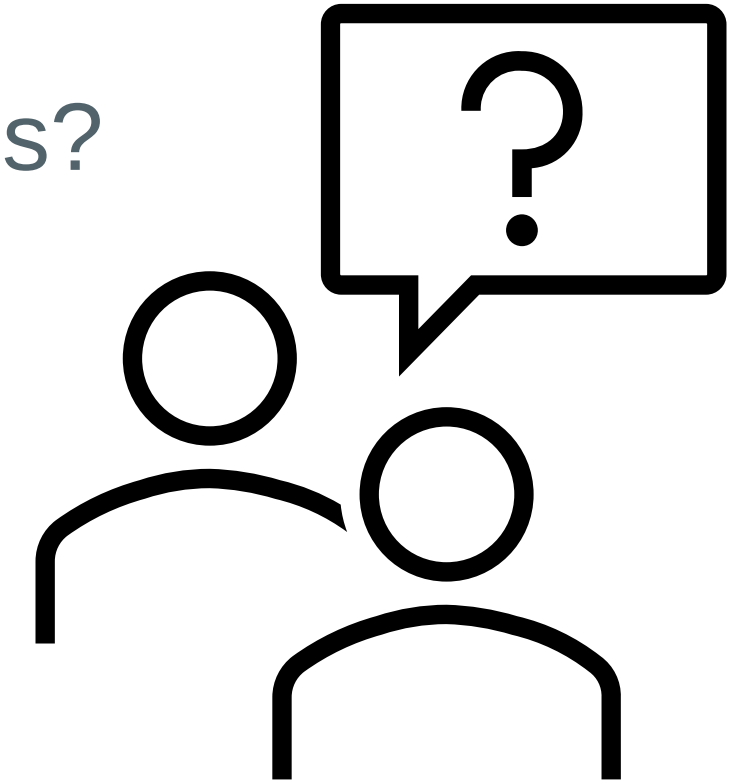
- Test tank located at the University of Alaska Fairbanks
- ~1 mm thick oil slick was placed in the tank before the vehicle applied herders around it
- The herders caused the slick to contract, thickening it to >3mm, sufficient for ignition
- 5 test burns over a four-day period
- The vehicle demonstrated its use for applying herder and igniting in-situ burns
- Potential tool for for remote sensing, wildlife hazing, and other spill response needs – further testing in summer 2023

A presentation describing the ROSV will be given at the Clean Gulf Conference. Full length video of test - https://www.youtube.com/watch?v=fla-7WMh04U.

OSRL's Progress and Plans

- To date:
  - Supply chain review
  - HSEQ and Logistics review
  - Operational review for storage, deployment, application kit and responder training
  - Internal overview training course for Responders
  - Compliance = Toxicity testing in UK
  - Chairing a Herder "Community of Practice" with industry, OSROs to work together!
- 2023 plans
  - Regulatory approval process to have Thickslick 6535 on UK list of approved oil spill treatment products
  - Stakeholder engagement in the UK – workshops etc
  - On water trials in Alaska in June 2023 (OSRL attended and supported)
- 2024 plans
  - OSRL operational capability build = kit, training, procedures, stockpile procurement etc
  - IOSC paper on Herders with ExxonMobil

Questions?



Thank you!