ADVANCES IN ISB: Surface Collecting Agents (aka Herders)

PRESENTATION OUTLINE

- Oil spill response options
- Basics of in situ burning
- Spill collecting agents (SCA's) aka, herders
- SCA's and mechanical recovery
- Prior research and development
- Current developments

THE NEED FOR HERDERS

Mechanical Recovery:
Booms & Skimmers

In-Situ Burning

Dispersants

- Responders need access to all tools in the toolbox
- In situ burning (ISB) is one of three primary offshore response options
- Currently, ISB requires deployment of large, heavy booms
- The only offshore operational use of ISB was during the DWH incident
- For other spills, slicks had spread, scattered, or stranded before fire-resistant booms could be deployed
- Herders can enable rapid ISB
- Aircraft can travel at speeds over ten times faster than boats
- Speed is the key to oil spill response

BACKGROUND ON IN-SITU BURNING (IPIECA / IOGP, 2016)

BASIC REQUIREMENTS

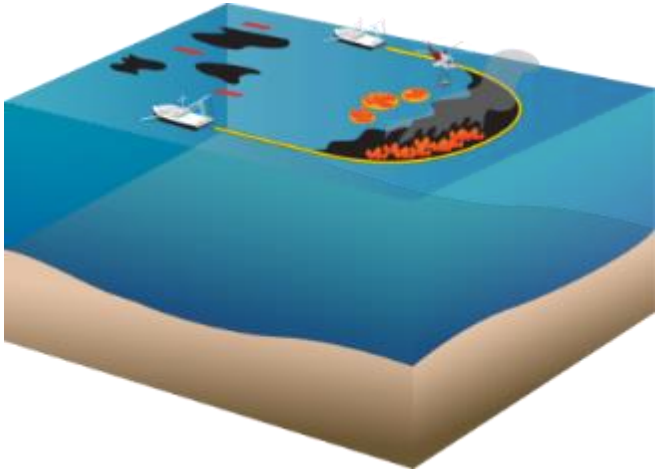
- Oil layer thickness must be at least 2 to 3 mm (0.08–0.12 in) to sustain combustion
- Oil must have some volatiles and not contain too much water

EFFICIENCY OF IN-SITU BURNING

- Efficiency of a burn depends on the oil thickness
  - "Chimney effect" (convective wind herding) thickens oil during burn
- Thick oil layers can burn at a rate of 2.5 mm/minute (1 inch in 10 minutes).
- Burn rate limits burn times to 10 – 30 minutes for free-floating oil slicks thereby mitigating potential hazard of uncontained oil fires
- Combustion normally continues until the final thickness is approximately 1 mm, burn efficiencies in excess of 90% can be achieved

IPIECA / IOGP, 2016, Controlled In-situ Burning of Spilled Oil, International Association of Oil & Gas Producers, IOGP Report 523.

SCA TECHNOLOGY DESCRIPTION

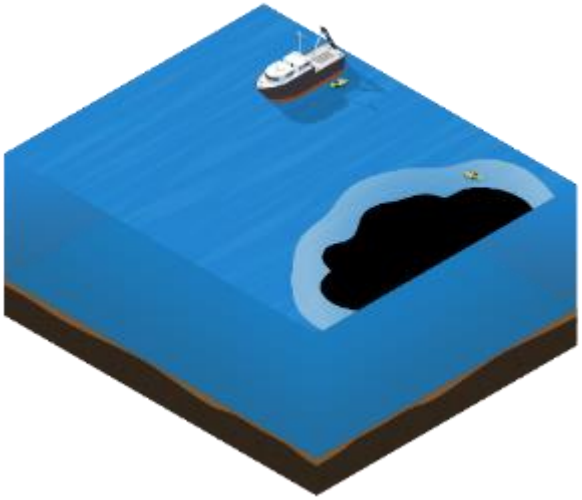


SCAs use a ‘surfactant boom’ to thicken slicks—no boundary required (Garrett & Barger, 1972)

SCAs typically require at least an order of magnitude less product than treating slicks with dispersants (Buist et al., 2014)

SCA technology originally developed for open water (Garrett & Barger, 1972); in 2000’s research focused on marine applications with ice; but more recent research has again concentrated on open water (Cooper et al., 2017; SL Ross, 2012; Buist et al., 2011)

The goal is to develop another tool that can be rapidly applied to make ISB a routinely used response option



- Buist, I., & Nedwed, T., 2011. Using Herders for Rapid *In situ* Burning of Oil Spills on Open Water, International Oil Spill Conference Proceedings, Mar 2011, Vol. 2011, No. 1 pp. abs231.
- Buist, I., Nedwed, T., Tidwell, A., Lane, P., Newsom, P., & Flagg, K., 2014. Update on Developing and Commercializing Oil Herders for In-Situ Burning, International Oil Spill Conference Proceedings, May 2014, Vol. 2014, No. 1 pp. 1441-1456.
- Cooper, D., Buist, I., Potter, S., Daling, P., Singsaas, I., Lewis, A., 2017. Experiments at Sea with Herders and *In Situ* Burning, International Oil Spill Conference Proceedings, May 2017, Vol. 2017, No. 1 pp. 2184-2203.
- 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.
- SL Ross, 2012. Research on Using Oil Herding Agents for Rapid Response *In situ* Burning of Oil Slicks on Open Water, U.S. Dep. Of the Interior Bureau of Safety and Environmental Enforcements Oil Spill Response Research (OSRR) Program, Herndon, VA.

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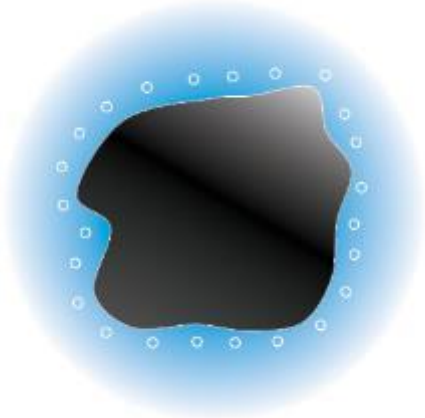
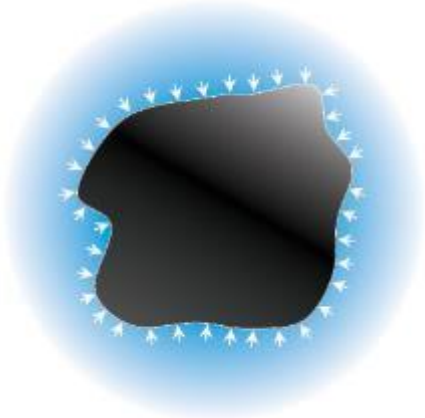


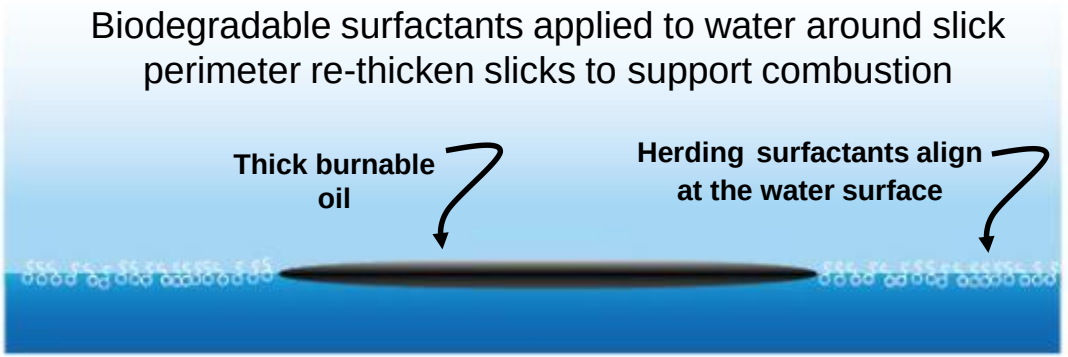
SCAs sprayed on water around perimeter of slick



SCAs rapidly spread to form monolayer of surfactant on water surface

SCAs change surface tension of water forcing slick into smaller area

Biodegradable surfactants applied to water around slick perimeter re-thicken slicks to support combustion



SCA's AND MECHANICAL RECOVERY

- 70's research focused on enhancing skimming with SCA's, however
  - SCA's do not eliminate the logistical issues associated with mechanical recovery
  - Skimming herded but free-floating oil slicks is inefficient
    - Skimmers have to be continuously repositioned in free-floating oil slicks
    - Skimmers were developed for thick oil (multi centimeters thick) (ASTM F2709-18; McKinney et al., 2017).
- SCA's can remove oil / sheens under structures in marinas and away from nearshore areas

- ASTM F2709-18, Standard Test Method for Determining a Measured Nameplate Recovery Rate of Stationary Oil Skimmer Systems, ASTM Book of Standards Volume 11.08. Accessed online at https://www.astm.org/Standards/F2709.htm, on September 24, 2019.
- McKinney, K., Caplis, J., DeVitis, D., and Van Dyke, K., 2017. Evaluation of Oleophilic Skimmer Performance in Diminishing Oil Slick Thicknesses. International Oil Spill Conference Proceedings May 2017, Vol. 2017, No. 1 (May 2017) pp. 1366-1381.

PRIOR RESEARCH

Over 15 years of research has proven that SCA for ISB works
- Much development performed under temperate, open-water conditions

SCAs have been formulated to be low toxicity and rapidly biodegradable, e.g., Thickslick™ 6535 SCA

SCAs may work in sea states greater than boom 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 SCAs (ThickSlick™ 6535 and OP-40) are listed on the EPA NPL for potential use in US waters

Results of EPA Required Toxicity Testing for NCP Listing

SCA	Menidia beryllina (minnow) 96 hr LC_{50}	Mysidopsis bahia (shrimp) 48 hr LC_{50}
Thickslick™	138 ppm (practically non-toxic[a])	286 ppm (practically non-toxic[a])

[a]as defined by the US EPA aquatic toxicity ranking system (http://www.epa.gov/espp/litstatus/effects/redleg-frog/naled/appendix-i.pdf)

Results of Biodegradation Testing

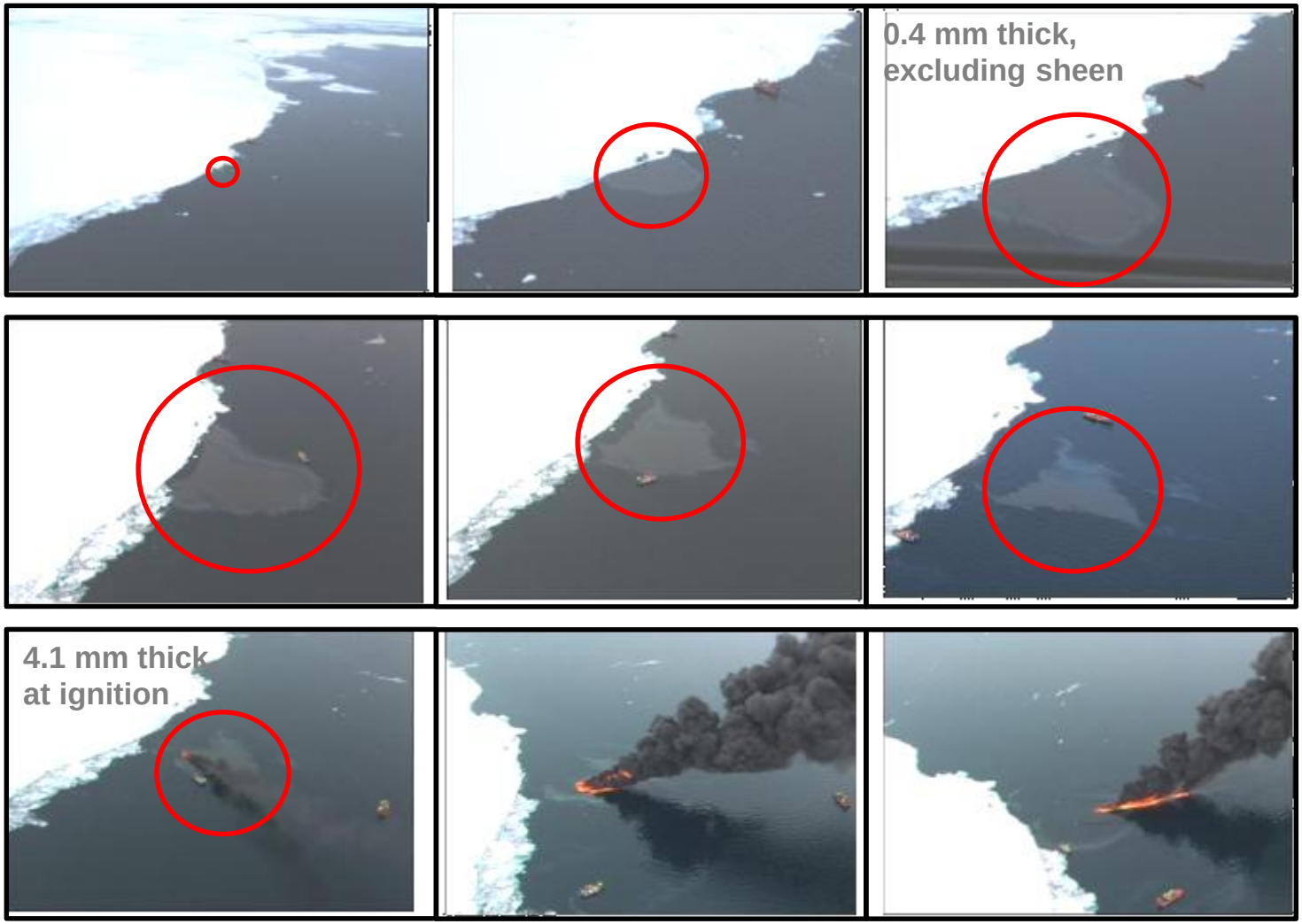
SCA	% biodegradation Day 1	% biodegradation Day 20
Thickslick™	14.8	>99

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.

PRIOR LABORATORY TESTING

FIELD RESULTS IN ICE (Buist, 2010)

PERFORMED UNDER A PRIOR JOINT INDUSTRY PROJECT



Oil release & spread (15 minutes)

630 liters of fresh crude

SCA applied & contracts slick (9 minutes)

Ignition & ISB (9 minutes)

Courtesy of Ian Buist/SL Ross

Buist, 2010. Report No. 6, Field Testing of the USN Oil Herding Agent on Heidrun Crude in Loose Drift Ice, Oil in Ice – JIP, SINTEF Materials and Chemistry, Marine Environmental Technology, 15.03.2010. Available on-line 8/29/2019 at https://www.sintef.no/globalassets/project/jip_oil_in_ice/dokumenter/publications/jip-rep-no-6-fex2008-herders-final.pdf

FIELD RESULTS IN ICE - VIDEO

FIELD TESTING – FAIRBANKS, ALASKA 2015

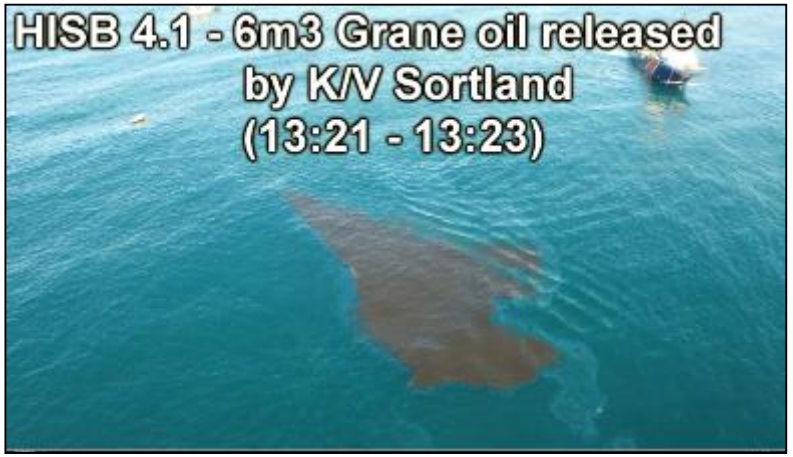
(Potter, 2017)

- Oil released in the centre of the basin and allowed to spread (~ 1 barrel).
- A helicopter sprayed SCA (approximately 1/150 barrel).
- Helicopter ignited slick with Helitorch.
- Two successful burns

Potter, S., Buist, I., Aggarwal, S., Schnabel, W., Garron, J., Bullock, Perkins, R., & Lane, P., 2017. Aerial Application of Herding Agents can Enhance *In-situ* Burning in Partial Ice Cover, International Oil Spill Conference Proceedings, May 2017, Vol. 2017, No. 1 pp. 2955-2975.

Field Testing – Offshore Norway 2016

(Cooper, 2017)



Control slick with no SCA application 50 minutes after release

Slick after SCA application / before burn

Slick burning

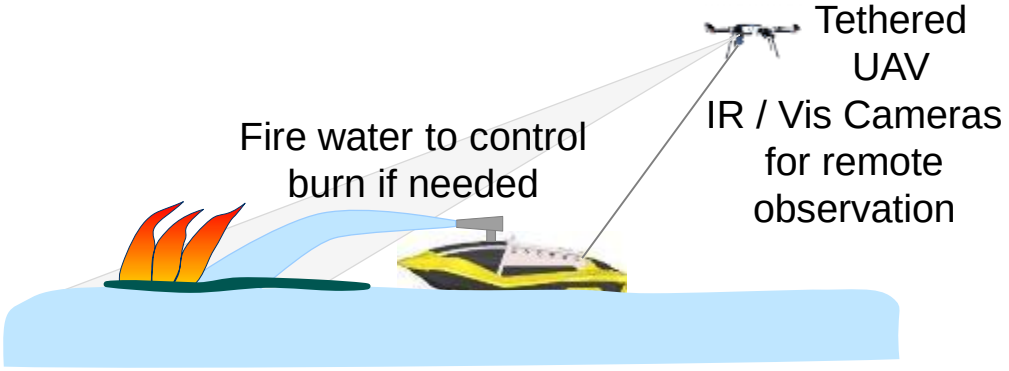
- Field test conducted June 14, 2016
- First known study to successfully burn free-floating marine oil slicks in open water
- Herded slick burned for total of ~30 min.
- Control slick (no SCA) burned for ~12 min.

Cooper, D., Buist, I., Potter, S., Daling, P., Singsaas, I., Lewis, A., 2017. Experiments at Sea with Herders and *In Situ* Burning, International Oil Spill Conference Proceedings, May 2017, Vol. 2017, No. 1 pp. 2184-2203.

Remotely Manned Surface Vehicle (RSV) for OSR

ExxonMobil is developing a multifunctional RSV for OSR

- 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
- Collision avoidance system
- SCA application / slick ignition
- VOC monitoring
- Aerial remote sensing with tethered UAV (visible / IR / other sensor)
- 4 surface / 2 underwater / 1 360˚ VR cameras
- Oil Slick sampling
- Underwater Lighting
- Modular sensor platform
- 350 lbs payload capability
- Fire control using jet pumps



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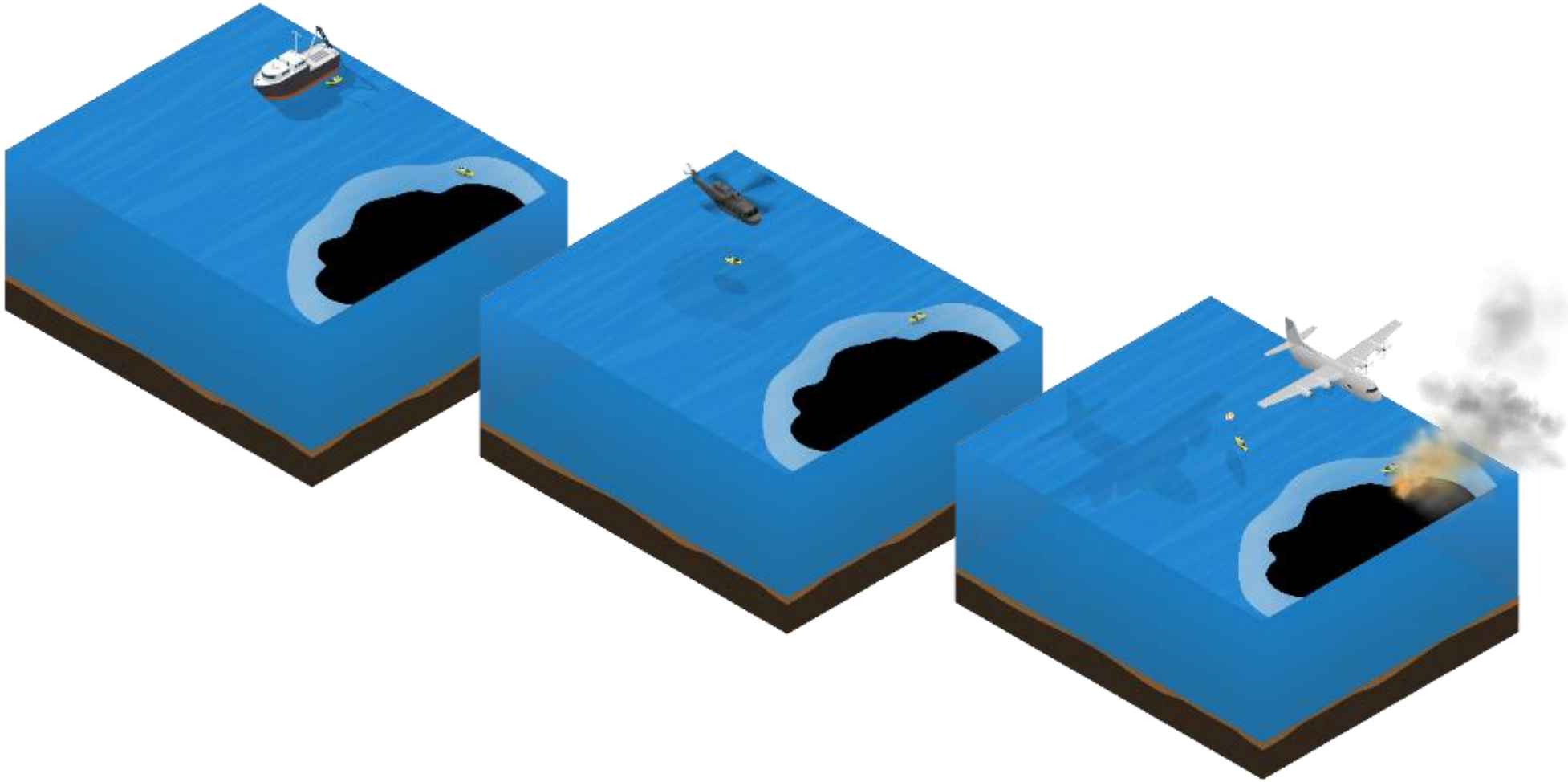

RSV Prototype Testing 2019

Other Recent Developments

- Successful field demonstration in Kazakhstan in fall 2018
- Chevron drill in May requested endorsement to use SCA
  - RRT 6 endorsement not given
    - Concerned about safety of burning free-floating oil slicks
    - Concerned about SCA effectiveness in temperate environment
- SCA / ISB field test planned for Canadian Multi-partner Research Initiative in 2020 / 2021

Summary on SCAs for ISB

- SCAs to enable *in situ* burning have undergone over 15 years of study
- Field / lab tests demonstrated they work in open temperate water – in seas up to 6 ft. with numerous white caps
- ISB of oil slicks is fast (burn rates up to 2.5 mm / minute) mitigating potential hazard of uncontained oil fire
- Herding typically requires very small quantities of a very low toxicity surfactant
- SCAs commercially available and on the US EPA NCP Product Schedule
- RSV SCA delivery / ignition system in final development
- US OSR organizations have stockpiles of SCAs & ignitors
- SCA technology ready for first use

QUESTIONS?