ADVANCES IN ISB: Herding Agents & Burning with Standard Booms

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” (wind herding) thickens oil during burn
- Thick oil layers normally 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.

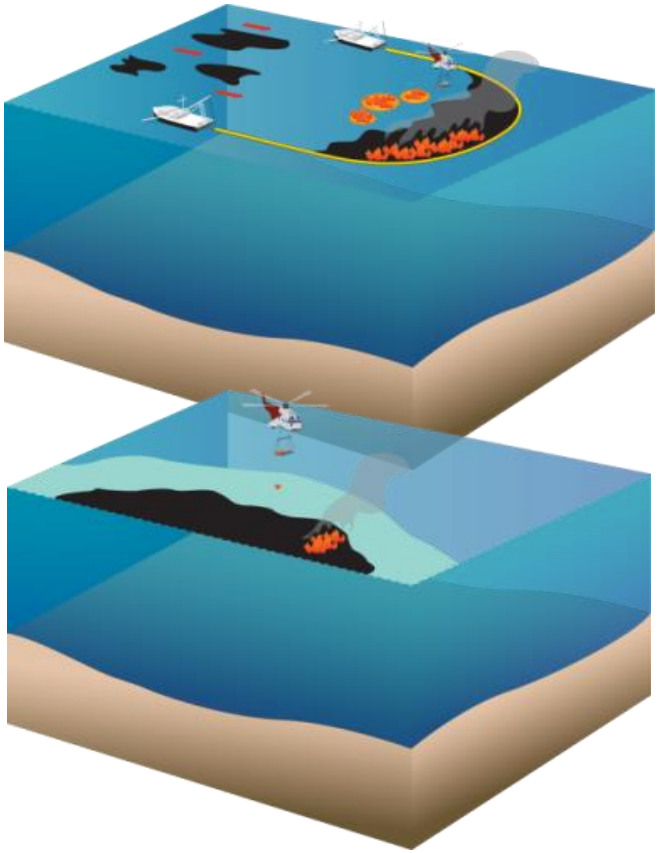
TECHNOLOGY DESCRIPTION

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

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

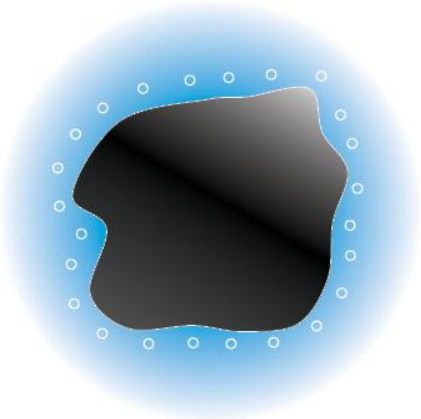
Herder technology originally developed for open water (Garrett & Barger, 1972); in 2000’s research focused on marine applications with ice; but more recent research has again concentrated on open water (Cooper et al., 2017; Buist et al., 2011)

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

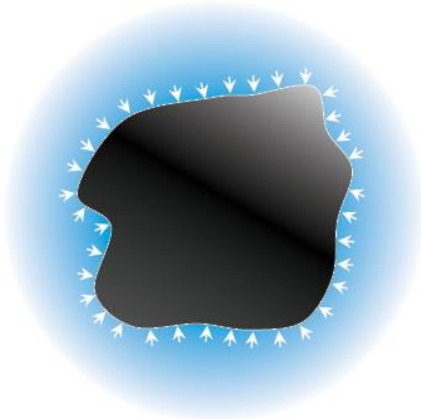


- Buist, I., & Nedwed, T., 2011. Using Herders for Rapid *In situ* Burning of Oil Spills on Open Water, International Oil Spill Conference Proceedings, Mar 2011, Vol. 2011, No. 1 pp. abs231.
- Buist, I., Nedwed, T., Tidwell, A., Lane, P., Newsom, P., & Flagg, K., 2014. Update on Developing and Commercializing 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.

TECHNOLOGY DESCRIPTION



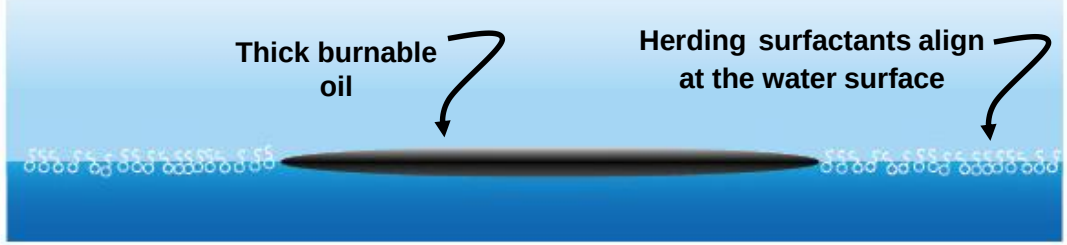
Herders sprayed on water around perimeter of slick via aircraft, boat, USV



Herders rapidly spread to form monolayer of surfactant on water surface

Herders change surface tension of water forcing slick into smaller area

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



PRIOR RESEARCH

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

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

Herders 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 herders (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

Herder	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

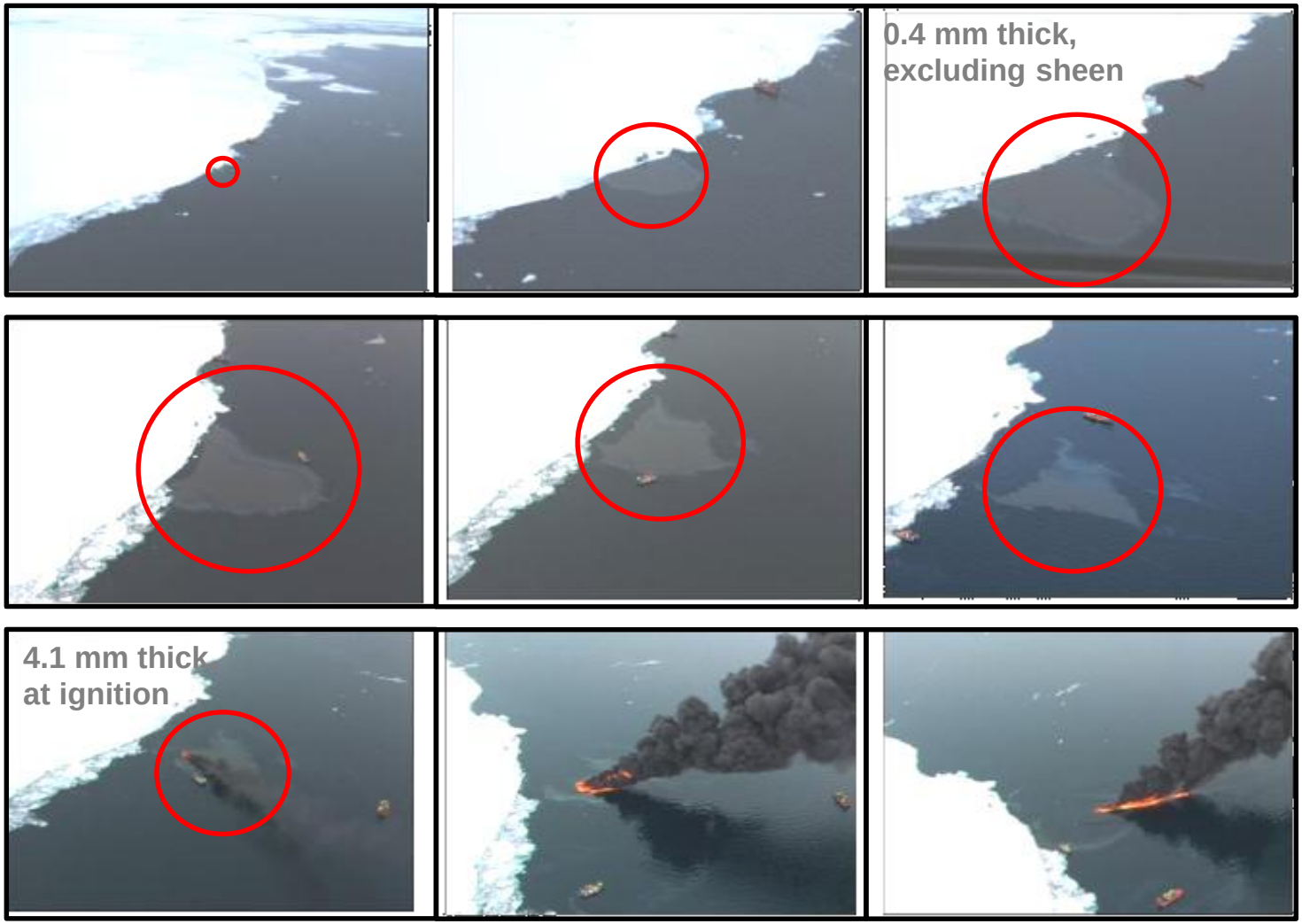
Herder	% biodegradation Day 1	% biodegradation Day 20
Thickslick™	14.8	>99

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

Herder 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

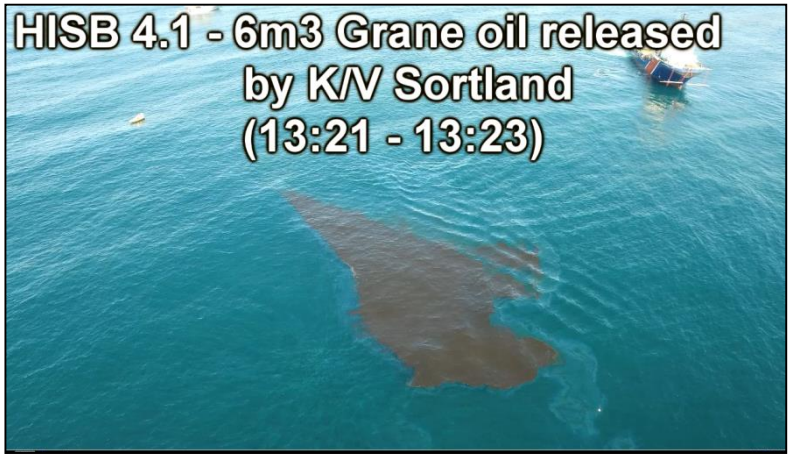
Field Testing – Fairbanks, Alaska 2015

(Potter, 2017)

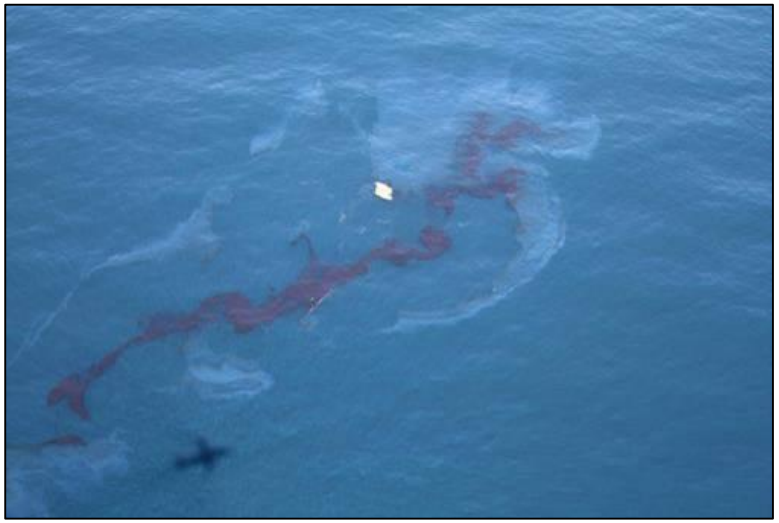
- Oil released in the centre of the basin and allowed to spread (~ 1 barrel).
- A helicopter sprayed herder (approximately 1/150 barrel).
- Helicopter ignited slick with Helitorch.
- Two successful burns

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 herder application
50 minutes after release



Slick after Herder
application / before burn

Slick burning

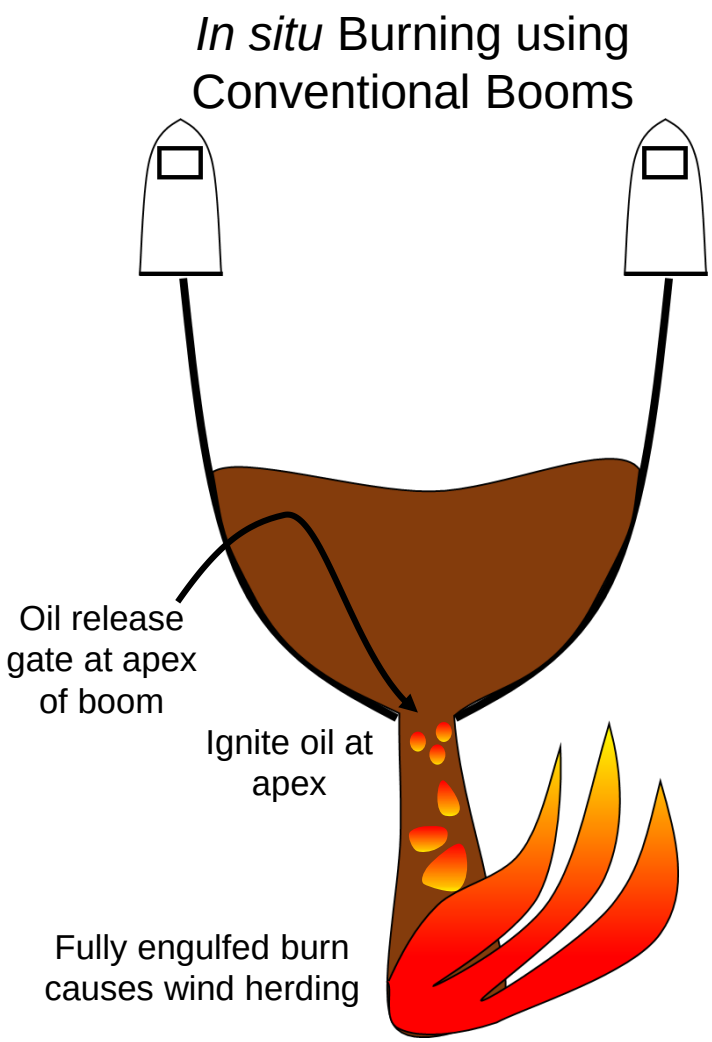
- Field test conducted June 14, 2016
- First known study to successfully burn free-floating marine oil slicks in open water
- Herded slick burned for total of ~30 min.
- Control slick (no herder) burned for ~12 min.

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.

Summary on Herders for ISB

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

ExxonMobil Burning Tongue



Issue:

- Fire boom is a logistical challenge to deploy offshore because of its weight and complexity
- Heat from multiple burns destroys boom (5 – 8 burns possible)

Concept:

- Conduct ISB using conventional ocean boom – no fire boom.
- Corral & thicken oil slicks, open gate at the apex of the boom to produce finger of thick burnable oil
- Immediately ignite finger once the oil leaves the boom.
- Within a few 10s of seconds, the finger will fully engulf in flame
  - convective winds from the burn will cause additional thickening of the oil.
- Field tests in the 80's demonstrated concept as did burns during DWH
- Burning a thin, long finger more efficient than standard pool fire.

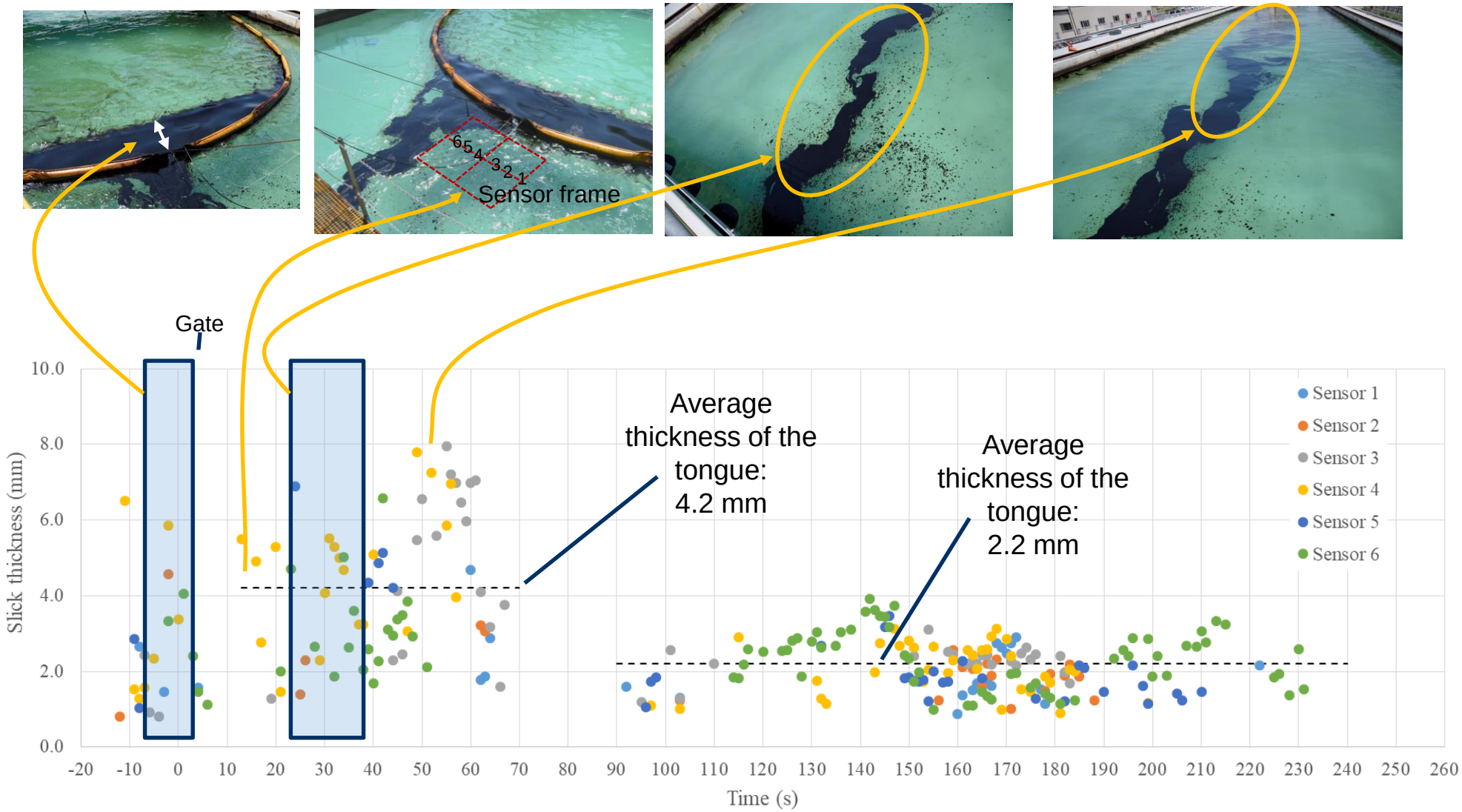
Status

- Tested the concept at Ohmsett in June 2019

Next steps

- Build / test a full-scale system
- Test at large tank in Fairbanks, AK in 2020

Burning Tongue – weathered oil (1-4 days)



Video showing convergence zone behind boom

Summary on Burning Tongue

- Conventional booms can be used for ISB to eliminate need for heavy, fire-resistant boom
- Free-floating oil can burn; “chimney effect” thickens free-floating oil during burn (Guenette & Sveum, 1995; Ross, 1986)
- OHMSETT testing found the “convergence zone” behind boom significantly enhanced oil thickening; slicks remained 3 – 5 mm thick for over 3 minutes

U.S. Coast Guard, May 19, 2010

- Guenette, C C, and Sveum, P. *In-situ burning of uncontained crude oil and emulsions.* Norway: N. 1995. Available from SINTEF, N-7034 Trondheim, Norway.
- Ross SL. Environmental Research Ltd and Energetex Engineering, In-Situ Burning of Uncontained Oil Slicks, EE-60. Ottawa, ON: Environment Canada; 1986.

QUESTIONS?