Use of Herding Agents to Facilitate In-Situ Burning
Presentation Overview

• Two experiments performed in 2015, 2016
• First involved “ice”; second involved open water
• Brief reference to companion study:
  – Windows of opportunity
ISB Experiment in “Ice” Objectives

• Validate use of herders in conjunction with ISB
• Validate use of helicopter-borne
  – herder application system; and
  – igniters
## Summary of testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Oil volume</th>
<th>Herding agent</th>
<th>HeliTorch Fuel</th>
<th>Max Slick Area</th>
<th>Burn Efficiency</th>
<th>Herder success</th>
<th>Aerial ignition success?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>By weight*</td>
<td>By area**</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>70 L</td>
<td>1 L OP40</td>
<td>60% diesel/ 40% gas</td>
<td>101 m²</td>
<td>86%</td>
<td>--</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>75 L</td>
<td>4 L OP40</td>
<td>100% gas</td>
<td>193 m²</td>
<td>59%</td>
<td>--</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>151 L</td>
<td>5 L OP40</td>
<td>20% diesel/ 80% gas</td>
<td>185 m²</td>
<td>94%</td>
<td>73 to 79%</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>155 L</td>
<td>1 L TS6535</td>
<td>20% diesel/ 80% gas</td>
<td>277 m²</td>
<td>73%</td>
<td>--</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>155 L</td>
<td>4 L TS6535</td>
<td>20% diesel/ 80% gas</td>
<td>157 m²</td>
<td>86%</td>
<td>74 to 84%</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Quantifies mass burn efficiency of free floating slick burning + sidewall-associated slick burning
**Quantifies volumetric burn efficiency of free floating slick burning only; not converted to mass since inherent measurement errors and burn rate assumptions preclude accuracy required for meaningful comparison
***Test 4 slick was ignited from the air, but only after slick was herded by wind against the sidewall
Experiments at Sea with Herders and In-Situ Burning
Primary objective:

Validate findings of an earlier study re: herders in open water
Methodology

• Three spills: 4 m$^3$ to 6 m$^3$
• One spill reference slick: no herder applied
• Herder applied from small boats
• Igniters manually applied approx. one hour after oil release
• Aerial imagery used to document experiments
## Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Burn duration, minutes</th>
<th>Volume burned, litres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>3390</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
<td>1226</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>770</td>
</tr>
</tbody>
</table>
Conclusions

- Successfully demonstrated open water HISB
- Higher wind speeds in test 3 may indicate an upper limit in open water of 4 to 5 m/s (10 kts)
- Reference slick, without the use of herder, was also partially ignited
Windows of Opportunity Research

• “If oils will flow, herders will work”
• At temperatures >10°C below pour point herders are ineffective
• As an oil emulsifies there is a loss of herder effectiveness
Conclusions

• Helicopter delivery system is being developed for application of herder and igniter

• In-situ burning should be considered a viable technique in:
  – Remote areas
  – Regions with partial ice cover
  – Inland areas with poor access