Assessing disturbance responses of Pacific walruses (*Odobenus rosmarus divergens*) to vessel presence in the Chukchi Sea

Sasha McFarland
Lisanne Aerts
Sheyna Wisdom
The Chukchi Sea

- ~56% is shallower than 50 m
- Covered by sea ice >8 months of the year, with partial coverage through the summer
Pacific Walrus in the Chukchi Sea

• Pagophilic
  – Calving
  – Protection
  – Transportation
  – Feeding – benthic

• Haulouts in AK
  – Sea ice
  – Transitioning to land locations

• 129,000 animals
Potential Threats

- **Environmental**
  - Sea ice retreat
  - Change in foraging
  - Ocean acidification

- **Anthropogenic**
  - Industry
  - Science
  - Shipping
  - Recreational
  - Subsistence

**Strategic Stock**
2013 Designation of Walrus Use Area

- Temporal restrictions
- ↑ reporting
- 805 m buffer zone
Chukchi Sea Environmental Studies Program (CSESP)

- Industry-funded science:
- 2008-2014 (July-October)
- Multi-disciplinary
2008-2013 Study Area

- **KLONDIKE**
  - 2008-2013

- **BURGER**
  - 2008-2013

- **STATOIL**
  - 2010-2013

- **GREATER HANNA SHOAL**
  - 2011-2012
2014 Study Area
At what distances do we see disturbance responses to vessel presence?
Methods

- Line transect surveys
- 2 vessels
- 2 observers
- 2 hour shifts/12 hours a day
- Observed to horizon, 180° in front of vessel
- Reticles for distance
- Effort data (weather, vessel)
- Sighting data (species, pod composition/numbers, behavior, movement, hauled out/in the water, and reaction)
Methods

R/V Westward Wind

R/V Norseman II
Methods
“Reaction”

Coded as strongest observed

• No = no observed reaction
“No”
“Reaction”

Coded as strongest observed

• No = no observed reaction
• Look = looked at vessel
“Look”
“Reaction”

Coded as strongest observed

• No (NO) = no observed reaction
• Look (LO) = looked at vessel
• Change course/speed (CCS) = looked at vessel, then visibly accelerated or turned
• Dive (DI) = looked at vessel, then rapidly dived
Data Analysis

Linear Mixed Effects Models (AIC)

• Response: Distance (log-transformed)
• Fixed Effect: Reaction
• Random Effects:
  – Year
  – Area
  – Beaufort sea state
  – Vessel
  – Water/Ice

Tukey Contrasts for Multiple Comparisons of Means
Fixed Effects Sample Size

<table>
<thead>
<tr>
<th>Reaction</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>376</td>
</tr>
<tr>
<td>LO</td>
<td>190</td>
</tr>
<tr>
<td>CCS</td>
<td>50</td>
</tr>
<tr>
<td>DI</td>
<td>96</td>
</tr>
</tbody>
</table>

TOTAL SIGHTINGS = 712
**Random Effects Sample Size**

All random effects were included in the most parsimonious model.

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Area</th>
<th>n</th>
<th>Beaufort</th>
<th>n</th>
<th>Vessel</th>
<th>n</th>
<th>Water/Ice</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>20</td>
<td>Hanna</td>
<td>79</td>
<td>0-1</td>
<td>170</td>
<td>WW</td>
<td>630</td>
<td>Water</td>
<td>592</td>
</tr>
<tr>
<td>2010</td>
<td>51</td>
<td>Statoil</td>
<td>86</td>
<td>2-3</td>
<td>316</td>
<td>NII</td>
<td>82</td>
<td>Ice</td>
<td>120</td>
</tr>
<tr>
<td>2011</td>
<td>109</td>
<td>Burger</td>
<td>280</td>
<td>4-5</td>
<td>193</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>280</td>
<td>Other</td>
<td>267</td>
<td>&gt;5</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>178</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL SIGHTINGS = 712**
Differences in reaction types when compared by distance at which they occurred

<table>
<thead>
<tr>
<th></th>
<th>NO</th>
<th>LO</th>
<th>CCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO</td>
<td>&lt;0.001</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CCS</td>
<td>&lt;0.001</td>
<td>0.007</td>
<td>-</td>
</tr>
<tr>
<td>DI</td>
<td>&lt;0.001</td>
<td>0.008</td>
<td>1</td>
</tr>
</tbody>
</table>

No significant difference between Change course or speed (CCS) and Dive
Results: “None”

• 75% of walruses that did not react were within ~2000 m of the vessel
• The middle 50% of walruses that did not react were between 300 and 2000 m away
• The range of “no reaction” distances was ~0-4700 m, with a few up to 7000 m away.

n=376
Zoomed reaction by Distance (m)
Results: “Look”

- 75% of walruses that looked at the vessel were within ~500 m of the vessel.
- The middle 50% of walruses that looked at the vessel were between 150 and 500 m away.
- The range of distances at which walruses looked at the vessel was ~0-1000 m.
- Beyond 1000 m, no walruses looked at the vessel.

n=190
Results: Change course/speed (CCS), Dive

- 75% of walruses that CCS/dived were within ~300 m of the vessel
- The middle 50% of walruses that CCS/dived were between 75 and 300 m away
- The range of distances at which walruses CCS/dived was ~0-600 m, with 7 exceptions (6 animals ~700 m, 1 animal ~1000 m).

n=146
Summary

• Reactions differ by distance
  – There is no difference between CCS and DI
  – NO is different than LO and CCS/DI
  – LO is different than CCS/DI

• Relative to current 805 m exclusion zone:
  – Only 7 sightings exhibiting CCS or DI reactions were >600 m from the vessel
  – 4 sightings exhibiting the LO reaction were >1,000 m from the vessel, all others within 1000 m

• Design a specific disturbance study

• Collaboration for publication
Data publically available

www.chukchiscience.com

Podcast:
Chukchi Sea Environmental Studies Program: Research at the Edge of the World

– Interviews with the scientists
– website and iTunes
Thank you!

- CSESP Colleagues
- Captains and crew of WW, NII
- Fairweather Science Colleagues
- Community of Wainwright
- Sponsors
- Colleagues who assisted with analysis methodology