US Geological Survey 2010 Cruise and Monitoring Report for the Beaufort Sea

Jon Childs, USGS
Deborah Hutchinson, USGS

Arctic Stakeholder Open-Water Workshop
Anchorage, AK
7 March 2011

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US Geological Survey 2010 Cruise and Monitoring Report for the Beaufort Sea

- US Extended Continental Shelf Program
- Overview of 2010 Bilateral Program
- Seismic Source and Sound Levels
- Other Impacts on Natural Environment
- Monitoring
- Mitigation
- Monitoring Results
- Ancillary Environmental Science

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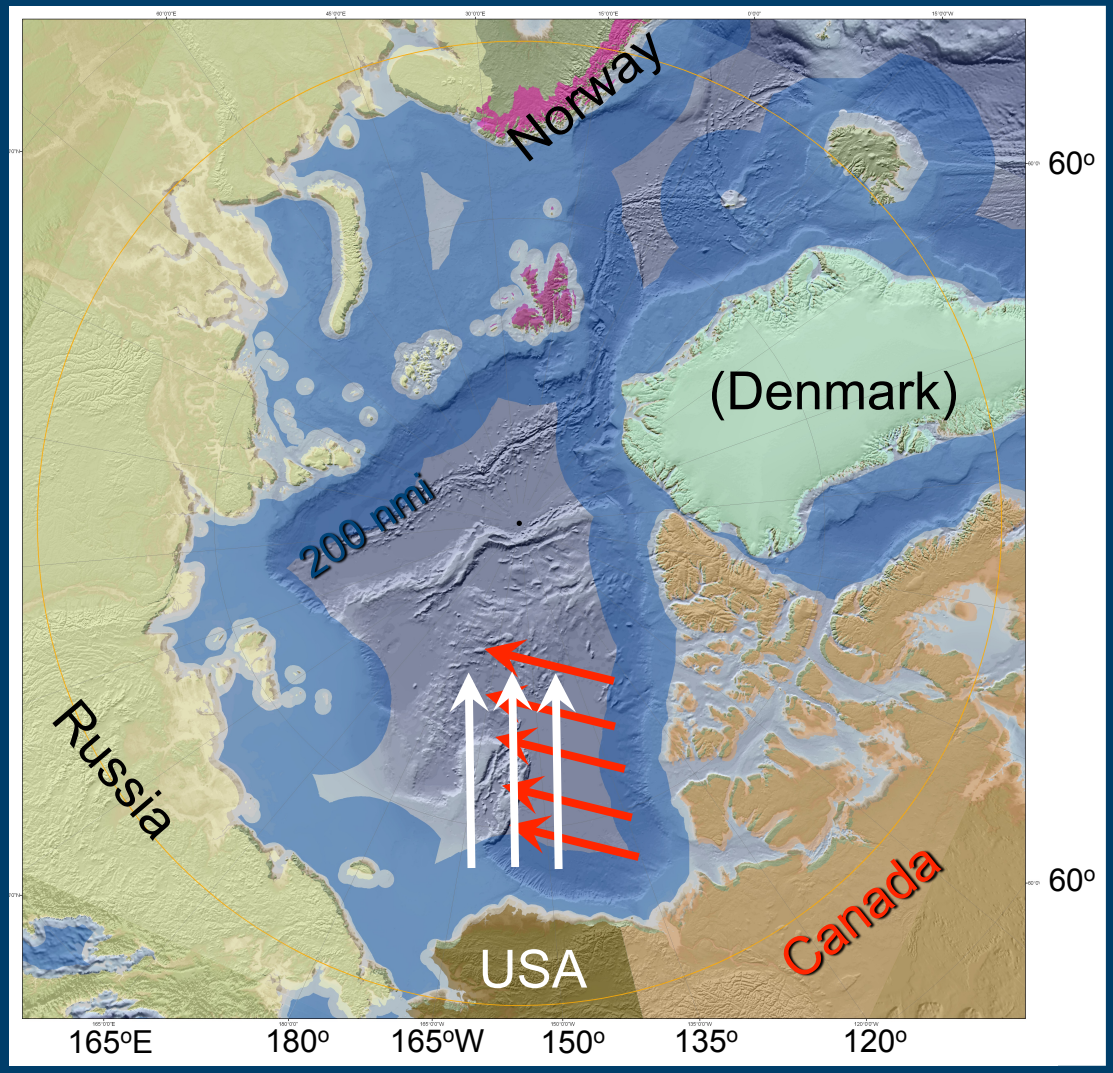
Extended Continental Shelf



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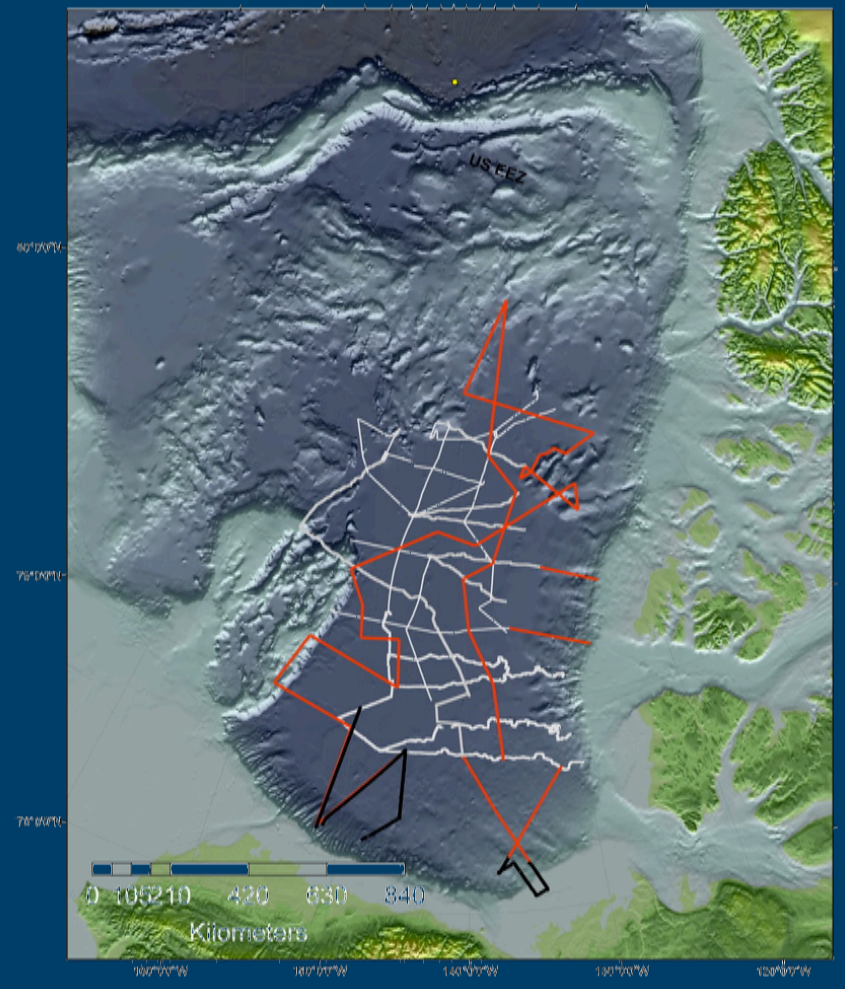
Overview of 2010 Program



Healy
2 Aug (Dutch Harbor)
6 Sept (Barrow)

Louis S. St-Laurent
7 Aug (Kugluktuk)
5 Sept (end two-ship ops)

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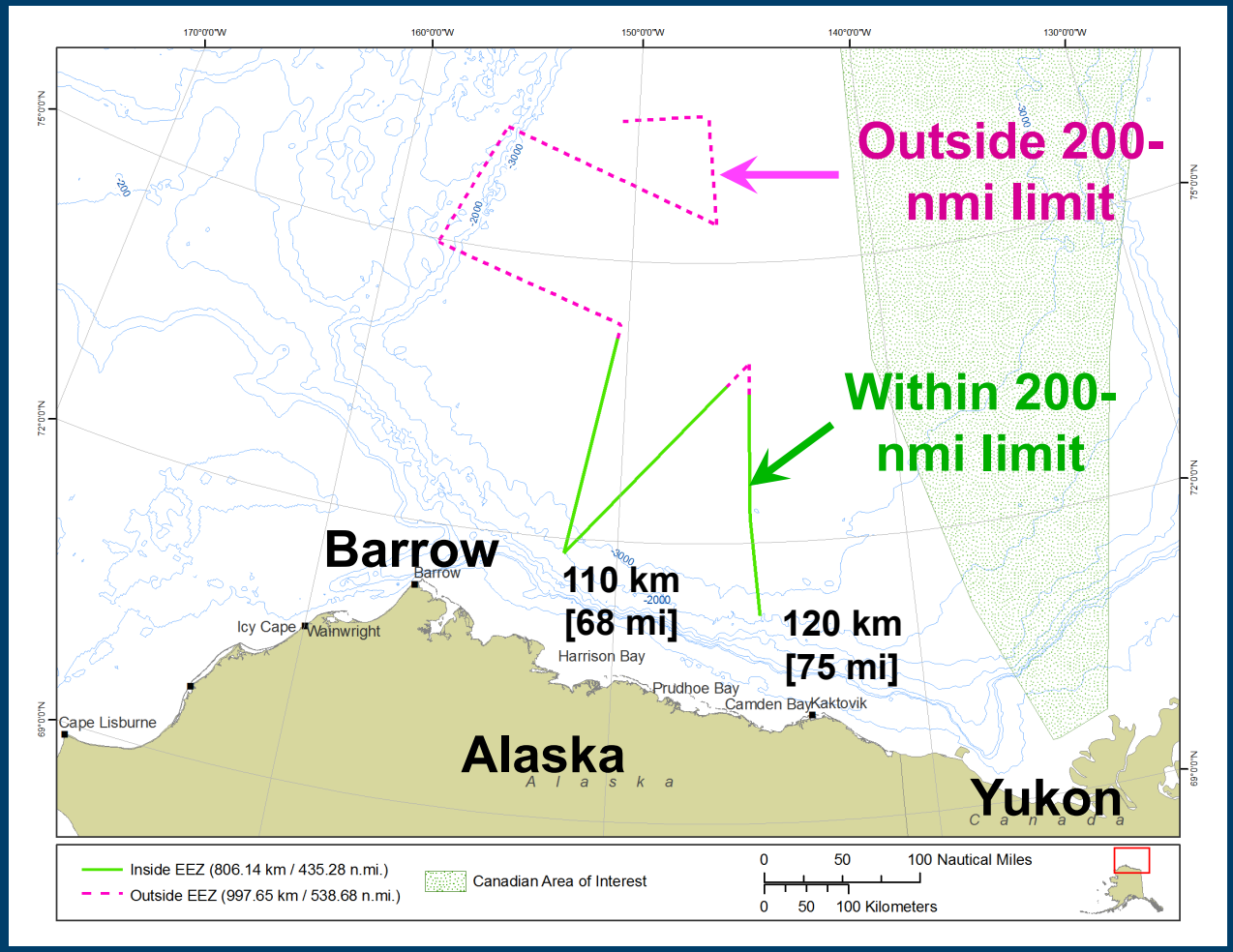
Lines of Concern for IHA



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For Multibeam Operations (US Ship):

All waters – US regulations apply

For the Seismic Operations (Canadian Ship):

Inside US 200-nmi Limit – US regulations apply

In International Waters – Canada regulations apply

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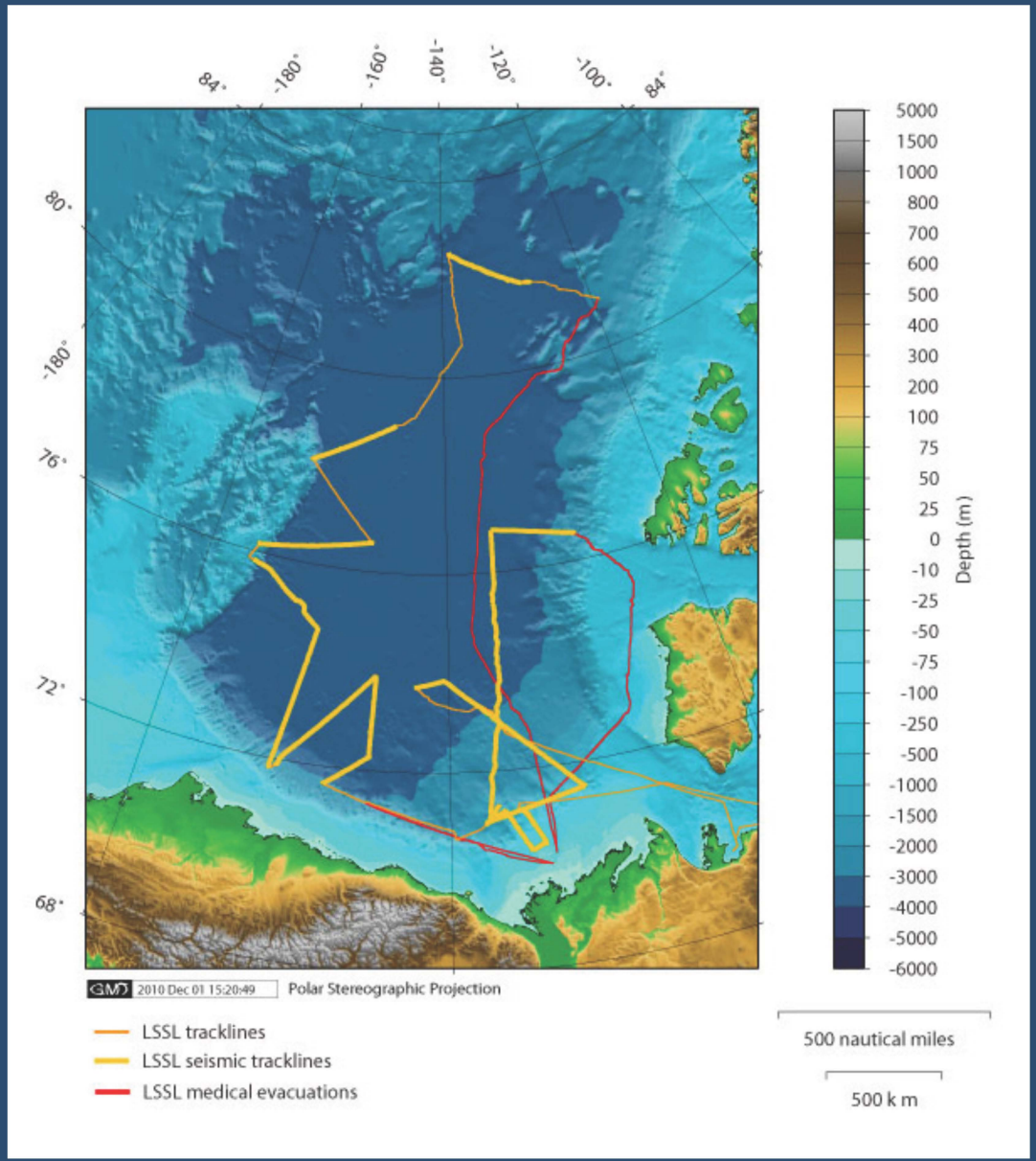

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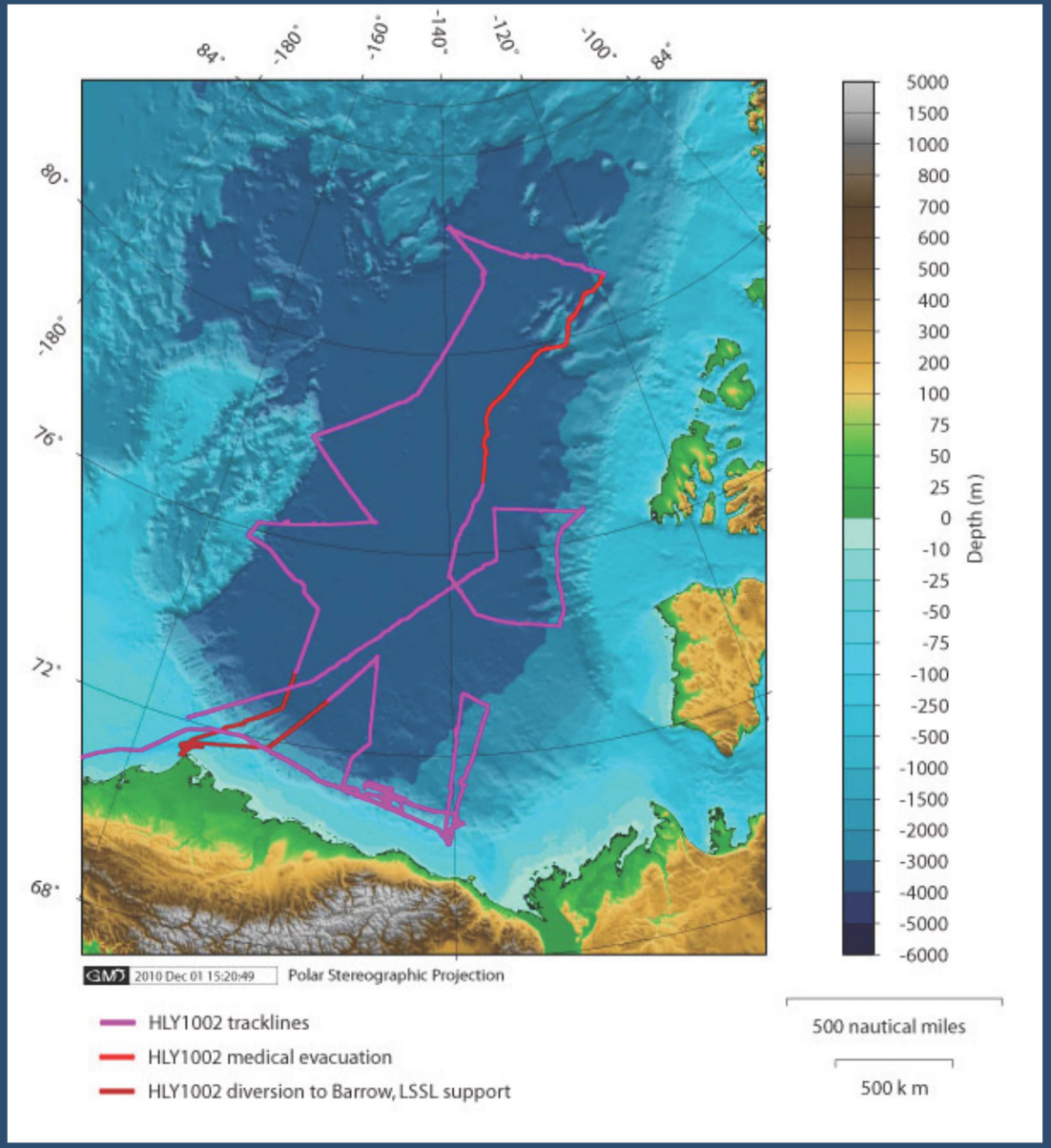

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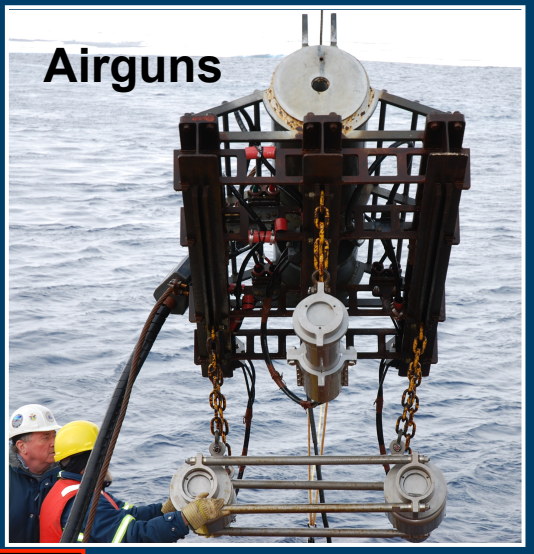
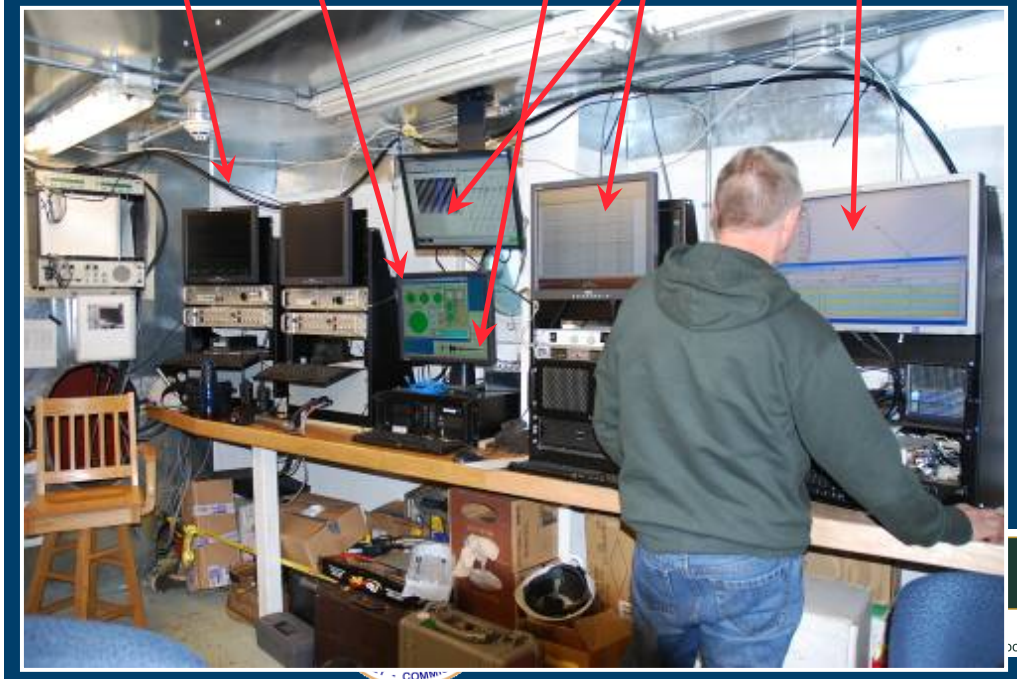
Seismic Source

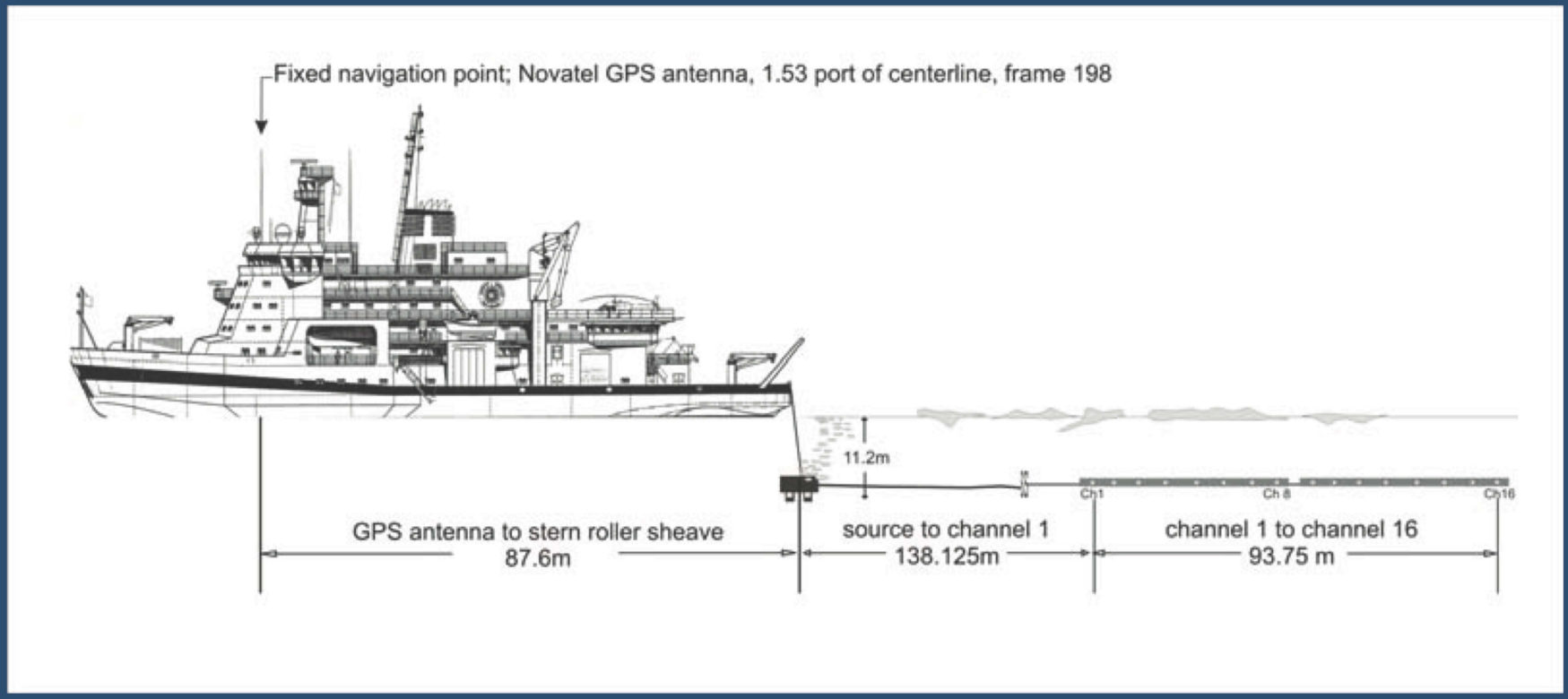


Compressor
Streamer
Airguns
Sonobuoy
Navigation



1 x 150 in^3
2 x 500 in^3
1150 in^3

Louis St-Laurent seismic details



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Safety Radii based on RMS
dB re: 1 mPa @ 1 m

Seismic Source Volume	Estimated Distance (m) 190 dB	180 dB	160 dB
150 in^3 mitigation gun	30	75	750
1150 in^3 (3-gun array)	100	500	2500

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Monitoring

MMOs

- 4 U.S. PSO aboard Healy (generally on bridge, 19.5 m [64 ft])
- 3 Canadian PSO aboard Louis (generally on flying bridge, 15.4 m [50 ft])
- 2 MMOs from Healy will join 3 from Louis for tracks in US waters
- USGS liaison aboard Louis for all two-ship operations
- For two-ship operations, 24 hr VHF communications
- Continuous Observations, including periods when no seismic
- U.S. MMOs aboard Louis had full authority for startup, ramp up, power down and shut down in US waters

Other Impacts on the Natural Environment

- Ice Breaking
  - Alters ice conditions around the vessel
  - Ice is highly variable at this time of year
  - Ice recloses and freezes

  Icebreaking by Healy considered continuous sound source; 120 dB threshold zone calculated

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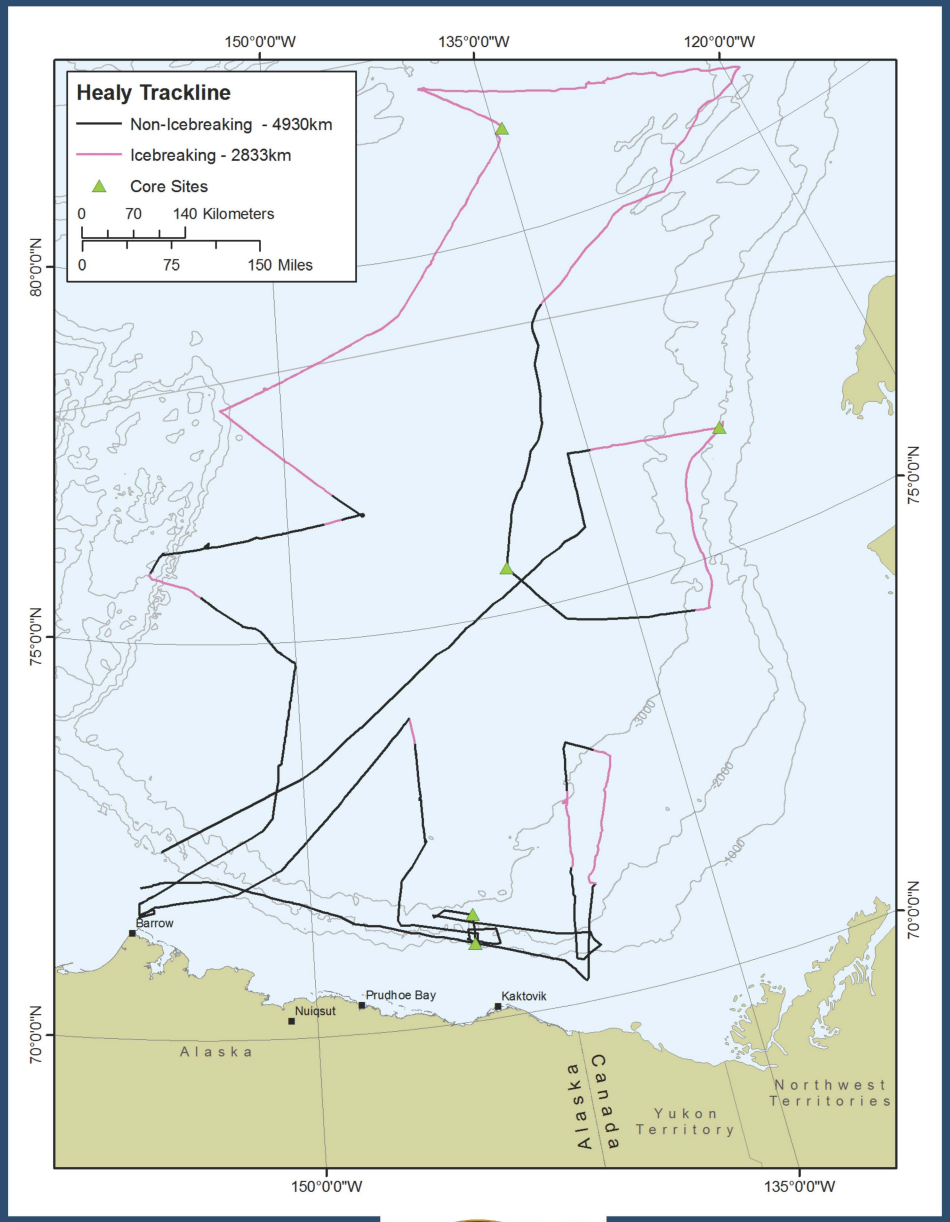

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Marine Mammal Observations

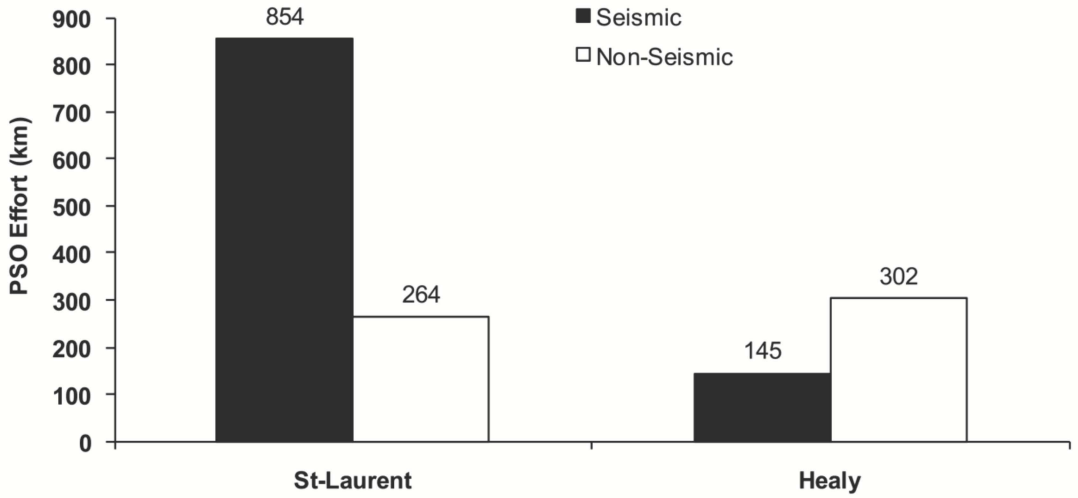

FIGURE 4.3. PSO effort (km) from the *Louis S. St-Laurent* and *Healy* by seismic activity during the 2010 geophysical survey inside the U.S. EEZ.

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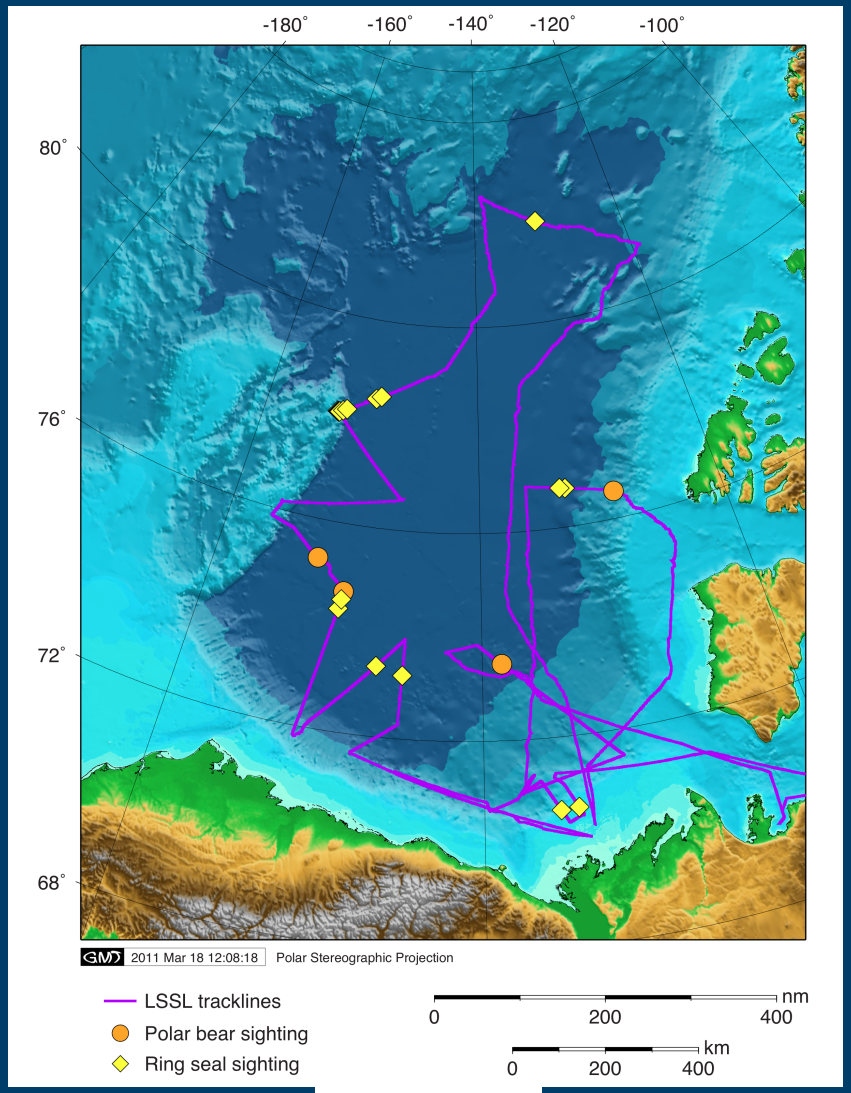
Ring seal and polar bear sightings from Louis St-Laurent



Ice seal observations

TABLE 4.1. Number of sightings (number of individuals) of seals from the *Louis S. St-Laurent* and *Healy* during the 2010 geophysical survey. Only sightings from the *Louis S. St-Laurent* that occurred within the U.S. EEZ are reported.

Species	*St-Laurent*	*Healy*	*Total*
Seals in Water			
Bearded Seal	0	1 (1)	***1 (1)***
Ringed Seal	6 (6)	21 (22)	***27 (28)***
Unidentified Seal	0	9 (9)	***9 (9)***
Seals on Ice			
Bearded Seal	0	7 (7)	***7 (7)***
Ringed Seal	0	21 (23)	***21 (23)***
Unidentified Seal	0	11 (14)	***11 (14)***
Total Seals	***6 (6)***	***70 (76)***	***76 (82)***

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Marine Mammal Observations

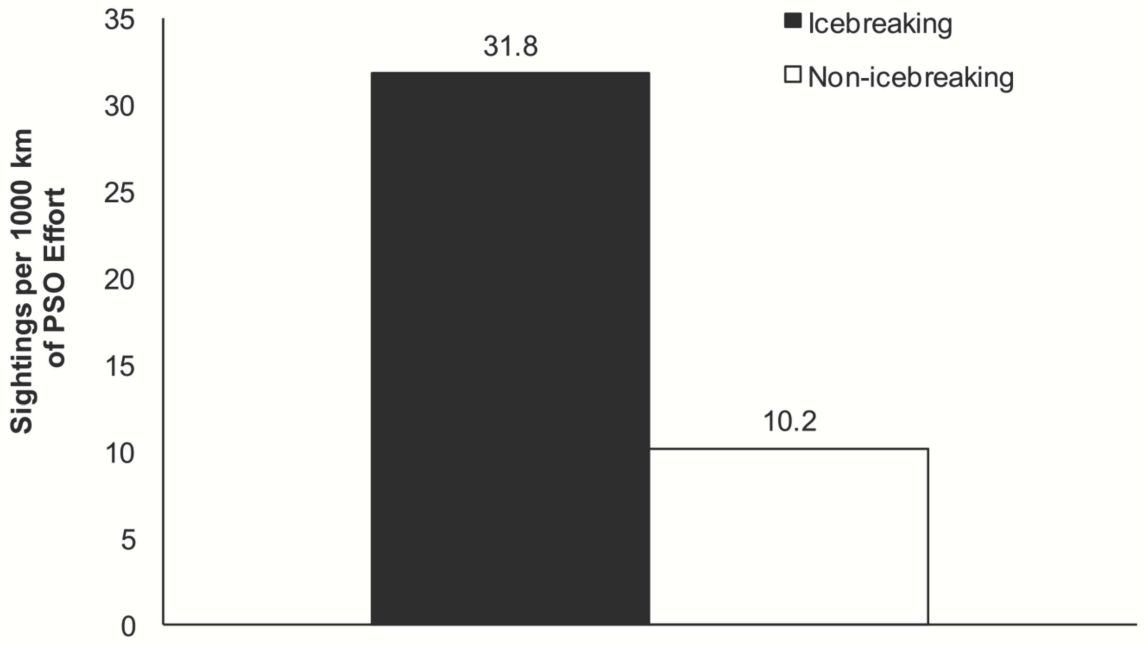

FIGURE 4.4. Seal sighting rates (animals in water and on ice) by icebreaking state from the *Healy* during the 2010 geophysical survey.

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Polar Bear Observations

TABLE 4.2. Number of sightings (number of individuals) of polar bears from the *Louis S. St-Laurent* and *Healy* during the 2010 geophysical survey.

Species	*St-Laurent*	*Healy*	*Total*
Polar Bears			
In Water	0	0	***0***
On Ice/land	1 (2)	12 (14)	***13 (16)***
Total Polar Bears	***1 (2)***	***12 (14)***	***13 (16)***

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Marine Mammal Observations

TABLE 4.11. Estimated summer densities of marine mammals, in polar pack ice habitat in the Arctic Ocean. Densities are corrected for *f*(0) and *g*(0) biases.

Species	Density - Polar Pack Average (No. individuals /1000 km^2)	Density - Polar Pack Maximum (No. individuals /1000 km^2)
Cetaceans		
Beluga	3.5	7.1
Bowhead whale	0.6	1.2
Fin whale	0.0	0.1
Gray whale	0.0	0.1
Harbor porpoise	0.0	0.1
Humpback whale	0.0	0.1
Killer whale	0.0	0.1
Minke whale	0.0	0.1
Narwhal	0.0	0.1
Total Cetacean Density	***4.1***	***9.0***
Seals		
Bearded seal	1.3	5.1
Ringed seal	25.1	100.4
Spotted seal	0.0	0.0
Total Seal Density	***26.4***	***105.5***
Polar bears	***0.0***	***0.2***

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Marine Mammal Observations

TABLE 4.13. Estimated number of individual marine mammals exposed to received sound levels ≥120 dB (rms) while breaking ice outside U.S. waters during the 2010 USGS geophysical survey in the Arctic Ocean. Estimates are based on densities calculated from previous surveys in the region and the actual amount of icebreaking activity conducted in 2010.

	Number of Exposures to Sound Levels ≥120 dB re 1 µPa (rms)	
Species Group	**Based on Average Polar Pack Density**	**Based on Maximum Polar Pack Density**
Cetaceans	41	89
Seals	262	1046
Polar Bears	<1	2
Total	***303***	***1137***

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Ancillary Environmental Science

- Ice observations
- Piston coring
- Ocean acidification

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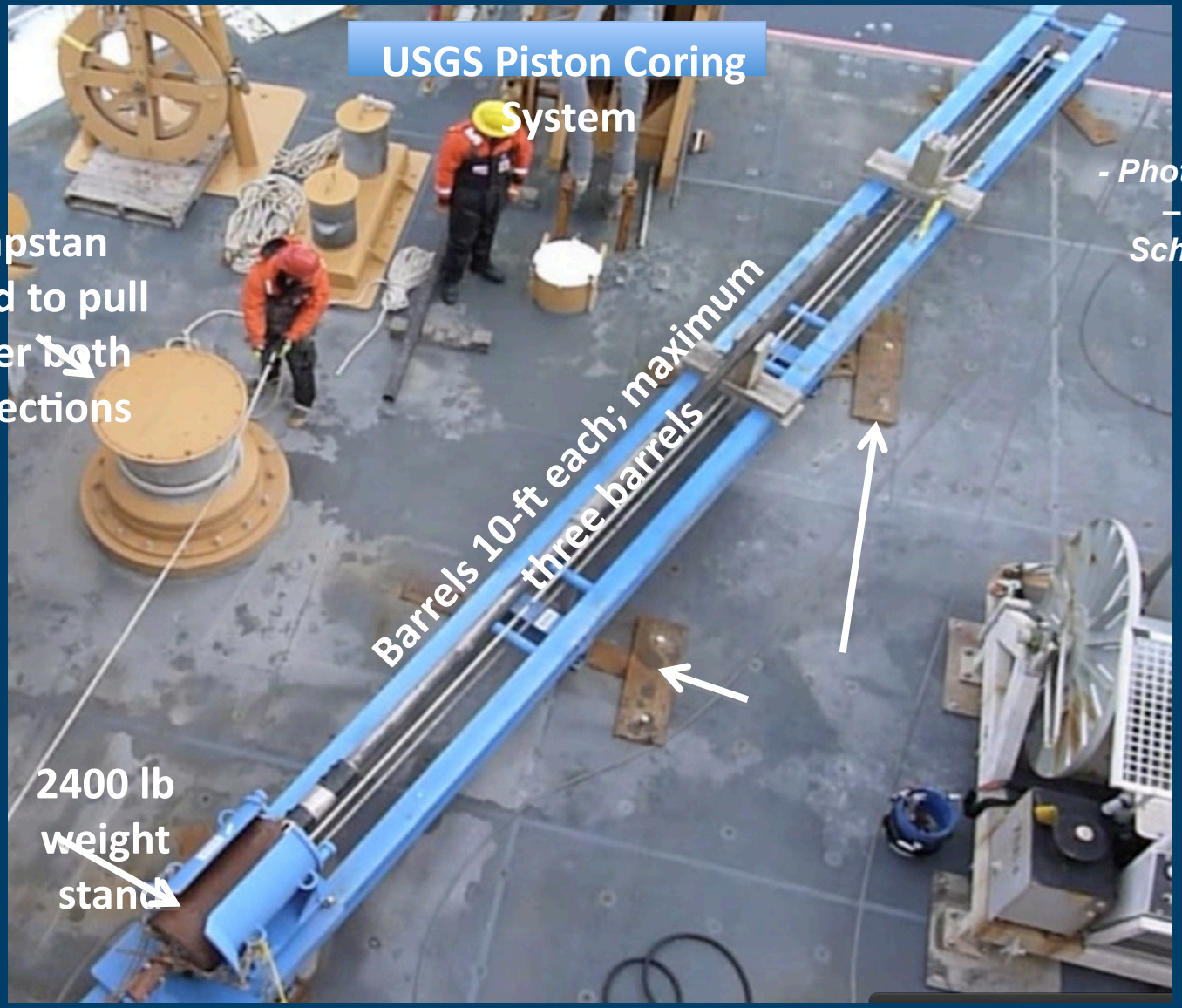
USGS Piston Coring System



- Photo credit – Bill Schmoker

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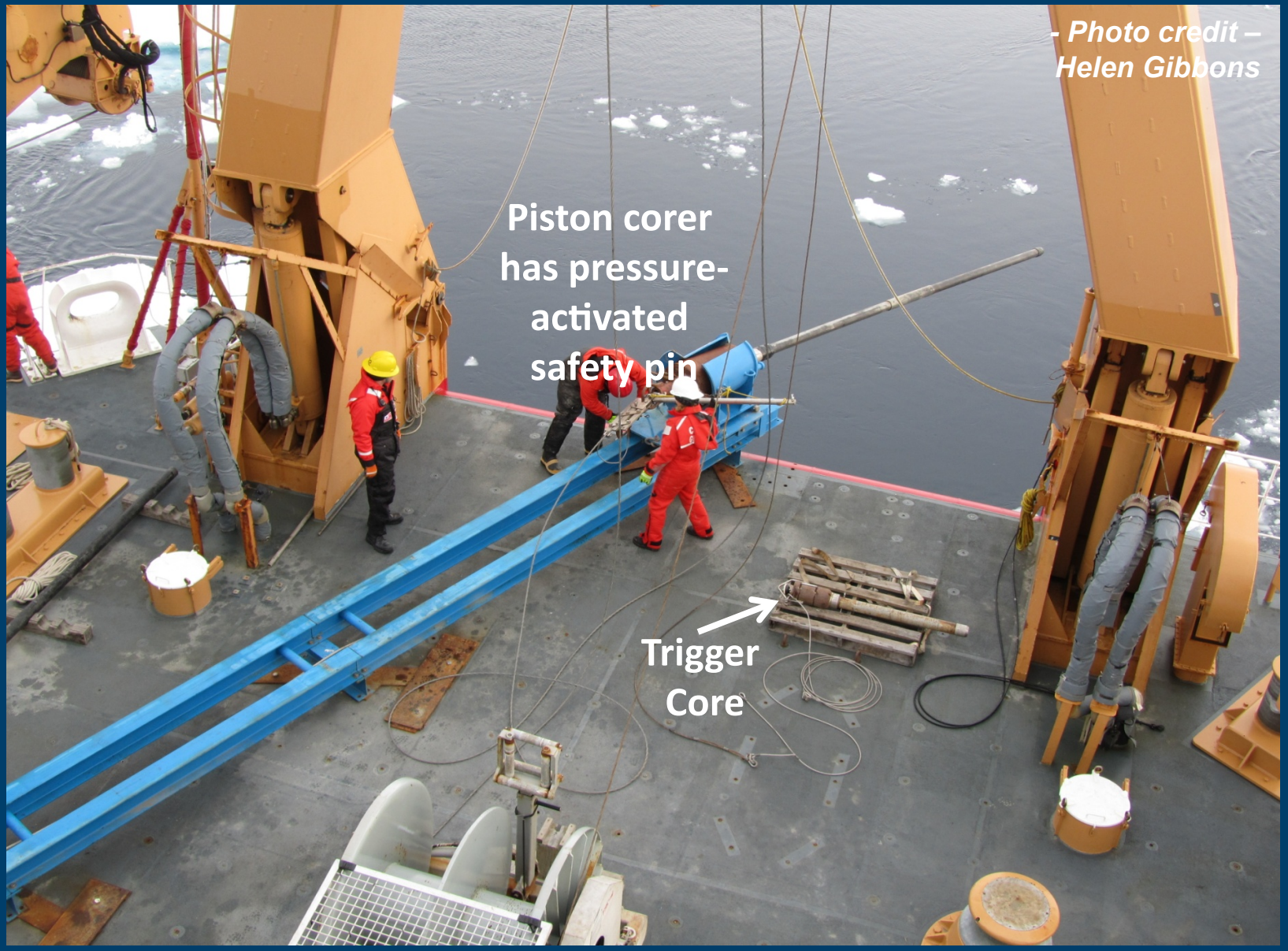
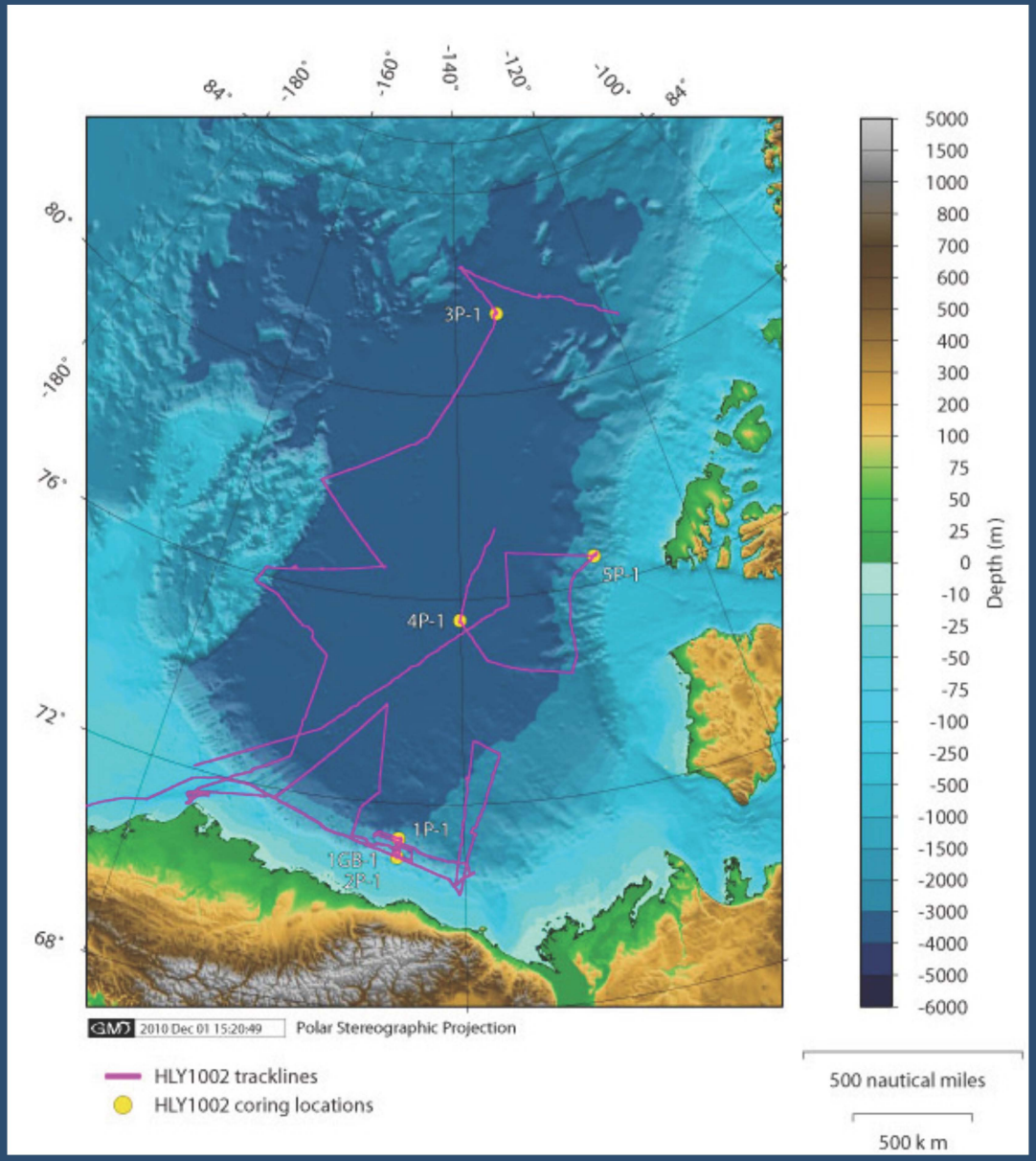

- Photo credit –
Helen Gibbons
Piston corer has pressure-activated safety pin
Trigger Core



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- Photo credit – Caroline Singler

Typical core recovery (Site 4)

Photo credit – Bill Schmel...

Gas Hydrate (Site 1)

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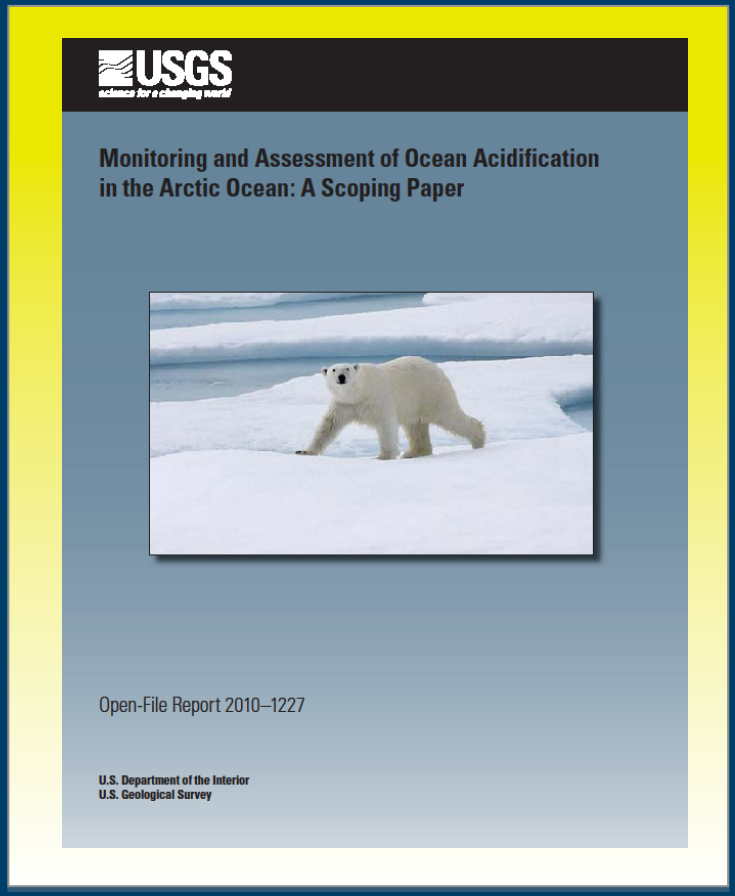
Arctic Ocean Acidification Project



Dept of Interior has recognized Arctic Ocean as priority ecosystem

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USF UNIVERSITY OF SOUTH FLORIDA COLLEGE OF MARINE SCIENCE

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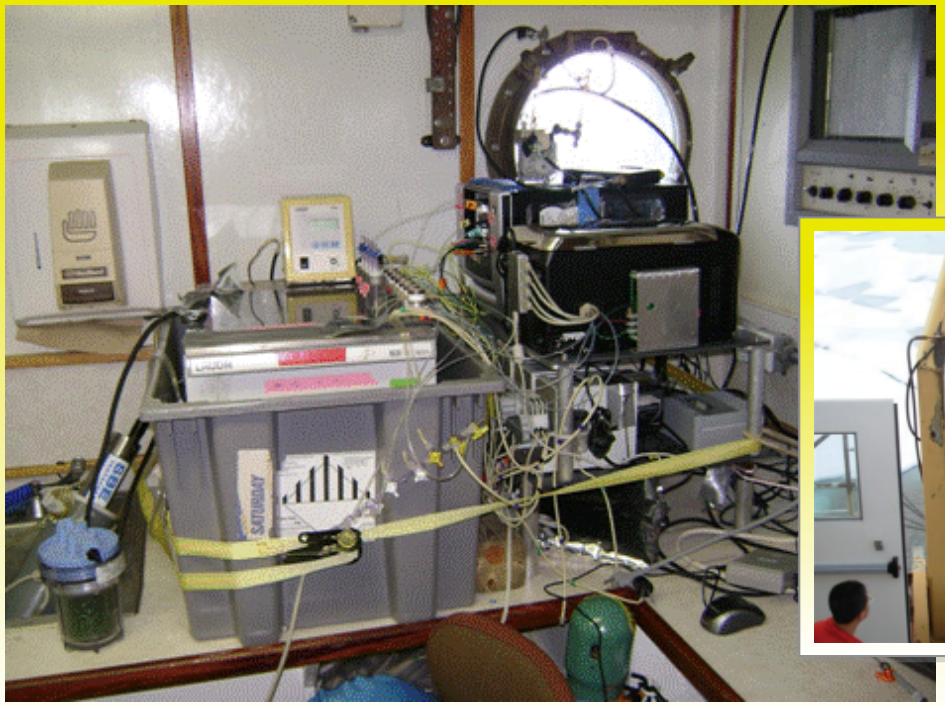
Arctic Ocean acidification



State-of - art equipment

- 22,000 data points- flow thru system: pH, DIC, pCO_2
- Collection every 2 min
- 8 Stations- water samples to 3500m

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Questions?