



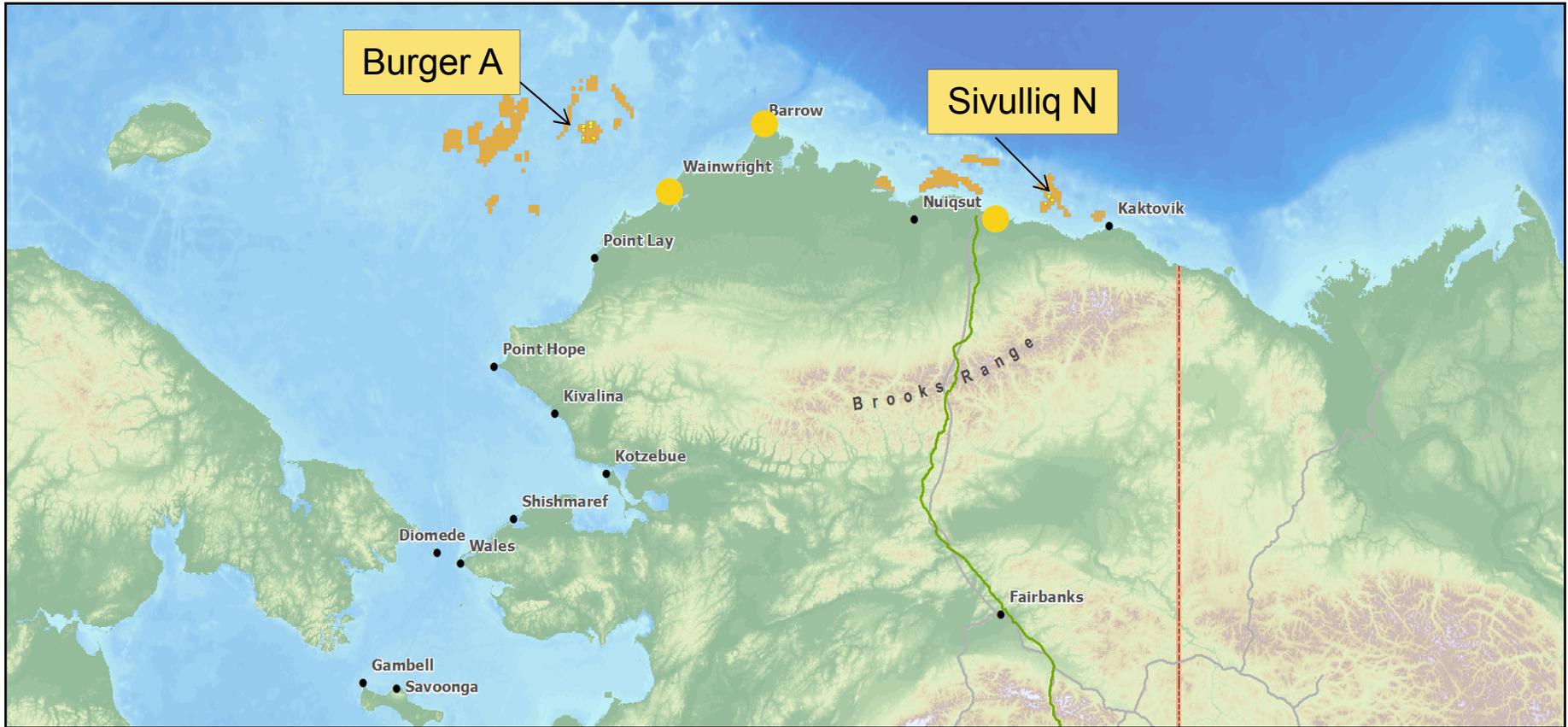
Shell's Alaska Venture Open Water Meeting 2012 Activities and Monitoring Results

March 5, 2013

Agenda

- Presentation Materials
 - Review of 2012 operations
 - Monitoring program overview
 - Details of select aspects of monitoring program
 - PSO programs
 - Acoustics
 - Sound Source Characterization – vessel strategy
 - Regional arrays
 - » Chukchi
 - » Beaufort
 - Aerial
 - Beaufort
 - Chukchi
- Q&A

Shell's 2012 Drilling Program



Key Dates in the Drilling Programs

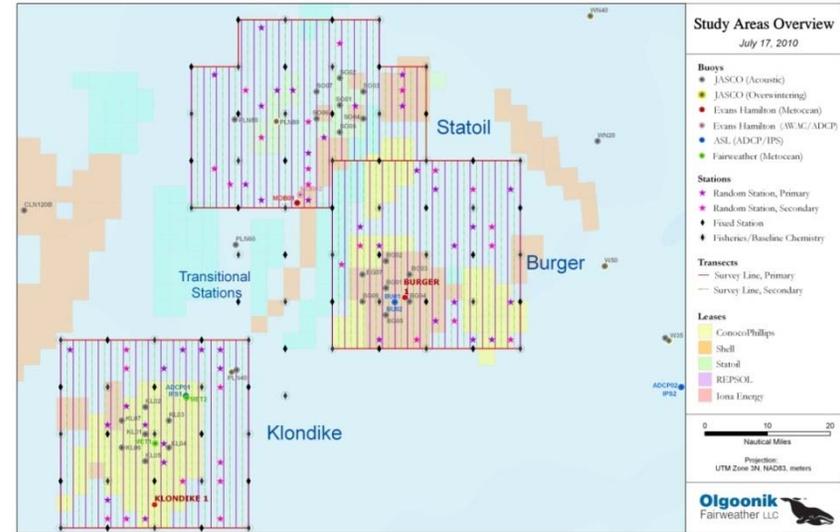
- Chukchi – Burger
 - Anchor Setting – August 8-10
 - Drillship on location – September 7 / 21
 - Drilling – September 23
 - Mud-line cellar – October 2 - 4
 - End of drilling – October 26
 - Left site – October 28
- Beaufort – Sivulliq
 - Anchor Setting – August 18-22
 - Drillship on location – September 25
 - Anchor hook-up – September 25-27
 - Drilling – October 3
 - Mud-line cellar – October 13-23
 - End of drilling – October 27



Science and Monitoring Program Overview

Chukchi Sea Lease Areas and Baseline Studies

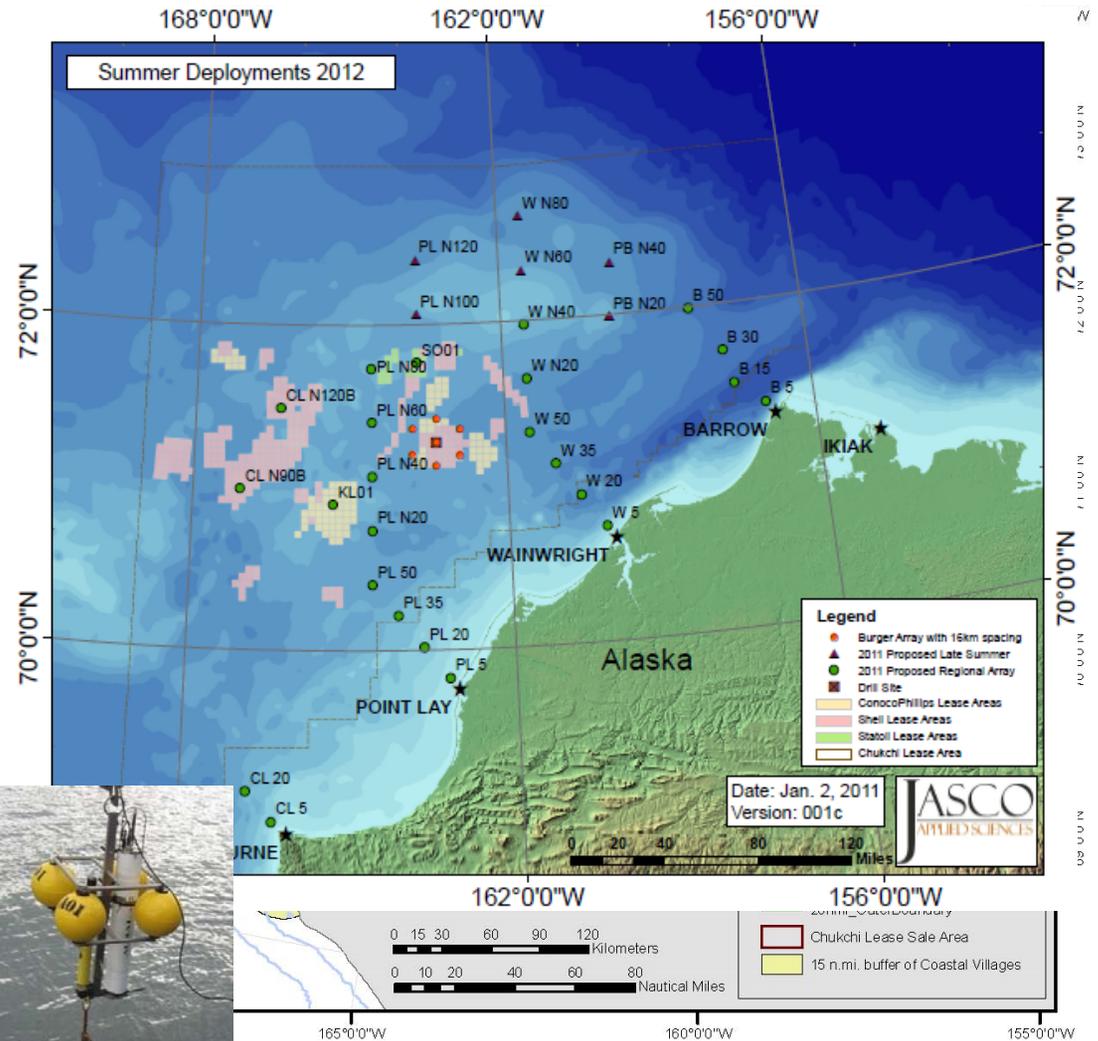
- Jointly funded by ConocoPhillips & Statoil
- Operated by native corporation
- Three areas of top priority
- Subject to intensive interdisciplinary study each year since 2008
 - Physical oceanography
 - Benthos
 - Plankton
 - Acoustics
 - Fishes
 - Marine Mammals
 - Marine Birds



Marine Mammal Observations

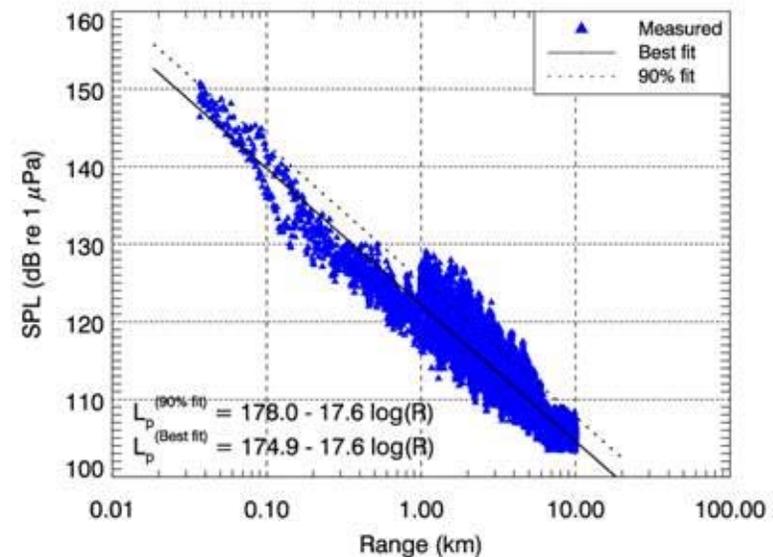
Triad of Information

- Vessel based observations
 - PSOs on all vessels
 - Integrated biologist/local knowledge staff
- Aerial observations
- Acoustics
 - Open water since 2006
 - Year around since 2007



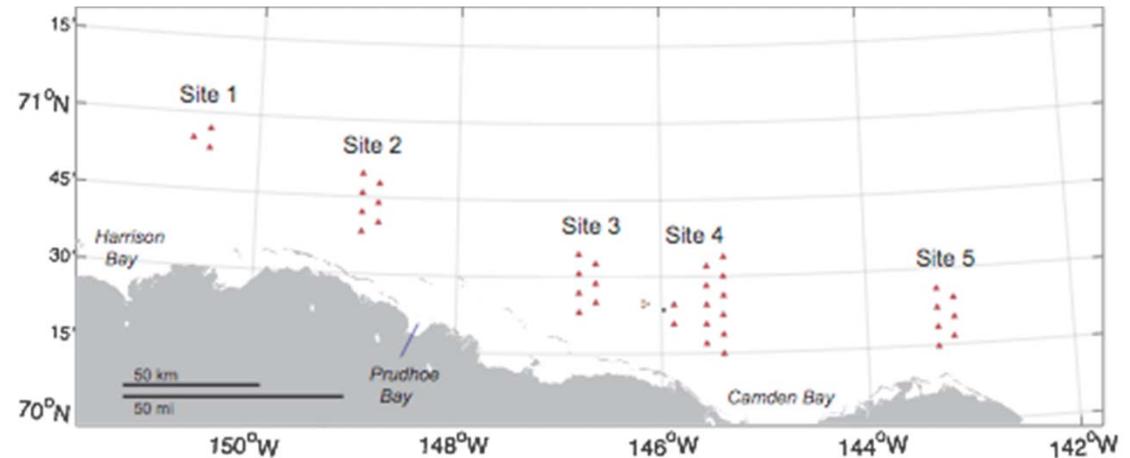
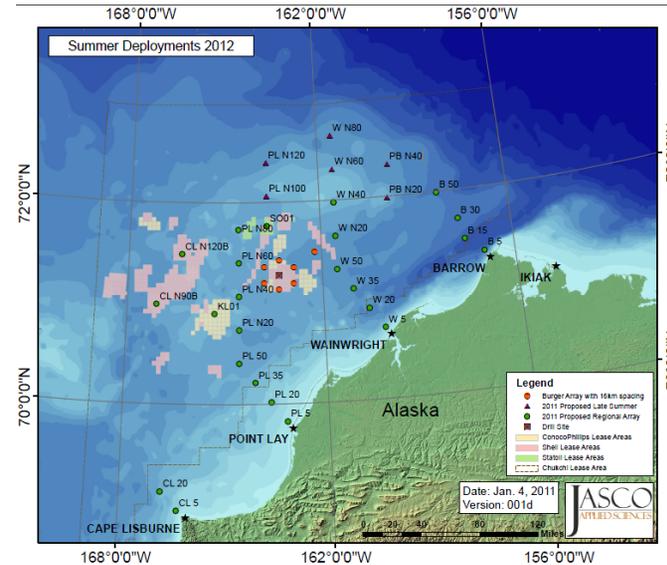
Acoustics – Sound Source Characterization

- SSC conducted on all vessels in each theater in which they operated
- Vessel SSCs at initiation of activities
- Real-time SSC for the drilling operation first 10 days at Sivuliq



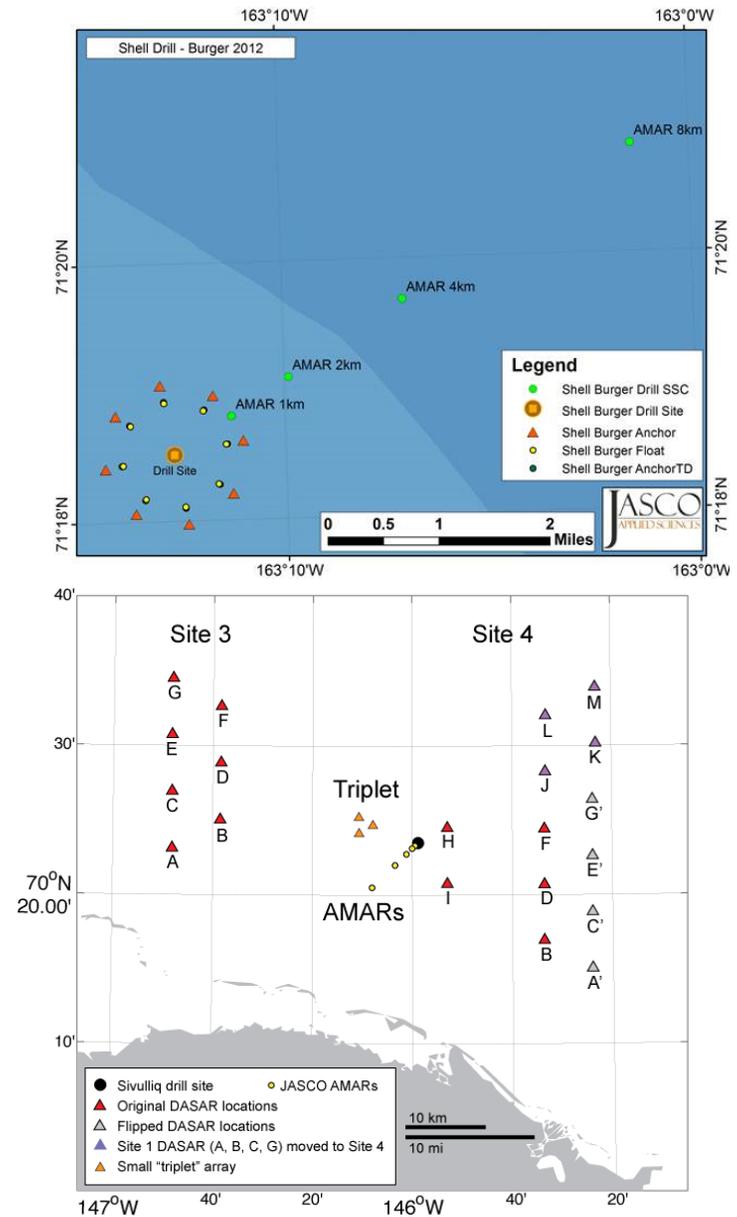
Acoustics – Regional arrays

- Acoustic recorders deployed in the Chukchi & Beaufort
- Localization capability in Beaufort
- Goals
 - Understand effects of industry sound on the distribution and behavior of marine mammals.
 - Understand patterns of distribution and movement



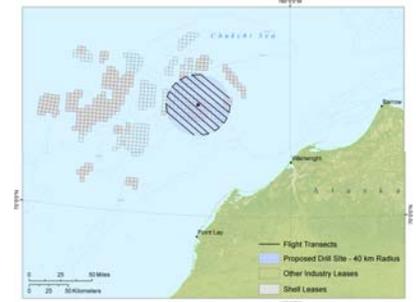
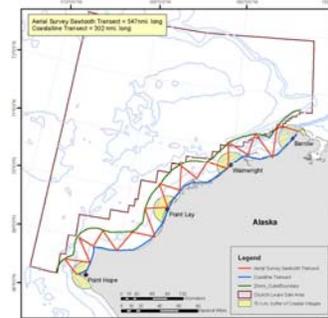
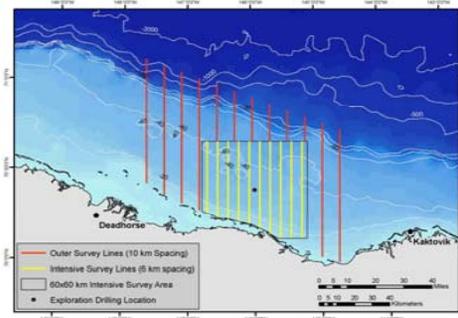
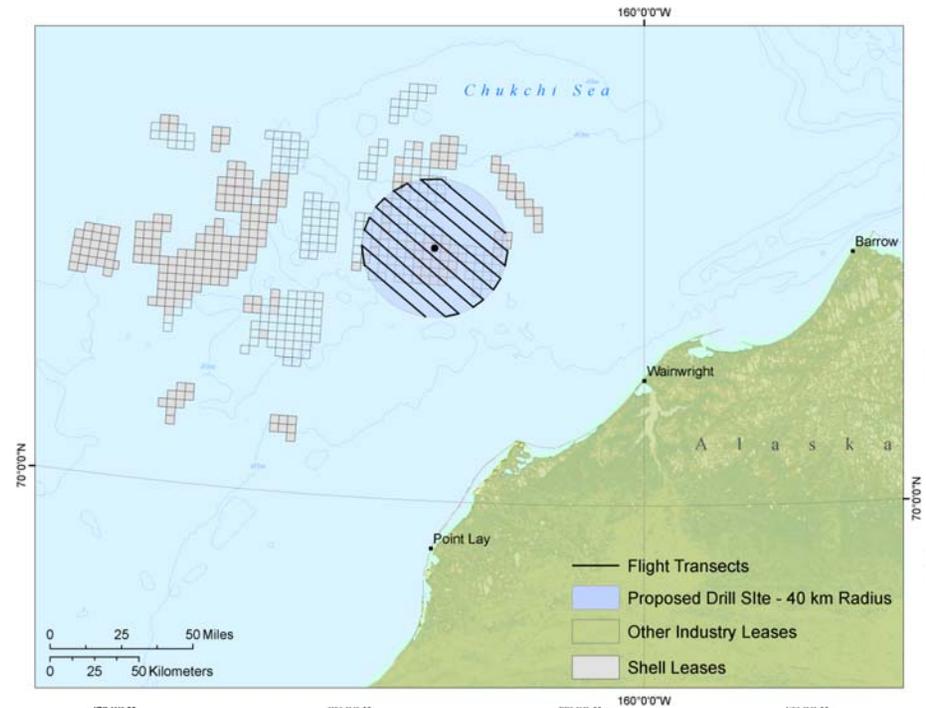
Acoustics – Site specific arrays

- Monitor and evaluate drilling related sound levels
- Collect distribution and movement information through call data
- Based upon things we have learned since 2006



Aerial Program

- Offshore overflights in the Beaufort
 - Manned flights w/ photography
 - Stratified sampling strategy
- Chukchi nearshore
 - Sawtooth pattern
 - Manned flights w/ photography
- Chukchi Burger prospect
 - Photographic survey
 - Manned aircraft
 - No PSOs





2012 Chukchi and Beaufort seas Vessel-based Monitoring Results



Alaska Research Associates, Inc.

2012 Vessel-based Monitoring Summary

- PSOs a team of biologists with LGL and Alaska Natives from ASRC and NANA
- PSOs deployed aboard 17 vessels
- 1-5 PSOs per vessel, 5 aboard each drill rig and primary ice-management vessel
- 57 vessel PSOs deployed at full operations
- 25,905 total PSO watch-hours
 - 14,888 in Chukchi Sea
 - 11,017 in Beaufort Sea
- 6 vessels with “Big-Eyes”
 - *Discoverer, Kulluk*
 - *Fennica, Nordica*
 - *Tor Viking, Aiviq*



2012 Vessel-based Monitoring Summary

- 2 PSOs on watch during all daylight drilling and ice-management activities (no ice management in Beaufort Sea during 2012)
- 1 PSO remained on watch during all nighttime drilling operations
- At least 1 PSO on watch during all other active vessel operations whenever possible and safe



Real-time PSO Data Entry: PSO Tracker

- Maximizes time with PSO eyes on the water: one click for date, time, lat/long
- Robust in-field QA/QC of data

The screenshot displays the PSO Tracker software interface. At the top, there are buttons for 'New Animal Sighting' (F1), 'Effort' (F2), 'Sighting' (F3), and 'New Effort' (F4). The current date and time are 12/17/2012 09:11:36. Below these are 'Admin', 'COM', 'GPS', and 'USB' buttons. The main section is titled 'Effort Not Complete'. It features a 'Watch' dropdown set to 'Watch Active', and input fields for 'Latitude: 61.1711', 'Longitude: -149.9212', 'Deg/min', and 'Time: 12/17/2012 09:09:10'. The data entry form is organized into several columns of fields:

Obs Loc: Bridge	Speed: 10	Visibility KM: 0.10	Ice Type: New
Port: Marc Bourdon	Activity: [highlighted]	Light or Dark: Dark	Ice Loc: Port
Center: Kermit The Frog	Line No: X	Glare Amount: None	Percent Ice: 10
Starboard: Willie Hugh Nelson	No Guns: X	Glare From: X	Pack Ice Distance: X km
Rec By: Marc Bourdon	Array Volume: 0	Glare To: X	

Additional fields include 'Closest Vessel Distance: 0.50 km', 'Closest Vessel Name: S.S Minnow', 'Other Vessels Within 10km: 5', 'Water Depth: 400 ft', and 'Wind Force (BF): 2'. A large text area contains the instruction: 'THIS IS A DETAILED COMMENT. IF THERE ARE VISIBILITY CLARIFICATIONS TO BE MADE THIS IS A GREAT PLACE TO EXPLAIN IT.' At the bottom, a 'Complete Effort Entry' button (F5) is visible.

Real-time PSO Data Entry: PSO Tracker

- Auto-generated log of data edits
- File written and saved in admin account, unavailable to PSOs in the field

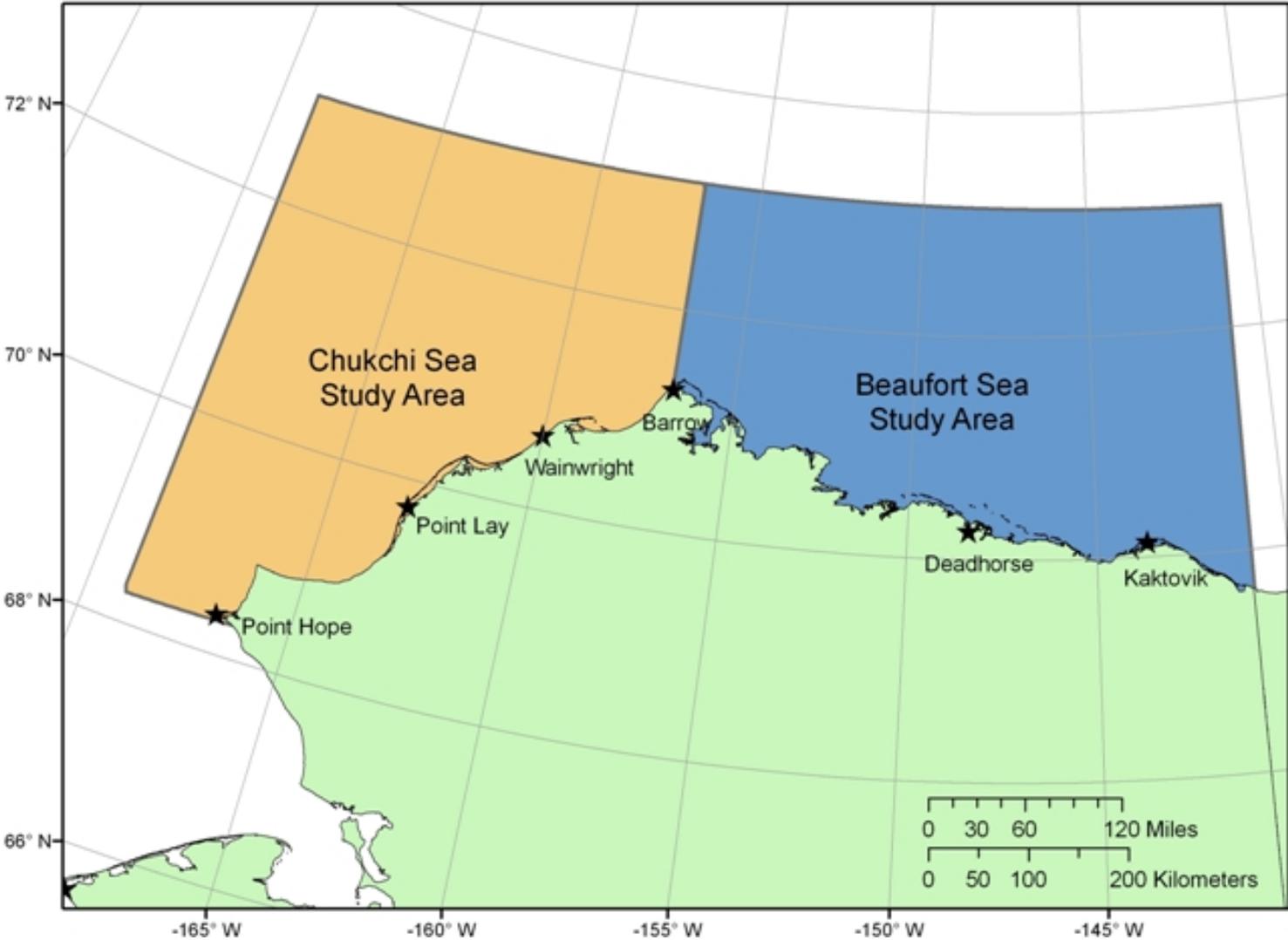
ChangeLog						
ID	TableName	ColumnName	ItemID	OriginalValue	NewValue	Changed
1	Effort	VisibilityKM	3636	10	X	10/23/2012 5:55:10 AM
2	Effort	VisibilityKM	3637	10	X	10/23/2012 5:55:17 AM
3	Effort	VisibilityKM	3638	10	X	10/23/2012 5:55:26 AM
4	Effort	VisibilityKM	3639	10	X	10/23/2012 5:55:35 AM
5	Effort	VisibilityKM	3640	10	X	10/23/2012 5:55:44 AM
6	Effort	OtherVesselDistance	3659	0.50	0.25	10/23/2012 3:06:00 PM
7	Effort	Comments	3663	2	ANCHORED ON WIRE WITH THE TUUQ	10/23/2012 5:00:55 PM
8	Effort	Watch	3671	W	WE	10/23/2012 9:01:47 PM
(New)						

Real-time PSO Data Entry: PSO Tracker

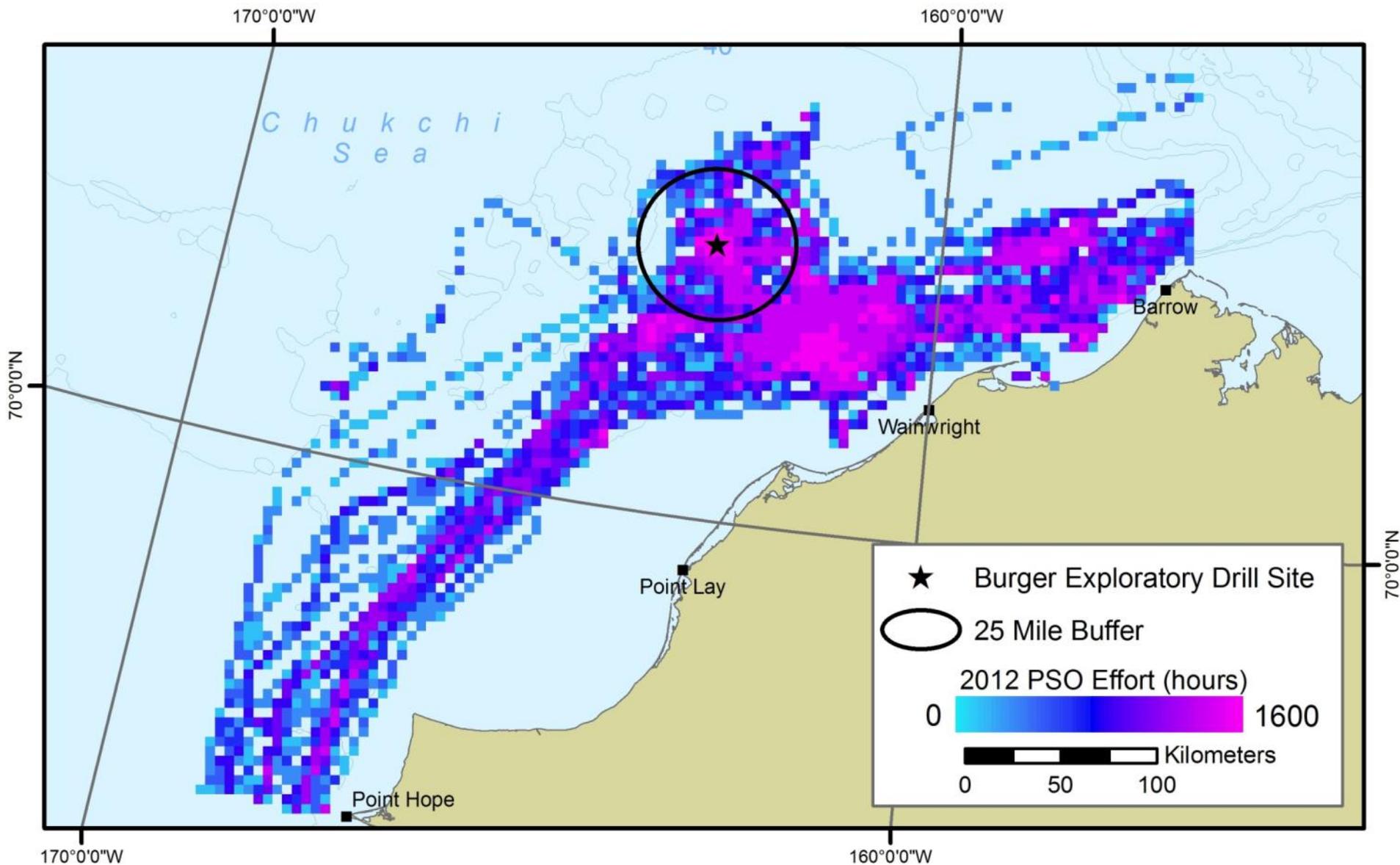
- Prompts for PSOs as data are entered, including scenarios requiring mitigation, flagging of incomplete data fields, etc.

The screenshot displays the 'PSO Tracker' software interface. At the top, there are buttons for 'New Animal Sighting' (F1), 'Effort' (F2), 'Sighting' (F3), and 'New Effort' (F4). The interface includes fields for 'Latitude', 'Longitude', and 'mm/dd/yyyy hh:mm:ss'. A 'Home' button is visible on the left. The main section is titled 'Sighting' and shows 'ID: 28' and 'Start Time: 12/26/2012 11:57:37'. The 'Species' is set to 'Pacific Walrus - Ivq' and 'Vessel Status' is empty. A 'Record' section indicates 'Not Complete' and has a 'Resight, Same Animal' button (F12). Below this, 'Record #' is 1, 'Latitude' is 0, 'Longitude' is 0, and 'Time' is 12/26/2012 11:57:37. The 'Individuals' field is 2, 'Juveniles' is 0, and 'Reticles/Eye' is E. 'Sighting Distance' is 600 m. A modal dialog box titled 'Comment' is open, containing the text: 'Please comment on this sighting. Be sure to include vessel speed, activity, and if it is not a mitigation, explain why.' and an 'OK' button. Other fields include 'Where At', 'Pace', 'Water or Ice', 'Observed By', 'Call Type', 'End Time', 'Recorded By', 'Closest Point of Approach', 'CPA Time' (F7), 'CPA Distance', 'CPA Where At', and a 'Complete Record' button (F5).

Chukchi Sea Vessel-based Monitoring Results



Chukchi Sea PSO Watch Effort



Chukchi Sea Cetacean Sightings (No. of Individuals)

Species	Jul - Aug	Sep - Nov	<i>Totals</i>
Beluga whale	1 (2)	0	1 (2)
Bowhead whale	9 (13)	108 (306)	117 (319)
Dall's porpoise	0	1 (4)	1 (4)
Fin whale	1 (1)	0	1 (1)
Gray whale	50 (118)	78 (138)	128 (256)
Harbor porpoise	1 (6)	0	1 (6)
Humpback whale	0	2 (6)	2 (6)
Killer whale	1 (2)	1 (3)	2 (5)
Minke whale	9 (11)	1 (1)	10 (12)
Unidentified mysticete whale	36 (53)	130 (240)	166 (293)
Unidentified whale	32 (51)	120 (224)	152 (275)
<i>Total Cetaceans</i>	140 (257)	441 (922)	581 (1179)



Chukchi Sea Seal Sightings (No. of Individuals)

Species	Jul - Aug	Sep - Nov	Totals
Bearded seal	58 (65)	91 (97)	149 (162)
Ringed seal	16 (17)	63 (68)	79 (85)
Spotted seal	31 (40)	37 (39)	68 (79)
Unidentified seal	199 (226)	388 (772)	587 (998)
Unidentified pinniped	24 (27)	31 (35)	55 (62)
Total Seals	328 (375)	610 (1011)	938 (1386)



Chukchi Sea Pacific Walrus Sightings (No. of Individuals)

On-ice or In-water	Jul - Aug	Sep - Nov	Totals
Walrus on-ice	30 (1125)	32 (3334)	62 (4459)
Walrus in-water	100 (291)	165 (2281)	265 (2572)
Mixed groups on-ice and in-water	3 (30)	8 (1617)	11 (1647)
Total Walruses	133 (1446)	205 (7232)	338 (8678)



Chukchi Sea Polar Bears (No. of Individuals)

On-ice or In-water	Jul - Aug	Sep - Nov	Totals
Polar bears on-ice	4 (5)	26 (36)	30 (41)
Polar bears in-water	0	16 (16)	16 (16)
Mixed groups on-ice and in-water	0	3 (4)	3 (4)
Total Polar Bears	4 (5)	45 (56)	49 (61)

Photo by professional photographer
on assignment



Photo by Shell PSO using Big Eyes
to maintain vessel distance



Chukchi Sea Vessel-based Mitigation Measures

Speed Reduction	Course Alteration	Other Mitigation	<i>Total</i>
182	73	26	<i>281</i>

- Majority of “Speed Reductions” were for walrus in the water
- “Other Mitigation” involved delay of equipment deployments, tow-transfers, and relocation of crew changes due to presence of marine mammals in the operational area



Chukchi Sea Drilling and Ice-management Sound Radii

Measured radii (in meters) of sound levels ranging between 120 and 190 dB (rms) for Drilling and Ice Management

Received Level dB (rms)	Drilling of Pilot Hole	Drilling of Mud-Line Cellar	Ice Management
≥190	<10	<10	<10
≥180	<10	20	<10
≥170	<10	40	20
≥160	<10	130	60
≥150	30	350	200
≥140	100	1000	730
≥130	390	2800	2600
≥120	1500	8100	9600

Chukchi Sea Vessel-based Sightings During Drilling

Species or Species Group	Number of Individuals Observed during Drilling Periods	Number of Individuals in Areas with RSLs of ≥ 120 dB (rms)
Cetaceans	107	2
Seals	396	10
Pacific Walruses*	574	480*
Polar Bears	0	0

*474 of the 480 walruses observed in areas with RSLs in the water ≥ 120 dB (rms) were hauled out on ice and would not have been exposed to the same RSLs as those in the water

Chukchi Sea Sightings During Ice Management

Species or Species Group	Number of Individuals Observed during Ice Management	Number of Individuals in Areas with RSLs of ≥ 120 dB (rms)
Cetaceans	27	3
Seals*	34	10*
Pacific Walruses*	985	329*
Polar Bears*	30	24*

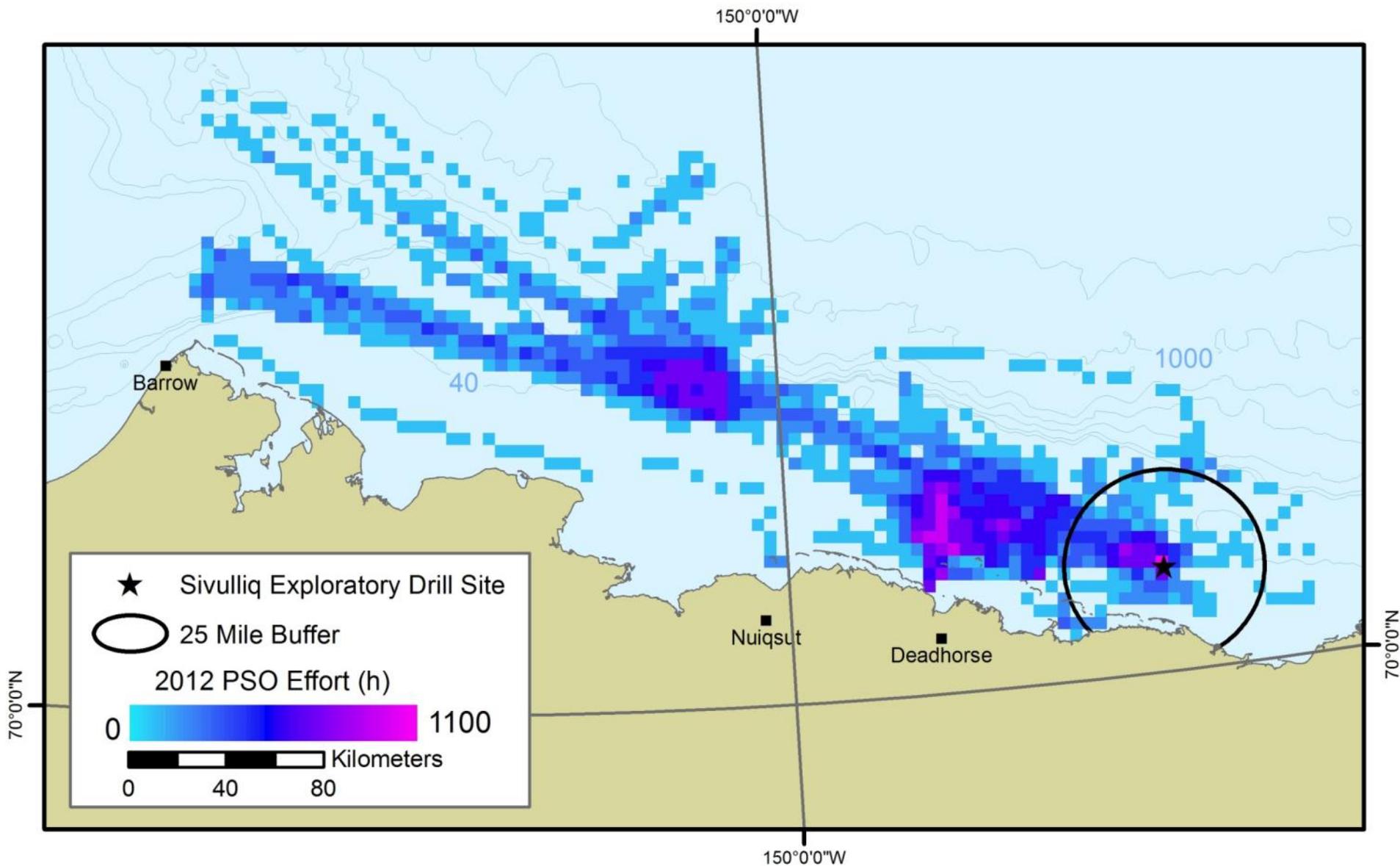
*3 of the 10 seals, 250 of the 329 walruses, and 19 of the 24 polar bears observed in areas with RSLs in the water ≥ 120 dB (rms) were hauled out on ice and would not have been exposed to the same RSLs as those in the water

Chukchi Sea Density-based Exposure Estimates

- Basal Area ensonified to ≥ 120 dB (rms) by Drilling and Ice Management Sounds
- X (times)
- Estimated Density of Marine Mammals
- = Estimated number of marine mammals exposed assuming no avoidance behavior

Species	Estimated No. Individuals Exposed to ≥ 120 dB (rms) from Drilling and Ice Management Sounds		
	Jul-Aug	Sep-Oct	<i>Estimated Totals</i>
Cetaceans			
Beluga	2	2	4
Narwhal	0	0	0
Killer whale	0	0	0
Harbor porpoise	0	1	1
Bowhead whale	1	23	24
Fin whale	0	0	0
Gray whale	11	7	18
Humpback whale	0	0	0
Minke whale	0	0	0
Total Cetaceans	14	33	47
Seals			
Bearded seal	6	10	16
Ribbon seal	0	1	1
Ringed seal	216	224	440
Spotted seal	4	5	9
Total Seals	226	240	466
Pacific Walrus	272	131	403
Polar Bear	3	1	4

Beaufort Sea PSO Watch Effort



Beaufort Sea Cetacean Sightings (No. of Individuals)

Species	Jul - Aug	Sep - Nov	<i>Totals</i>
Beluga whale	0	1 (13)	1 (13)
Bowhead whale	8 (9)	47 (98)	55 (107)
Gray whale	3 (4)	2 (2)	5 (6)
Minke whale	1 (1)	0	1 (1)
Unidentified mysticete whale	4 (10)	54 (97)	58 (107)
Unidentified whale	1 (1)	39 (60)	40 (61)
<i>Total Cetaceans</i>	17 (25)	142 (257)	160 (295)



Beaufort Sea Seal Sightings (No. of Individuals)

Species	Jul - Aug	Sep - Nov	<i>Totals</i>
Bearded seal	9 (9)	69 (70)	78 (79)
Ringed seal	0	151 (272)	151 (272)
Spotted seal	2 (2)	57 (61)	59 (63)
Unidentified seal	19 (20)	276 (429)	295 (449)
Unidentified pinniped	7 (8)	5 (9)	12 (17)
Total Seals	37 (39)	558 (841)	595 (880)



Beaufort Sea Pacific Walrus Sightings (No. of Individuals)

On-ice or In-water	Jul - Aug	Sep - Nov	Totals
Walrus on-ice	2 (8)	0	2 (8)
Walrus in-water	8 (12)	4 (4)	12 (16)
<i>Total Walruses</i>	10 (20)	4 (4)	14 (24)



Beaufort Sea Polar Bears (No. of Individuals)

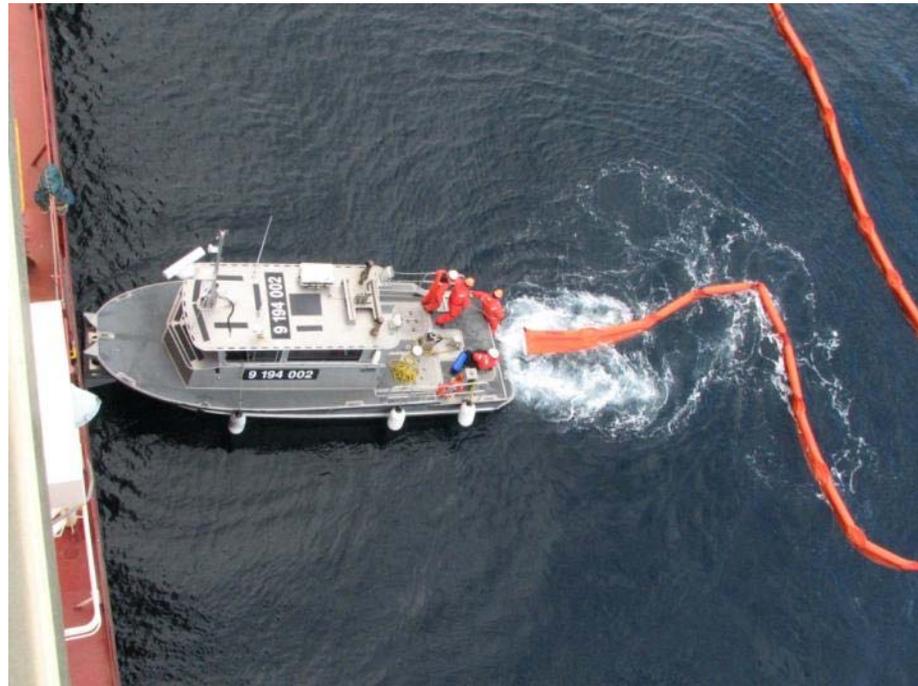
On-ice or In-water	Jul - Aug	Sep - Nov	Totals
Polar bears on-ice	9 (22)	13 (59)	22 (81)
Polar bears in-water	2 (2)	5 (21)	7 (23)
Total Polar Bears	11 (24)	18 (80)	29 (104)



Beaufort Sea Vessel-based Mitigation Measures

Speed Reduction	Course Alteration	Other Mitigation	<i>Total</i>
16	11	7	34

- Majority of mitigation measures were for bowhead whales and polar bears
- “Other Mitigation” involved delay of equipment deployments, tow-transfers, and other active vessel operations.



Beaufort Sea Drilling and Ice-management Sound Radii

Measured radii (in meters) of sound levels ranging between 120 and 190 dB (rms) for Drilling Activities

Received Level dB (rms)	Drilling of Pilot Hole	Drilling of Mud-Line Cellar	Ice Management ^a
≥190	<10	<10	-
≥180	<10	20	-
≥170	<10	60	-
≥160	<10	140	-
≥150	<10	360	-
≥140	30	930	-
≥130	150	2390	-
≥120	660	6200	-

^a Shell did not need to manage potentially hazardous ice floes in the Beaufort Sea during 2012.

Beaufort Sea Vessel-based Sightings During Drilling

Species or Species Group	Number of Individuals Observed during Drilling Periods	Number of Individuals in Areas with RLs of ≥ 120 dB (rms)
Cetaceans	4	3
Seals	123	81
Pacific Walruses	0	0
Polar Bears	15	0

Beaufort Sea Density-based Exposure Estimates

- Basal Area ensonified to ≥ 120 dB (rms) by Drilling Sounds
- X (times)
- Estimated Density of Marine Mammals
- = Estimated number of marine mammals exposed assuming no avoidance behavior

Species	Estimated No. Individuals Exposed to ≥ 120 dB (rms) from Drilling and Ice Management Sounds		
	Jul-Aug*	Sep-Oct	<i>Estimated Totals</i>
Cetaceans			
Beluga	0	1	<i>1</i>
Narwhal	0	0	<i>0</i>
Harbor porpoise	0	0	<i>0</i>
Gray whale	0	0	<i>0</i>
Bowhead Whale	0	9	<i>9</i>
<i>Total Cetaceans</i>	<i>0</i>	<i>10</i>	<i>10</i>
Seals			
Bearded seal	0	2	<i>2</i>
Ribbon seal	0	0	<i>0</i>
Ringed seal	0	40	<i>40</i>
Spotted seal	0	1	<i>1</i>
<i>Total Seals</i>	<i>0</i>	<i>43</i>	<i>43</i>
<i>Pacific walrus</i>	<i>0</i>	<i>0</i>	<i>0</i>
<i>Polar Bear</i>	<i>0</i>	<i>0</i>	<i>0</i>

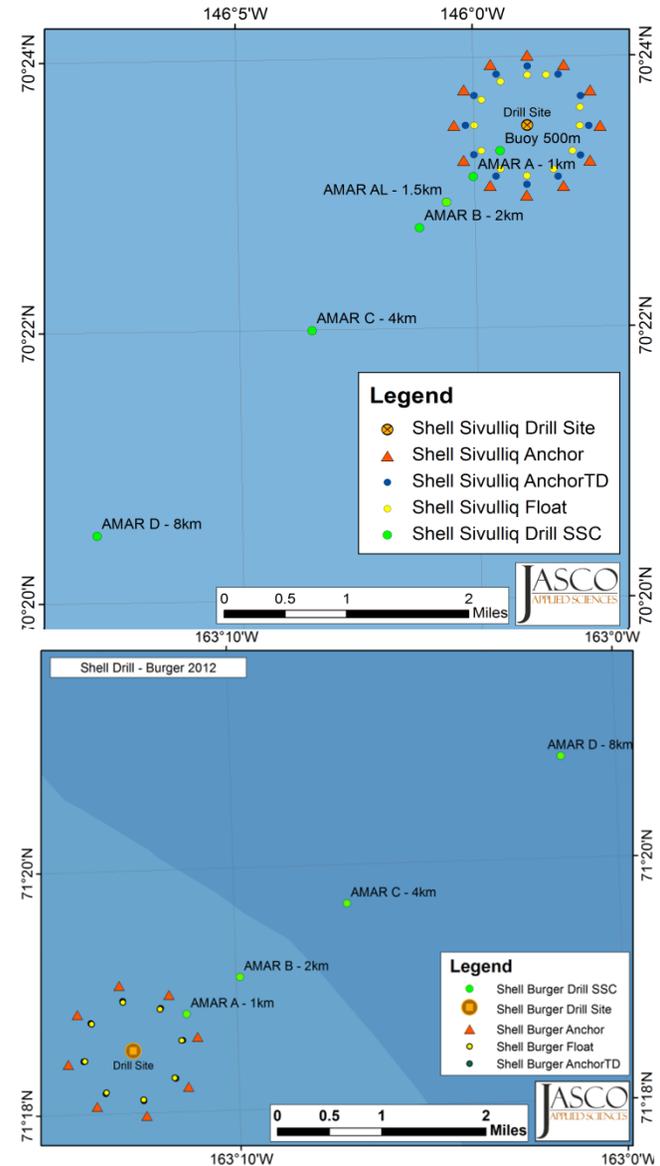
*All drilling occurred in Oct, thus no marine mammals were exposed to this activity in Jul-Aug



Drilling Program Sound Characterization

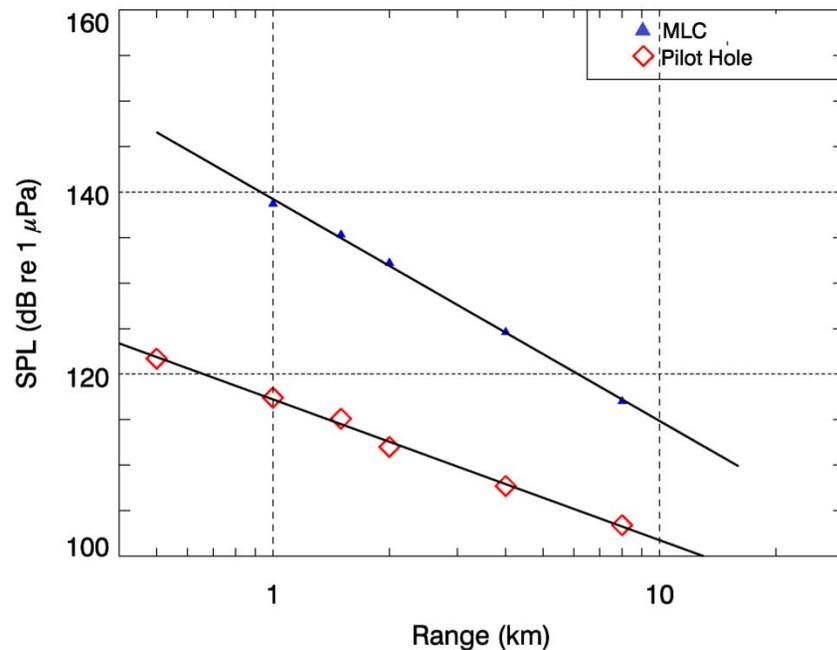
Drilling Sound Measurements

- Seabed AMAR recorders at 1, 2, 4 and 8 km at both drill-sites
- Real-time measurement at 500 m distance at Sivulliq only
- Extra recorder at 1.5 km at Sivulliq (used for better anchor-handling measurement)



Drilling Activity Noise Measurements

- Vessel noise often contributed to the sound levels measured at all SSC stations during drilling activities
- For several activities we identified a few hours where vessels were distant and didn't contribute:
 - Anchor Laying
 - Ice management
 - Mud-line cellar drilling
 - Pilot Hole drilling
 - Main hole drilling (multiple diameters)



Drilling Activity Distances to Thresholds - Sivulliq

Drill Site Activity	rms SPL Threshold Radii (m)			
	190 dB re 1 μ Pa	180 dB re 1 μ Pa	160 dB re 1 μ Pa	120 dB re 1 μ Pa
Anchor laying	< 10	< 12	63–120	12,000–29,000
Drilling of pilot hole	< 10	< 10	< 10	660
Drilling of MLC	< 10	20	140	6200

Comparison with Pre-Season Modeling

Received SPL (dB re 1 μ Pa)	Burger-A		Sivulliq-N*	
	2011 Model— Estimate (m)	2012 Measurement— Drilling 26 in hole (m)	2011 Model— Estimate (m)	2012 Measurement— Drilling 26 in hole (m)
140	71	100	112	30
130	260	390	427	150
120	1310	1500	2200	660

* *Noble Discoverer* used as noise source in model, *Kulluk* was measured noise source.

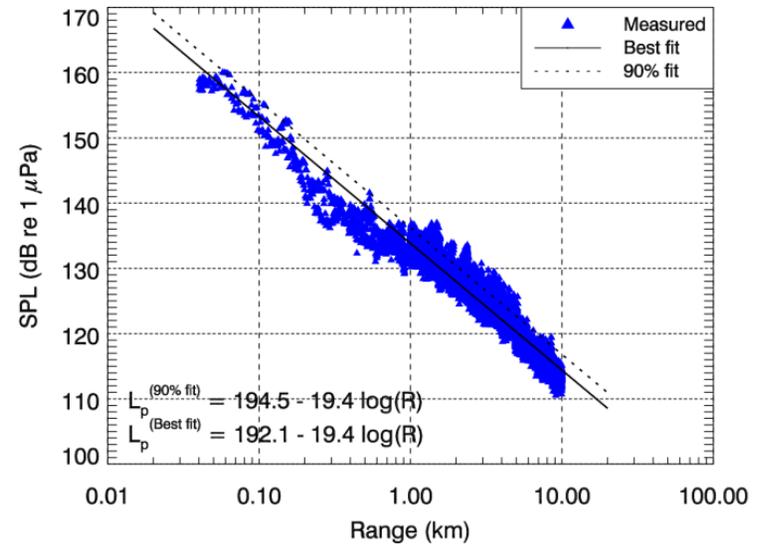
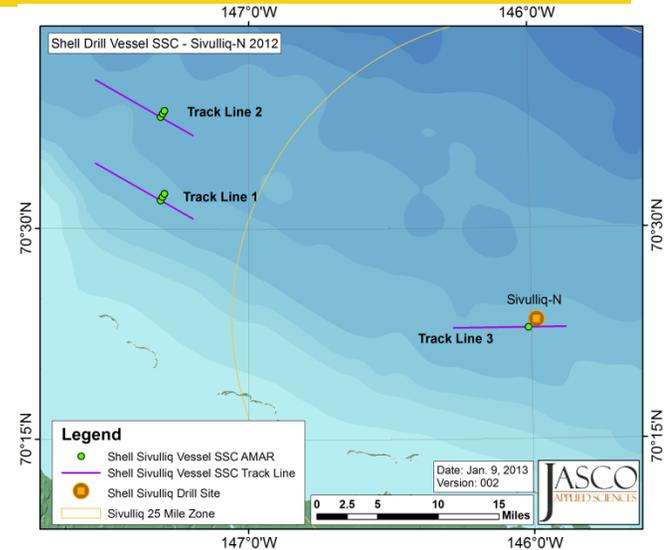
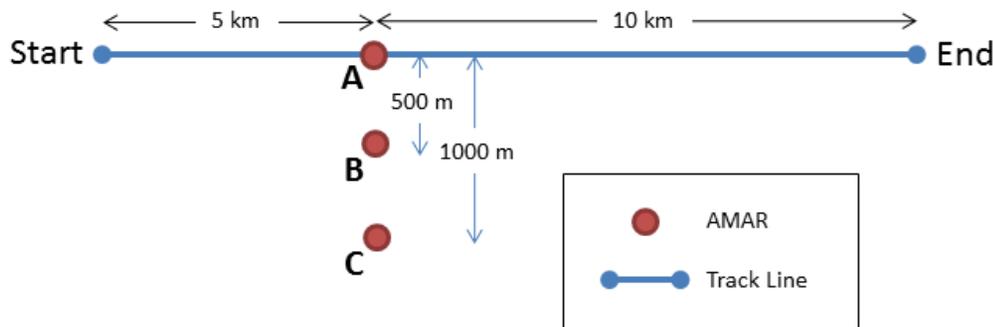
Drilling Activity Distances to Thresholds - Burger

SPL (dB re 1 μ Pa)	26 in hole	MLC	Ice Management
	Range (m)	Range (m)	Range (m)
190	< 10	< 10	< 10
180	< 10	20	< 10
170	< 10	40	20
160	< 10	130	60
150	30	350	200
140	100	1000	730
130	390	2800	2600
120	1500	8100	9600*

* Extrapolated beyond 8000 m maximum measurement distance

Vessel Sound Measurements

- Vessel sound measurements are made using 3 recorders
- 15 km sail track with 5 km approach and 10 km departure
- Designed to capture absolute levels and differences in emission levels in different directions



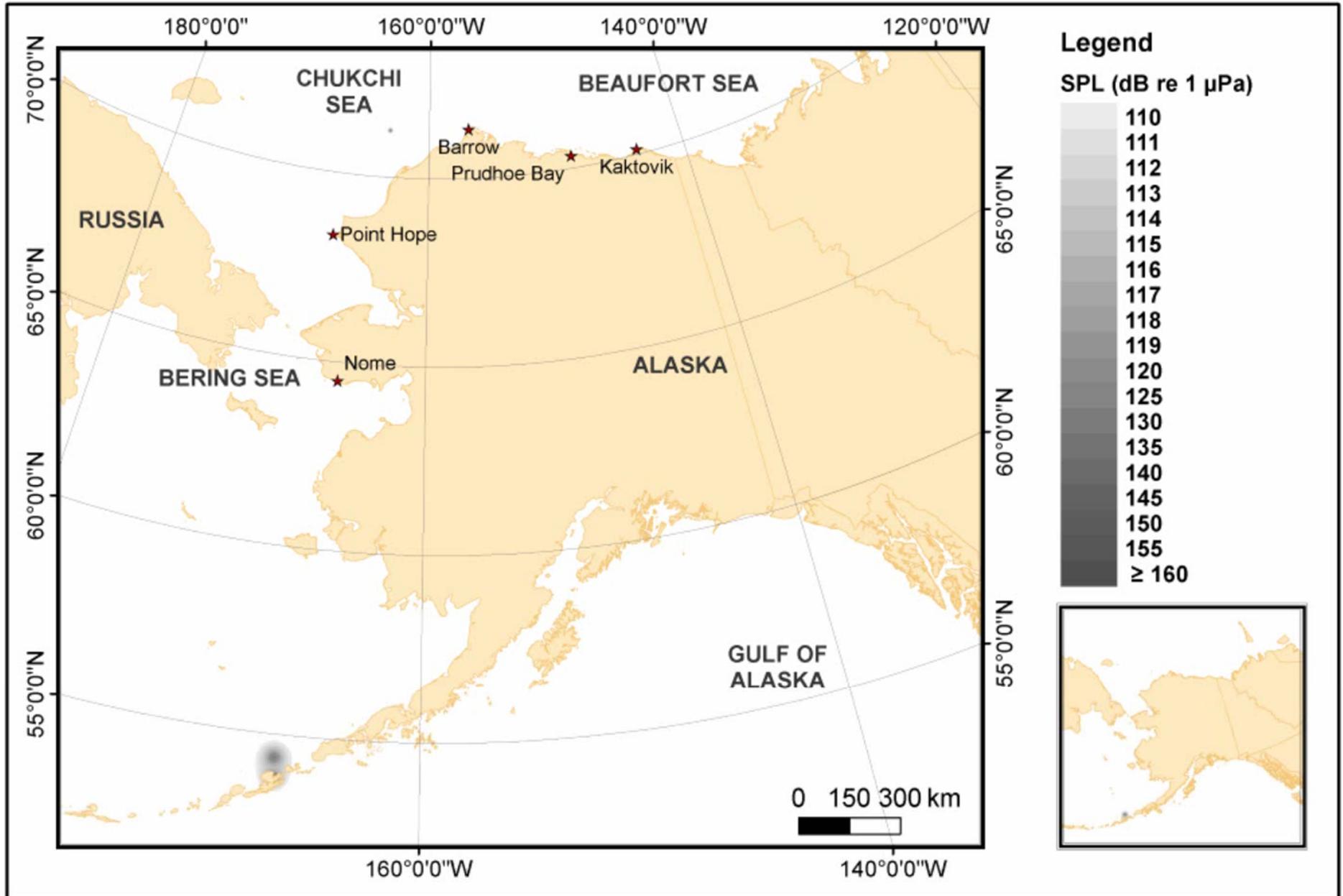
Vessel Sound Characterization Results - Chukchi

Vessel Name	rms SPL Threshold Radii (m)		
	180 dB re 1 μ Pa	160 dB re 1 μ Pa	120 dB re 1 μ Pa
<i>Affinity</i> –8.8 kts	0	< 10	1300
<i>Affinity</i> –9.0 kts	0	< 10	1400
<i>Aiviq</i> (towing the Kulluk)	< 10	110	19,000
<i>Fennica</i> –8.0 kts	< 10	11	2000
<i>Fennica</i> –12.0 kts	< 10	26	5000
<i>Guardsman</i> (towing the <i>Klamath</i>)	< 10	70	4700
<i>Harvey Explorer</i>	< 10	16	2000
<i>Harvey Spirit</i>	0	< 10	2600
<i>Nanuq</i> –9.1 kts	< 10	42	5200
<i>Nanuq</i> –10.8 kts	< 10	60	6900
<i>Noble Discoverer</i> (towed by <i>Tor Viking II</i>)	0	< 10	740
<i>Nordica</i>	< 10	40	4600
<i>Tor Viking II</i> (towing the <i>Noble Discoverer</i>)	< 10	25	4800

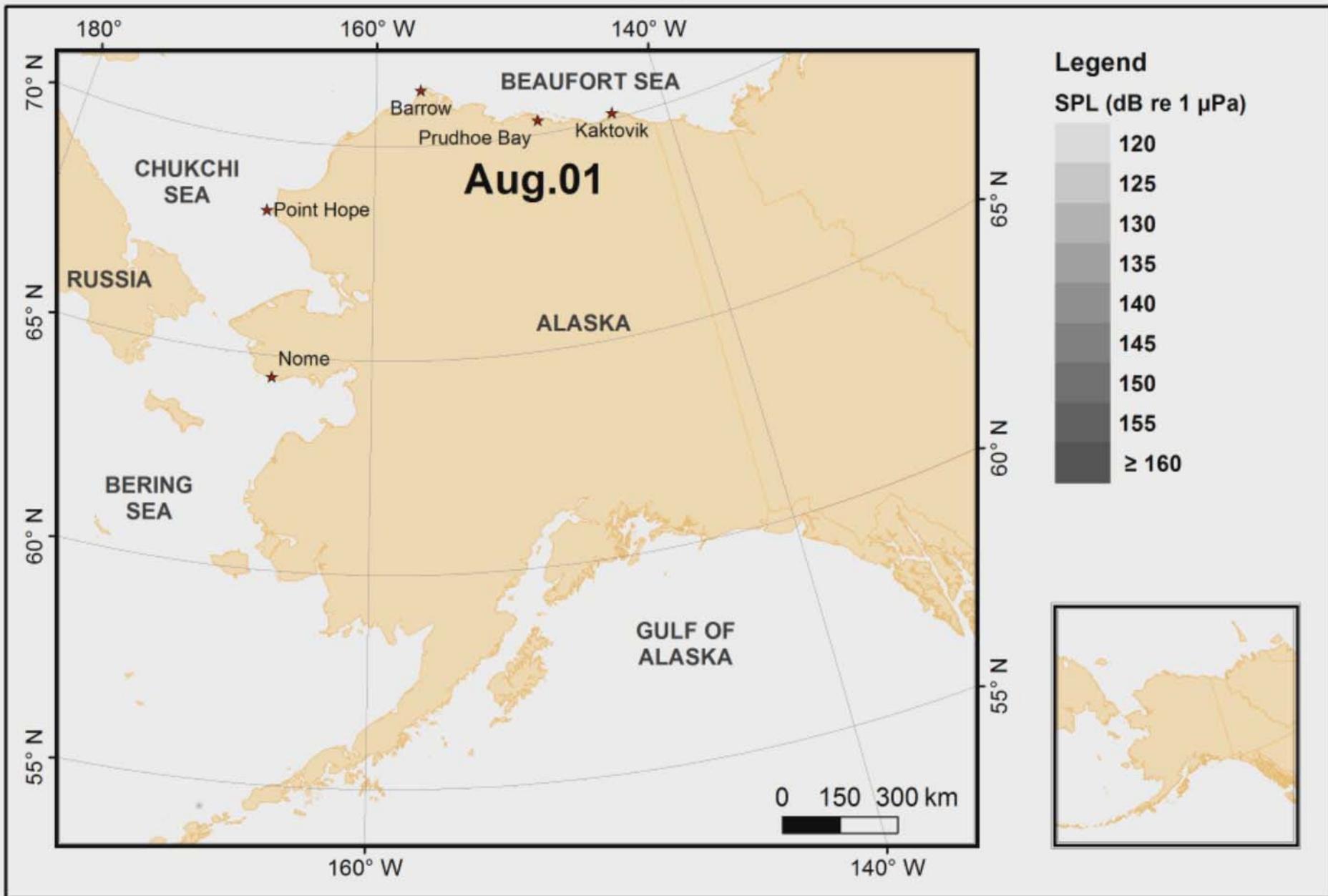
Vessel Sound Characterization Results - Beaufort

Vessel Name	rms SPL Threshold Radii (m)			
	190 dB re 1 μPa	180 dB re 1 μPa	160 dB re 1 μPa	120 dB re 1 μPa
<i>Affinity</i>	0	< 10	< 10	3000
<i>Aiviq</i>	0	< 10	67	11,000
<i>Arctic Seal</i>	0	0	< 10	510
<i>Lauren Foss (towing the Tuuq)</i>	0	< 10	< 10	1500
<i>Nordica</i>	< 10	< 10	24	4200
<i>Pt Oliktok</i>	0	< 10	< 10	830
<i>Sisuaq</i>	< 10	< 10	25	3000
<i>Tor Viking II</i>	0	< 10	30	12,000
<i>Warrior</i>	< 10	< 10	42	4400

01/08/2012 00:00



2012

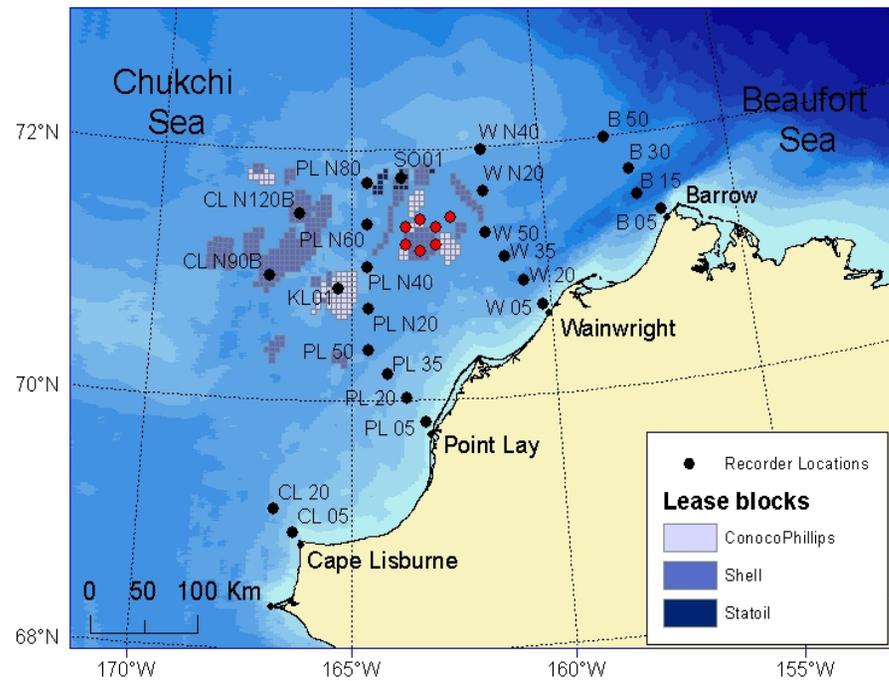




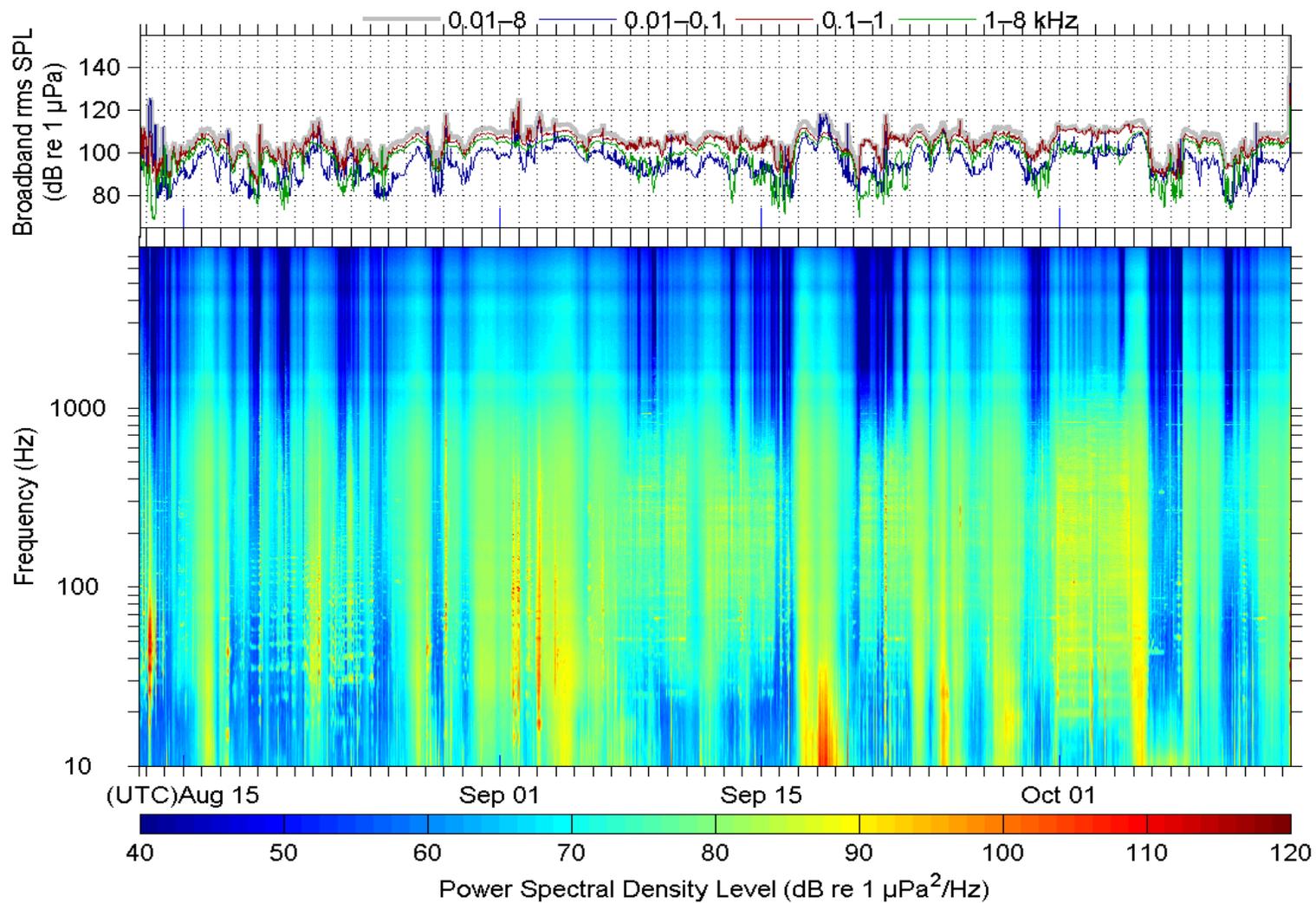
Chukchi Sea Environmental Studies Program Acoustics Survey

Chukchi Regional Acoustic Monitoring

- Part of the Chukchi Sea Environmental Studies Program (CSESP)
- 30 Recorders deployed from 8-14 August to 5-13 October
- This was the 6th year of the acoustics project within CSESP
- Purposes are to measure anthropogenic noise and to detect marine mammals

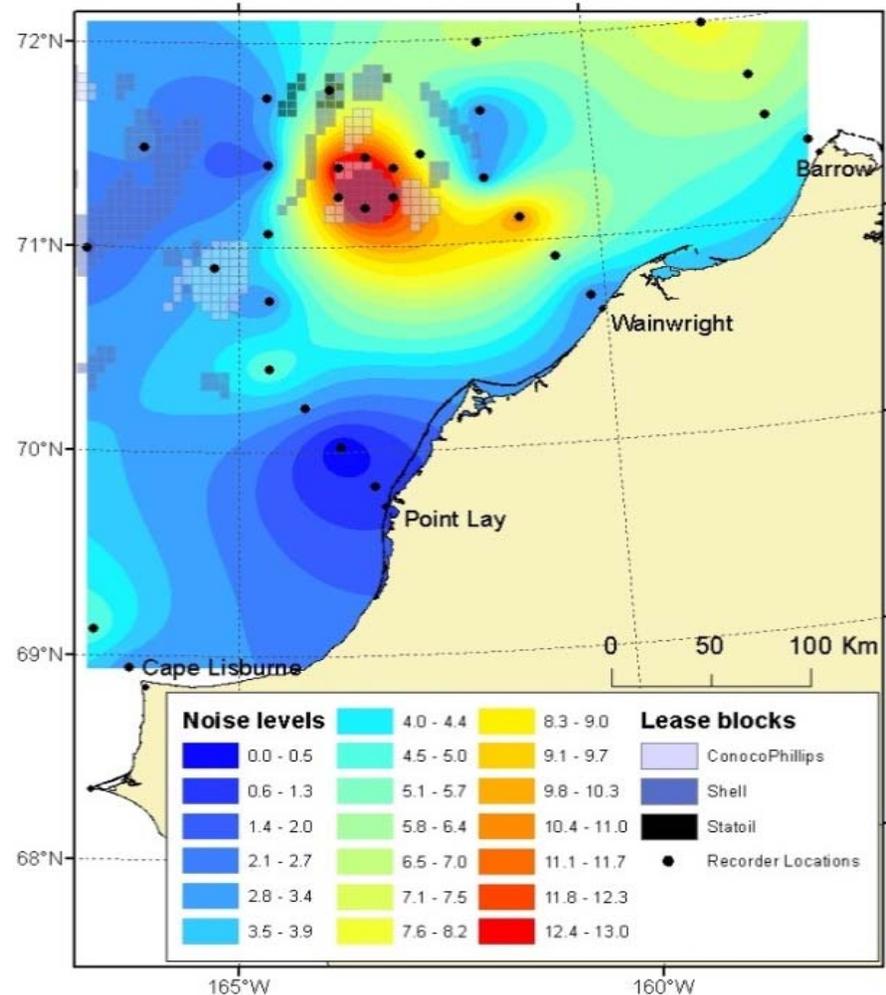


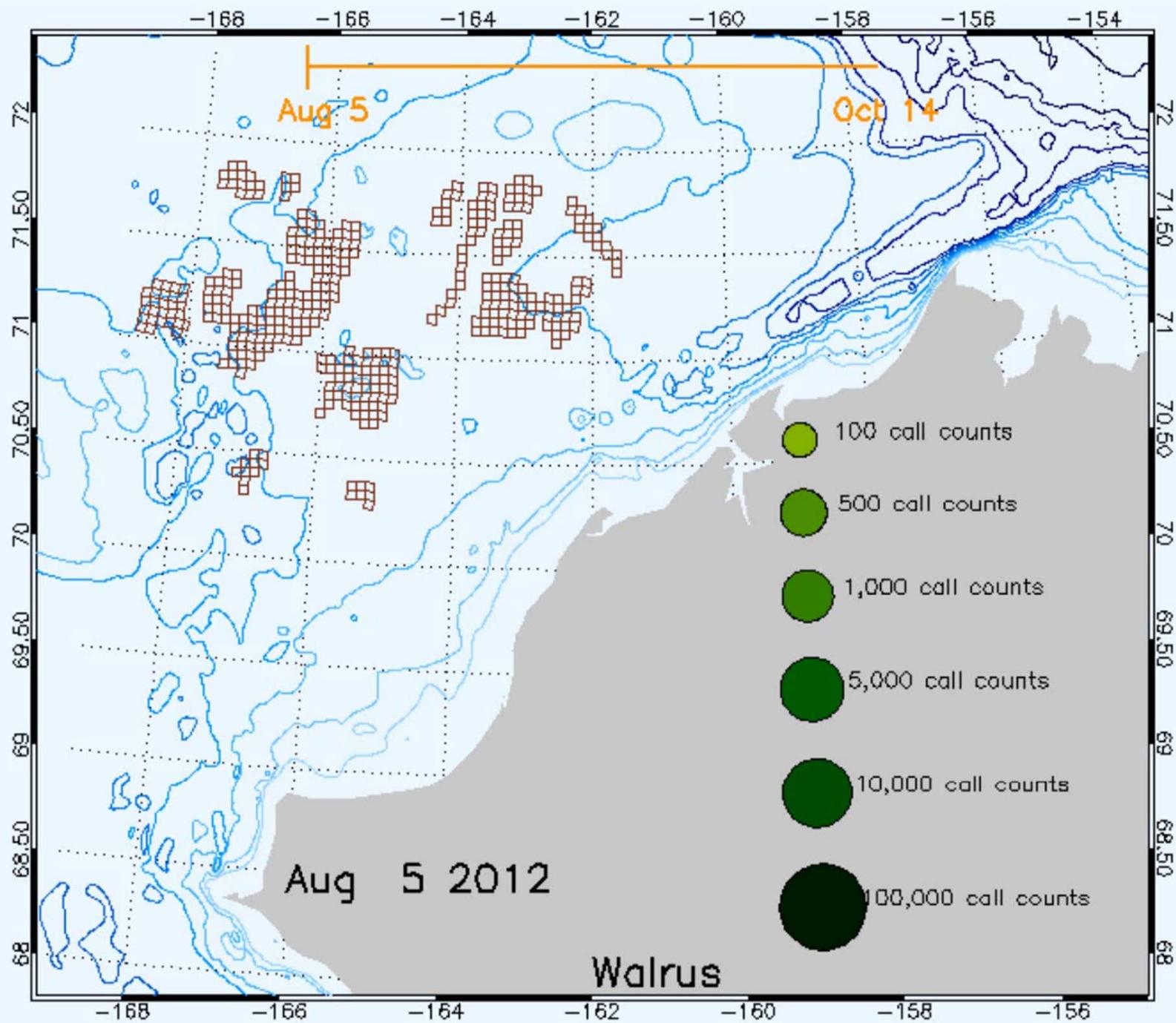
Sound Levels at PLN40, between Burger and Devils Paw

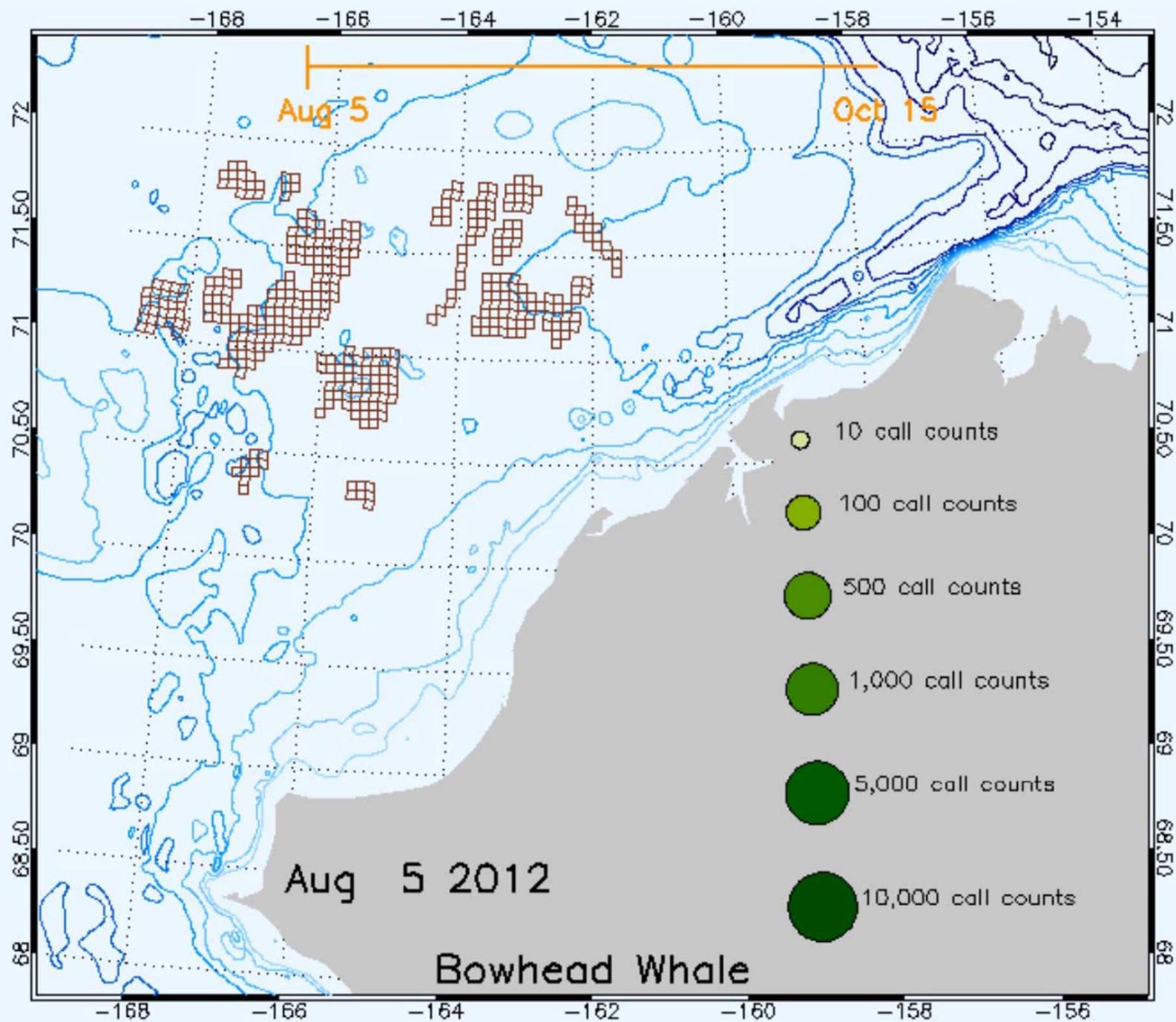


Vessel and Drilling Contribution to Ambient Noise

- Applied a vessel sound detector to identify time periods when vessels were present
- Calculated median sound levels at each recorder when vessels were present and when they were absent
- The plot at right shows the sound level difference between the vessels-present and not present time periods
- Median levels were approximately 13 dB above ambient at 16 km from Burger drillsite during drilling related activities









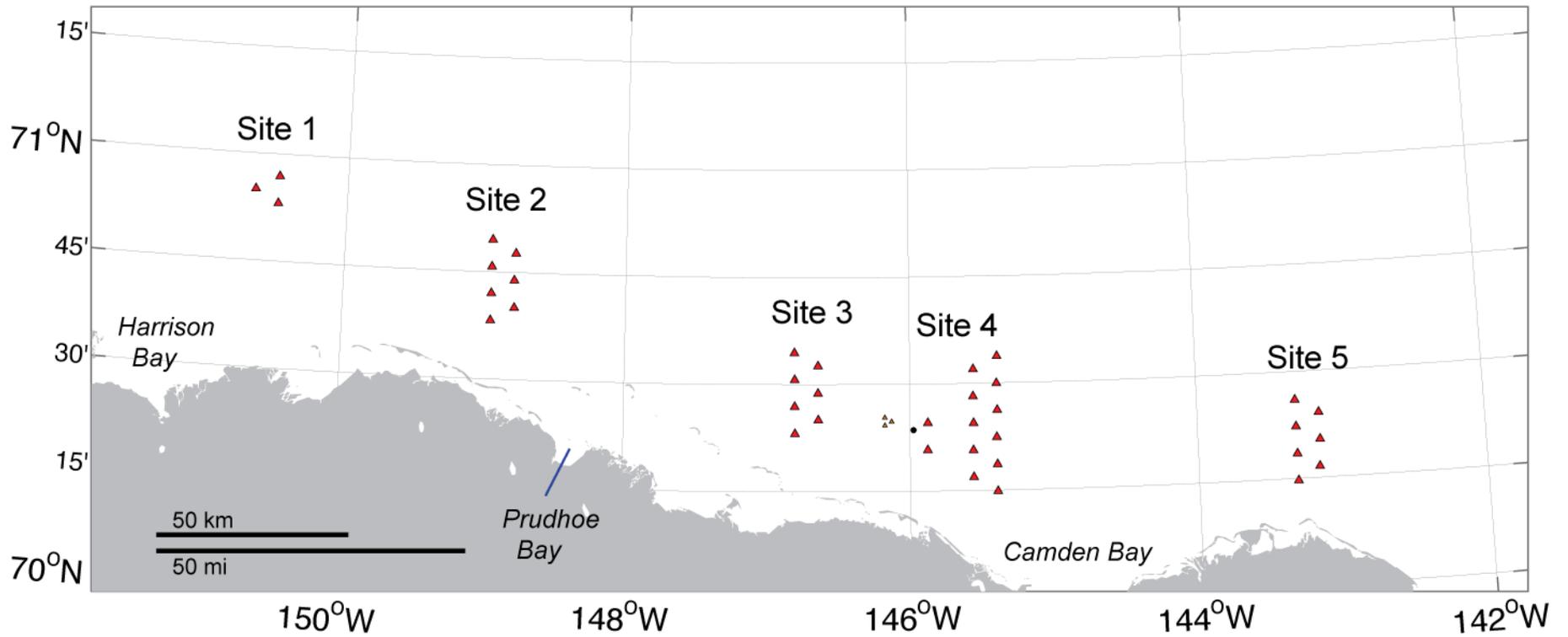
ACOUSTIC MONITORING IN THE BEAUFORT SEA

S. Blackwell, K. Kim, A. Conrad, D. Grebner,
R. Norman, A. Thode, C. Greene

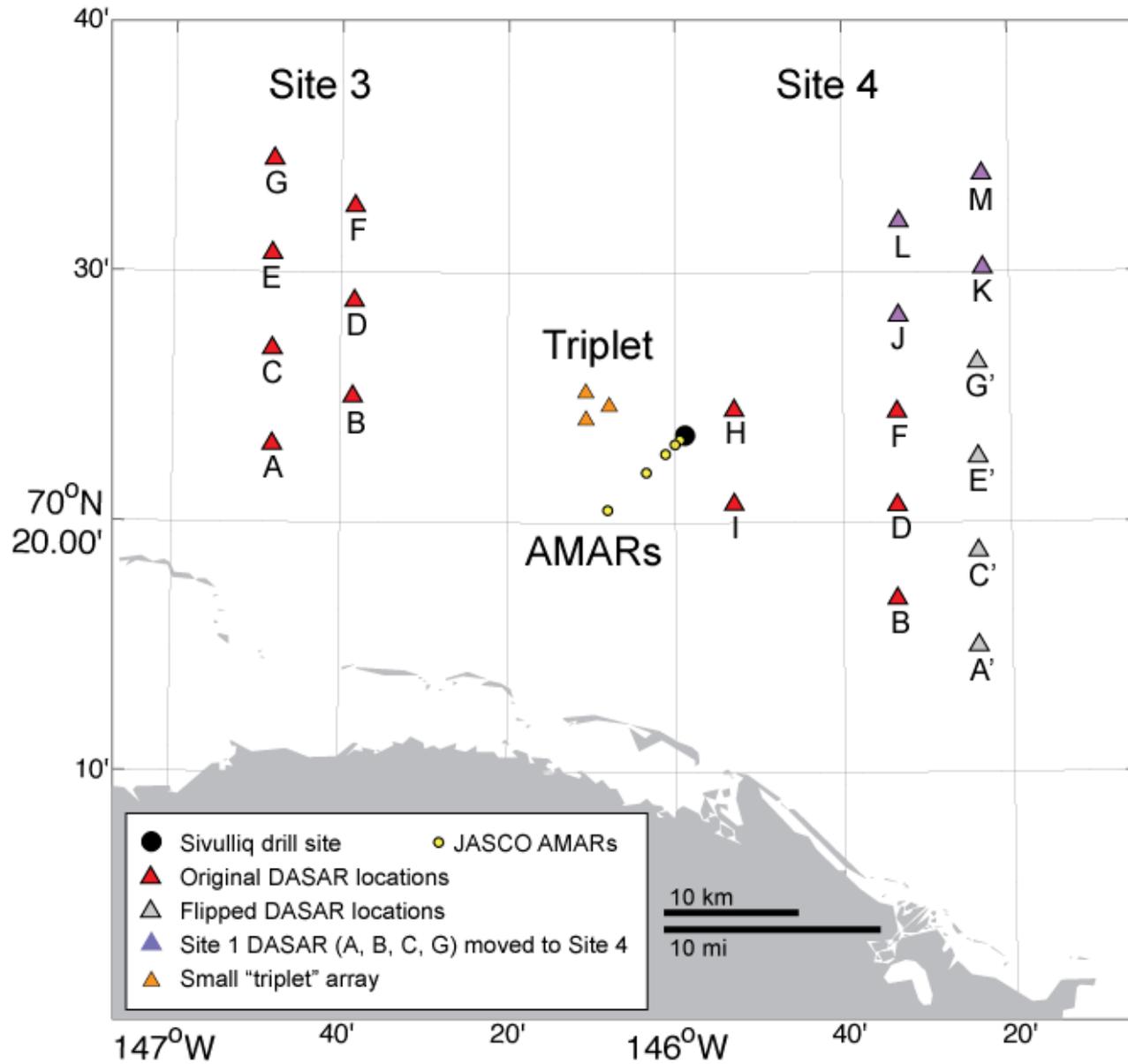
Open water meeting, 5-7 March 2013



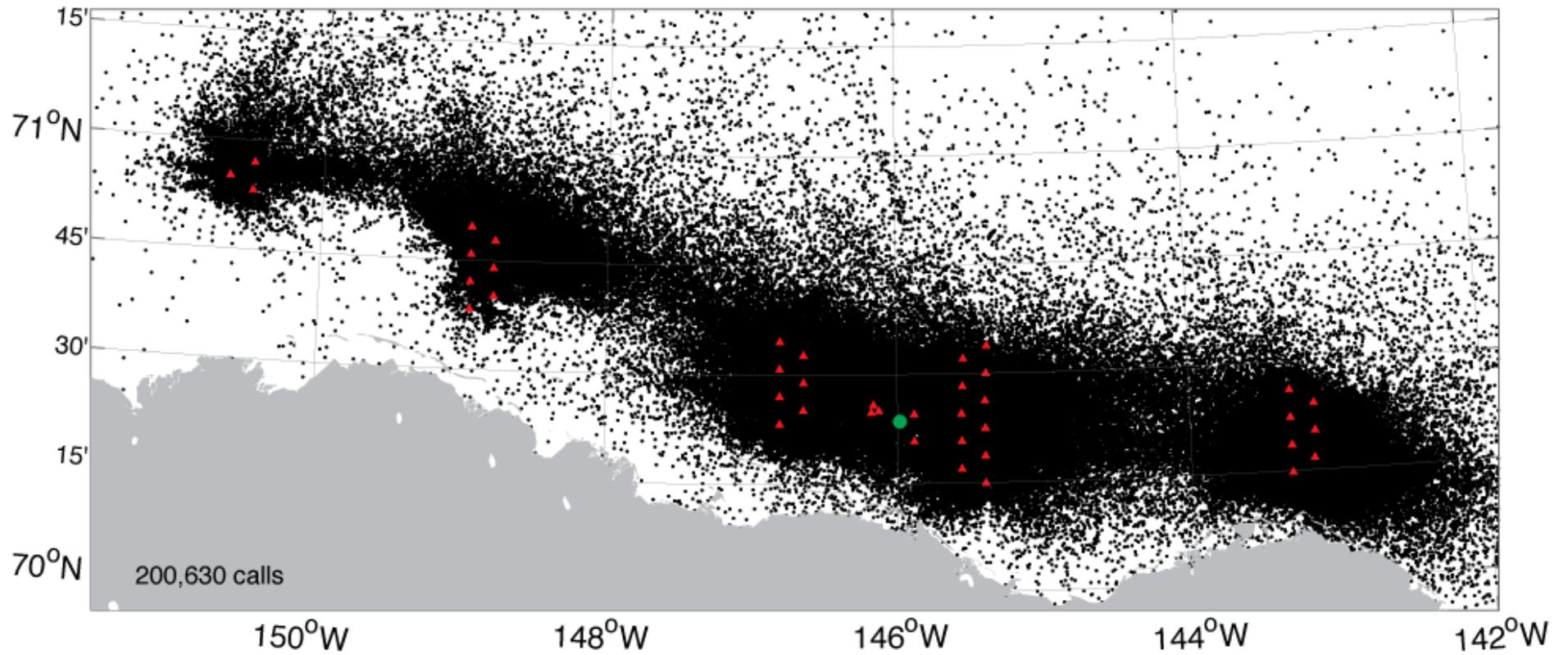
■ DASAR deployment locations in 2012 (40 recorders)



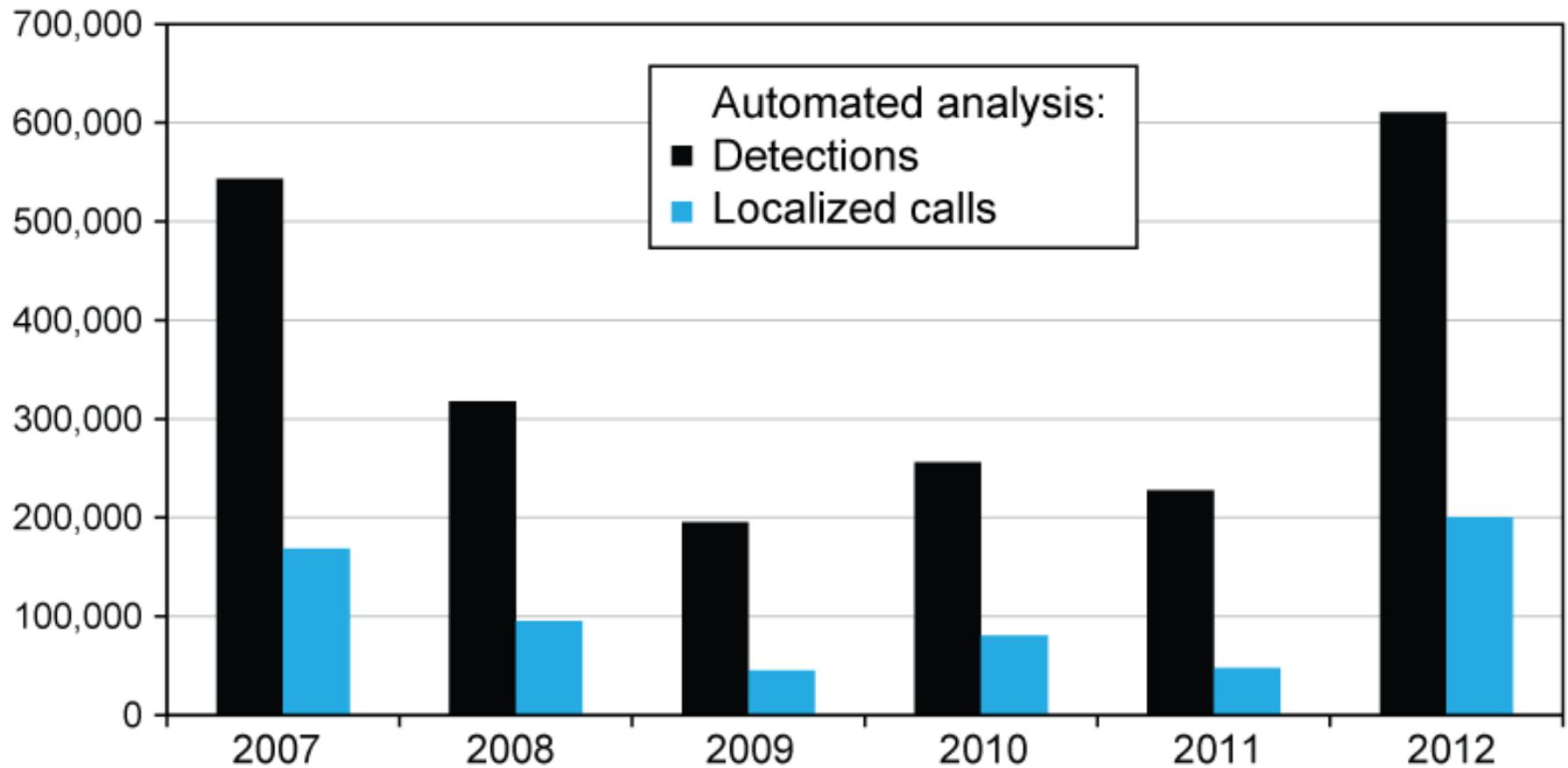
■ Zoom in on sites 3 and 4



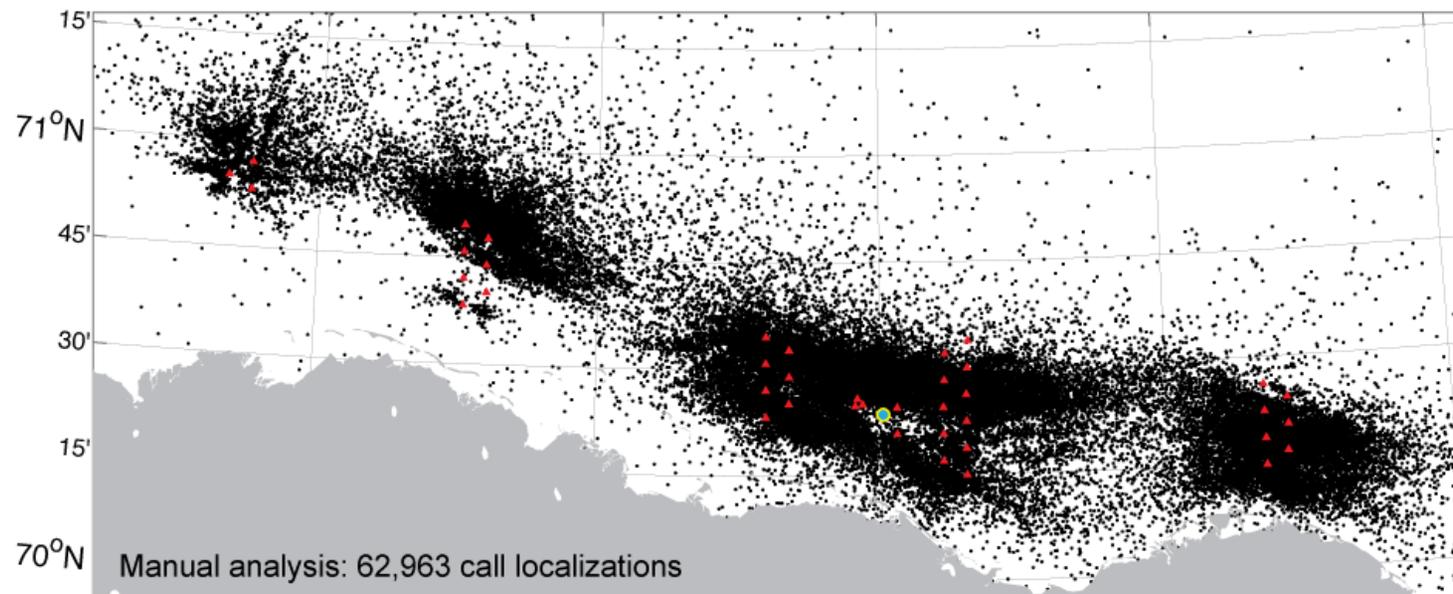
- Whale call localizations (automated analysis) for the entire 2012 season



- Detected and localized calls in 2007-2012 (includes only data from the 5 “standard” array locations)

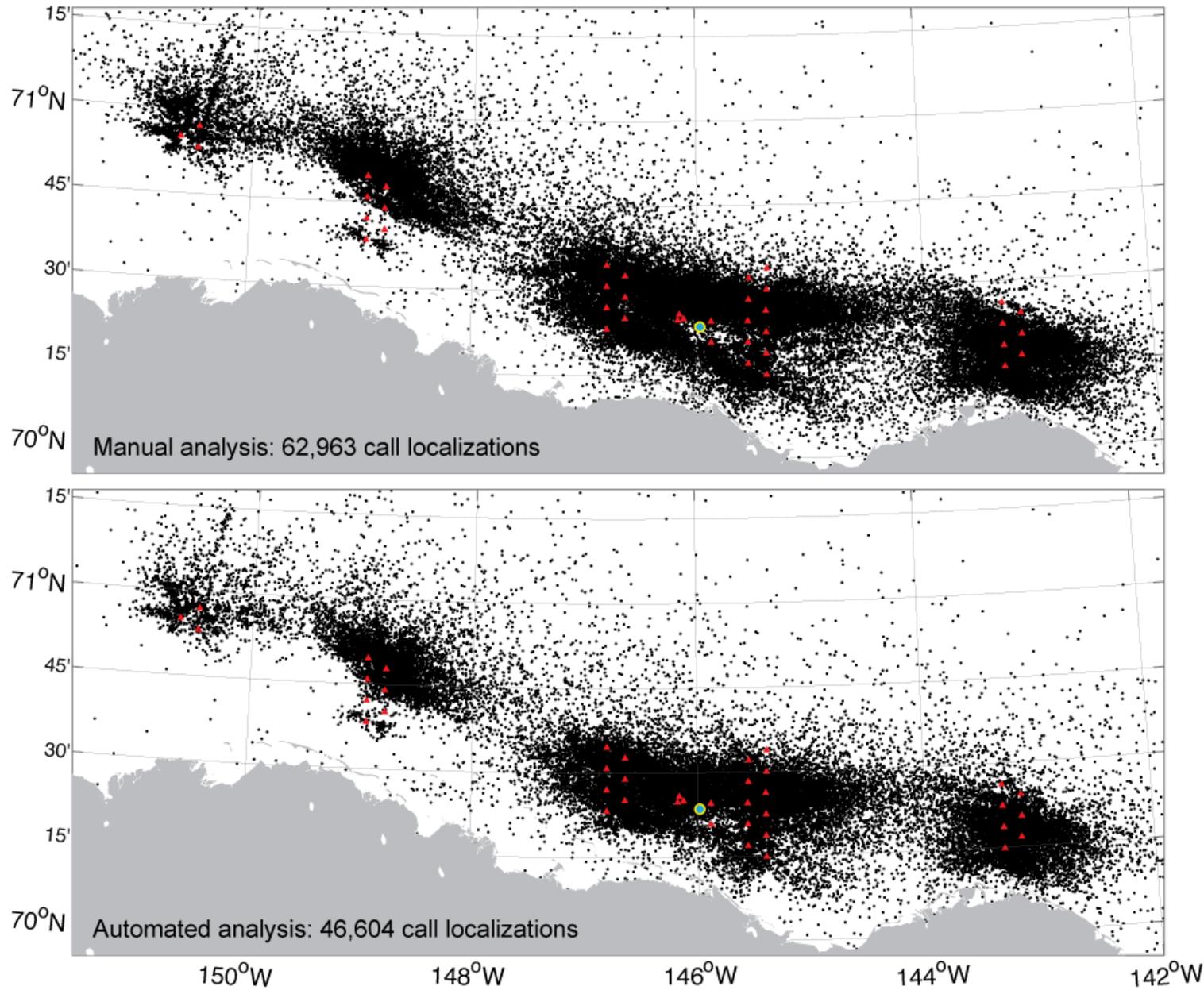


■ Manual and automated analyses of 9 days



- 25 Aug.
- 1 Sep.
- 7 Sep.
- 13 Sep.
- 18 Sep.
- 23 Sep.
- 26 Sep.
- 29 Sep.
- 5 Oct.

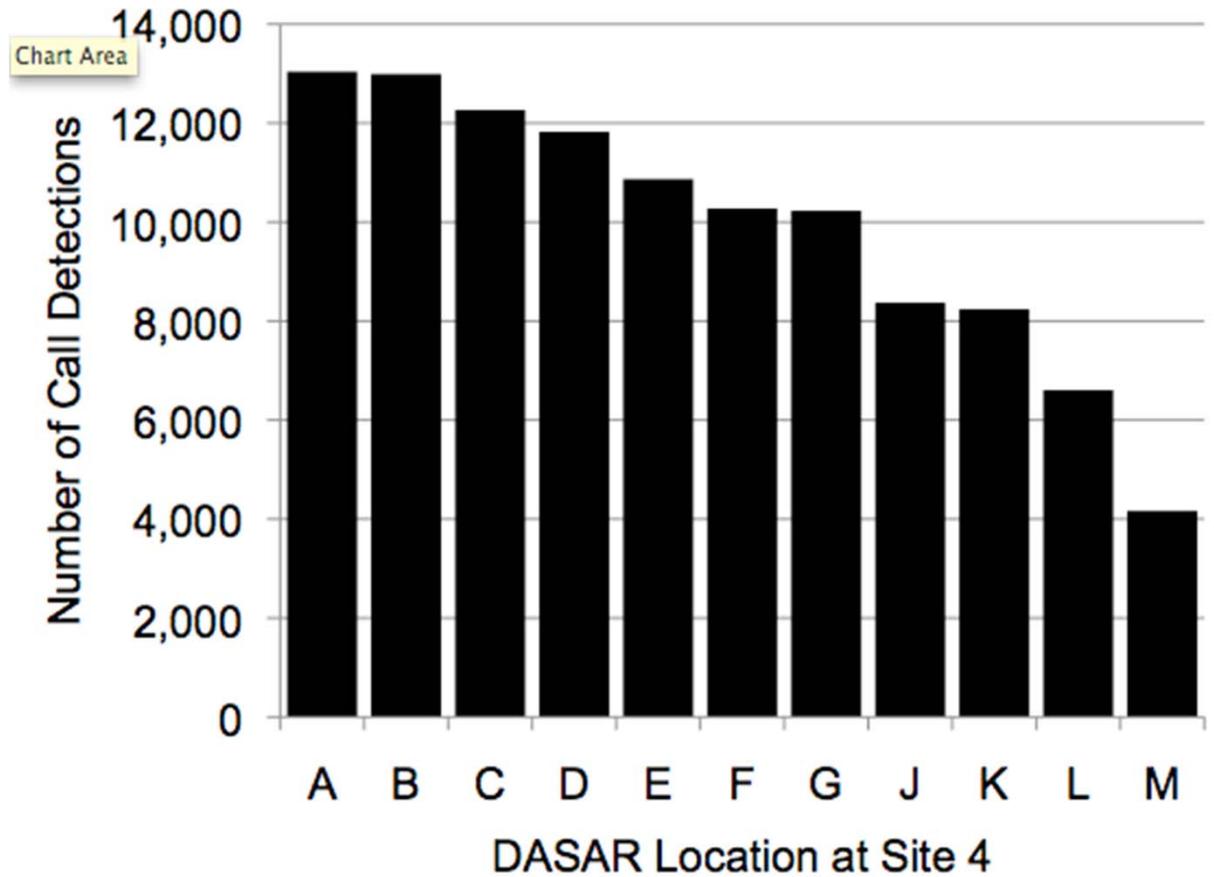
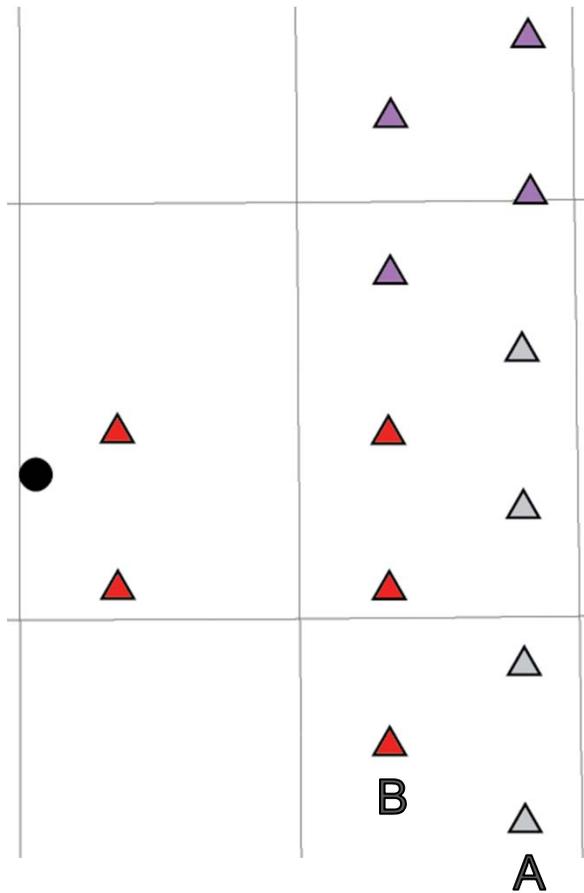
■ Manual and automated analyses of 9 days



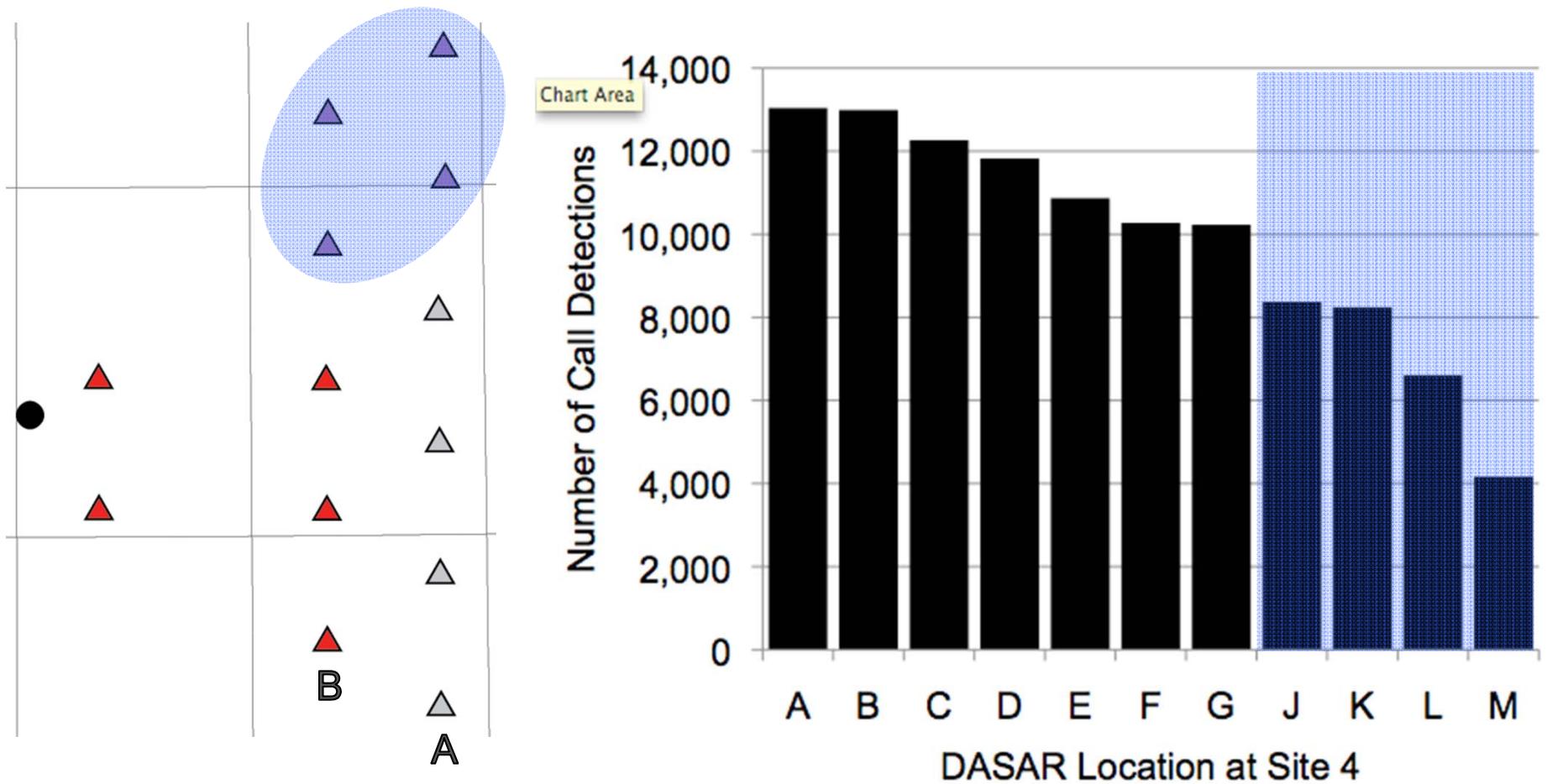
- 25 Aug.
- 1 Sep.
- 7 Sep.
- 13 Sep.
- 18 Sep.
- 23 Sep.
- 26 Sep.
- 29 Sep.
- 5 Oct.

26% fewer call localizations

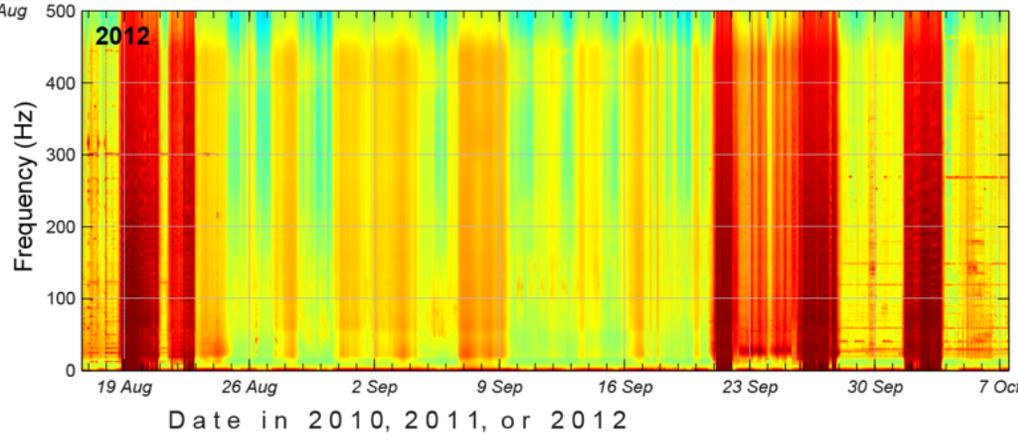
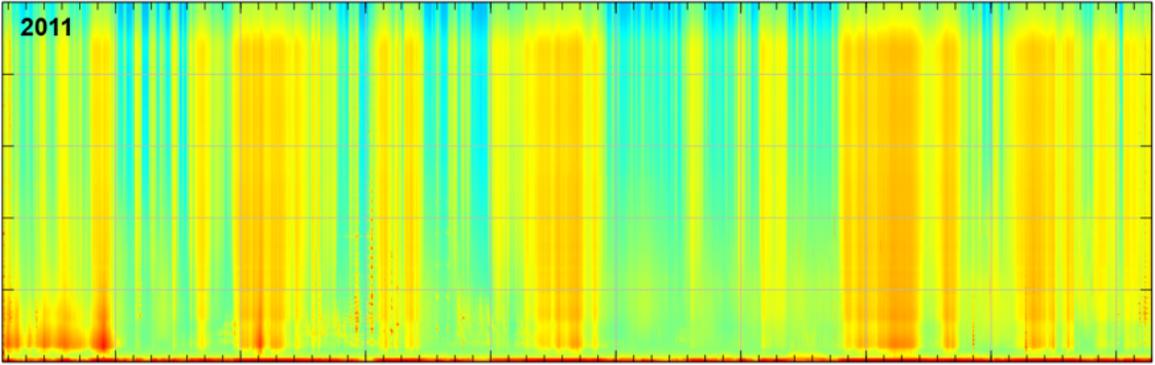
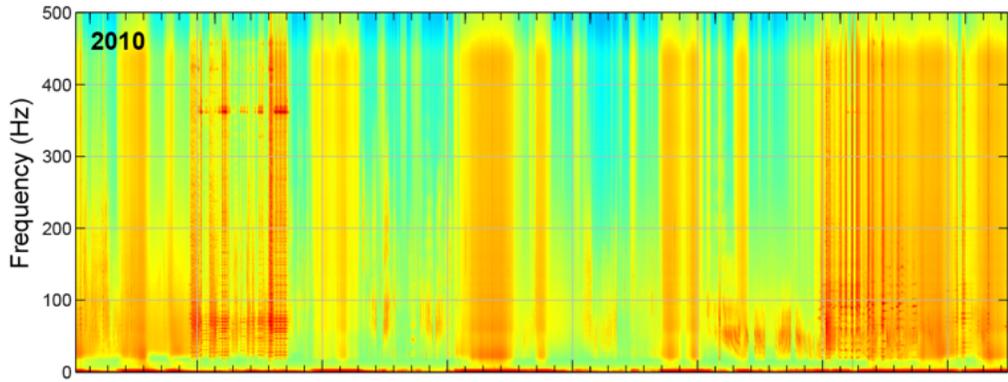
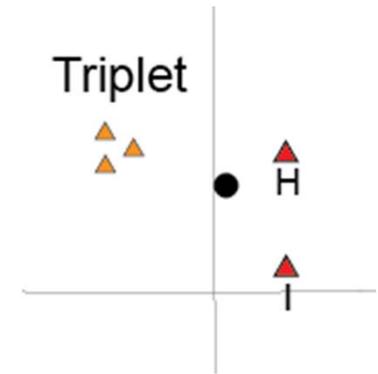
■ Call detection rates at the northern end of site 4



■ Call detection rates at the northern end of site 4



■ Three years of sound levels at location 4H

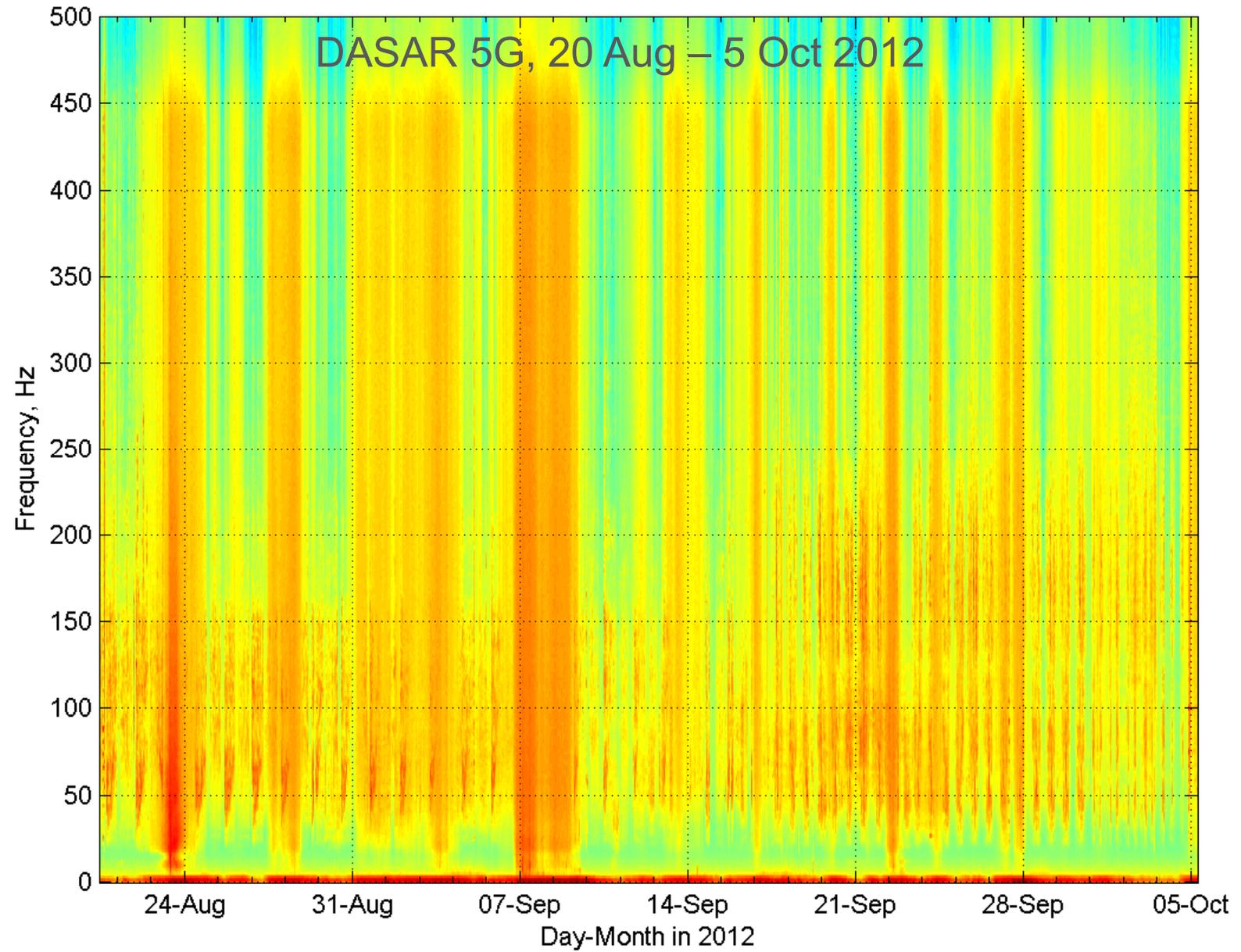


Percentile comparison:

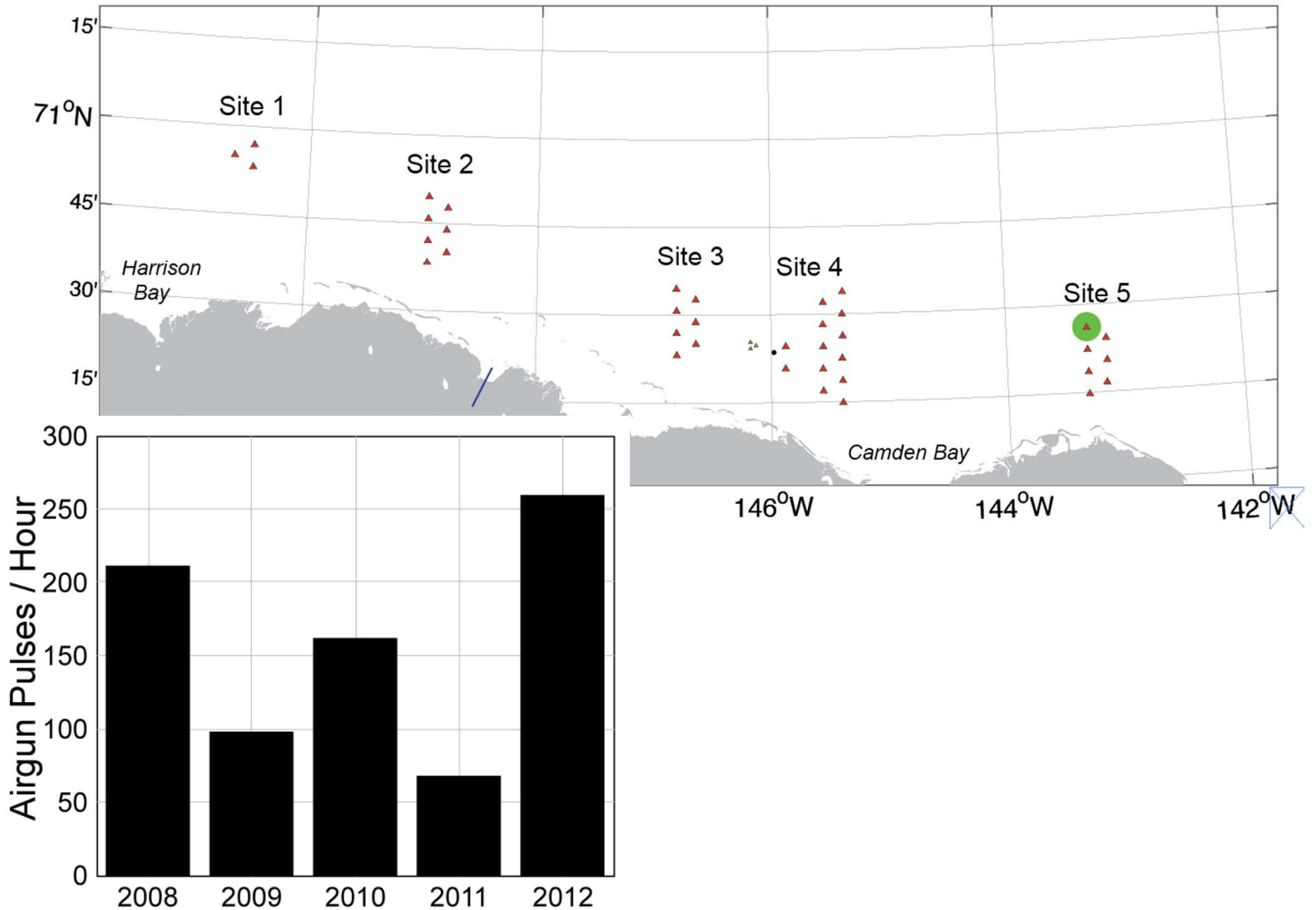
	2010	2011	2012
95th:	6	107	34
50th:	5	97	9
5th:	6	84	9

(all values dB re 1 μ Pa)

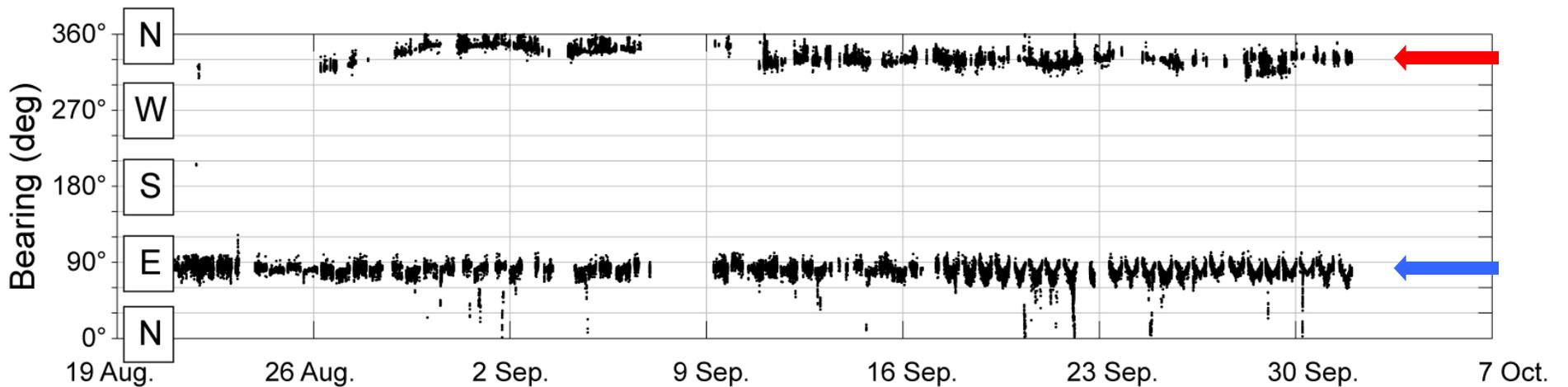
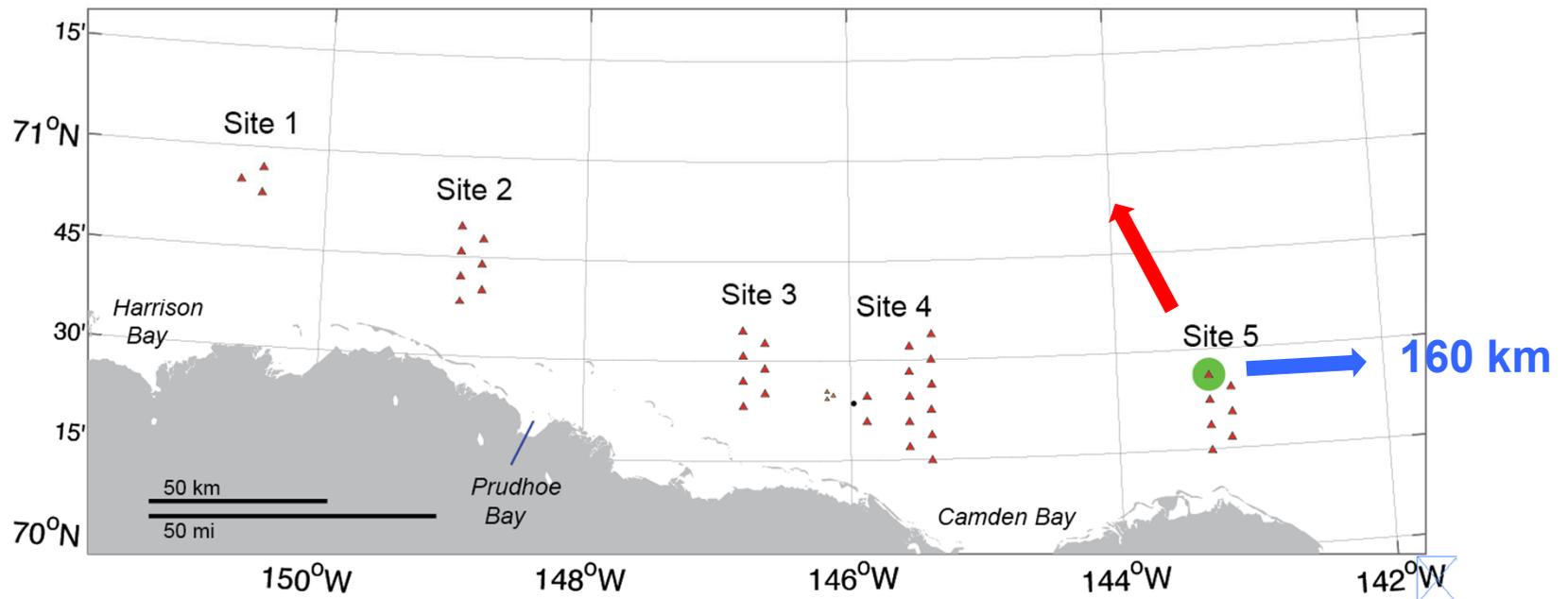
■ Anthropogenic activities: not only Shell



■ Other anthropogenic activities: airgun pulses at 5G

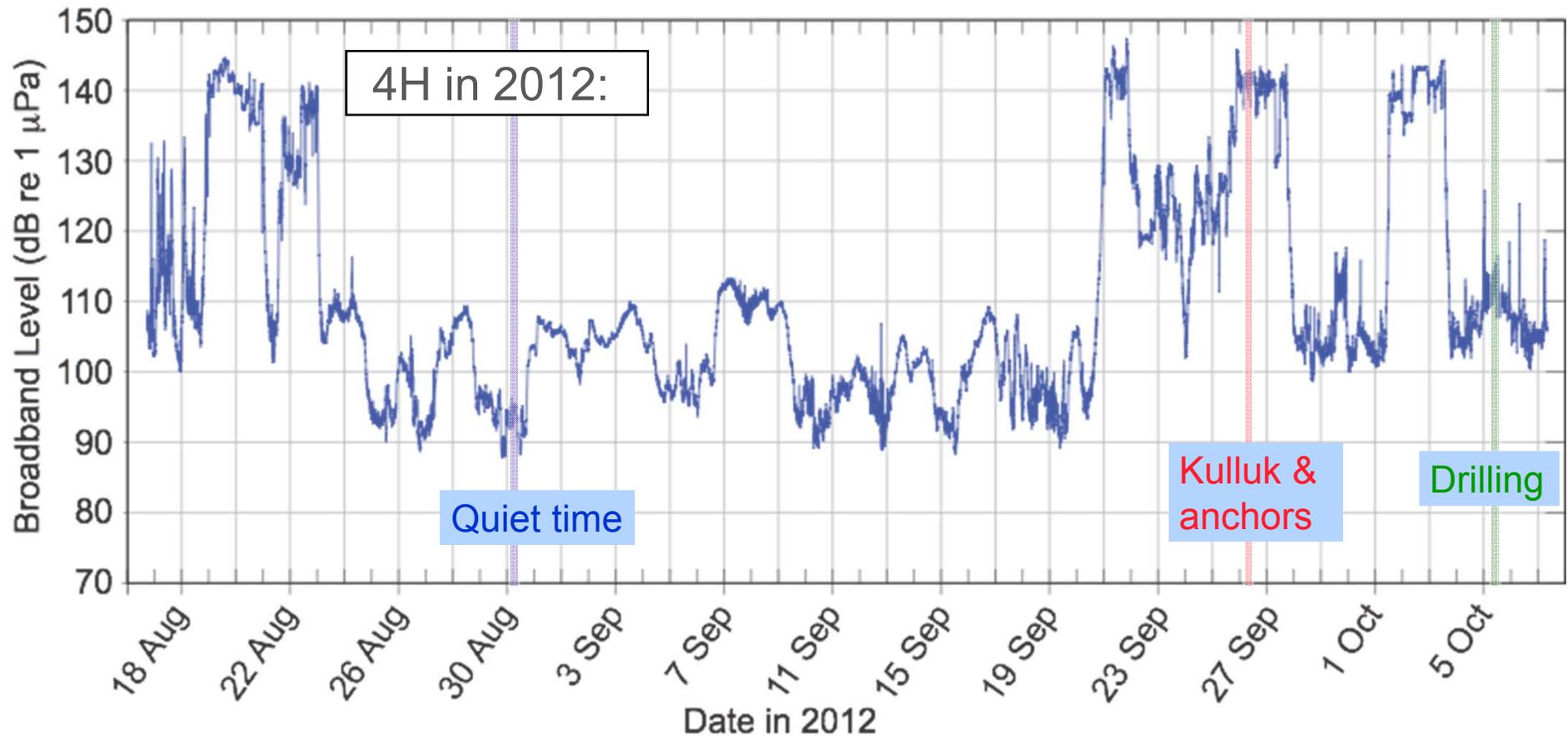


■ Other anthropogenic activities: airgun pulses at 5G

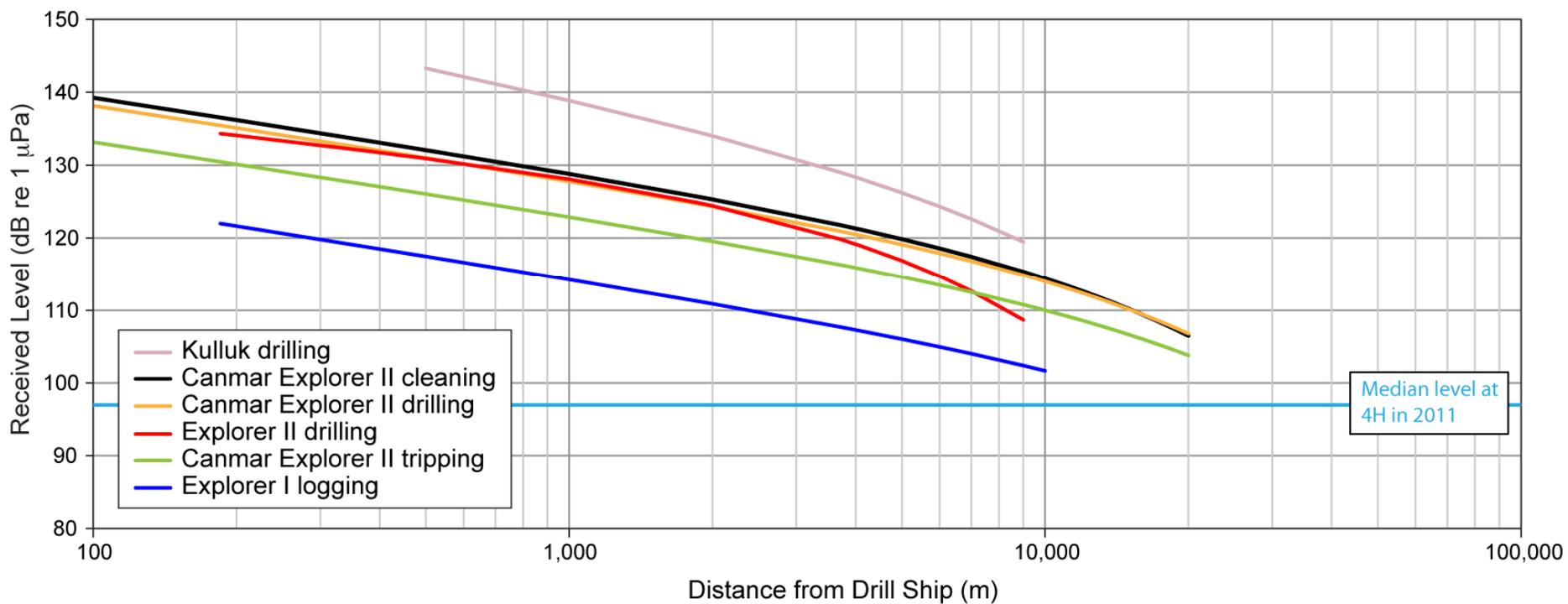


Received levels of broadband sound at DASARs during various activities:

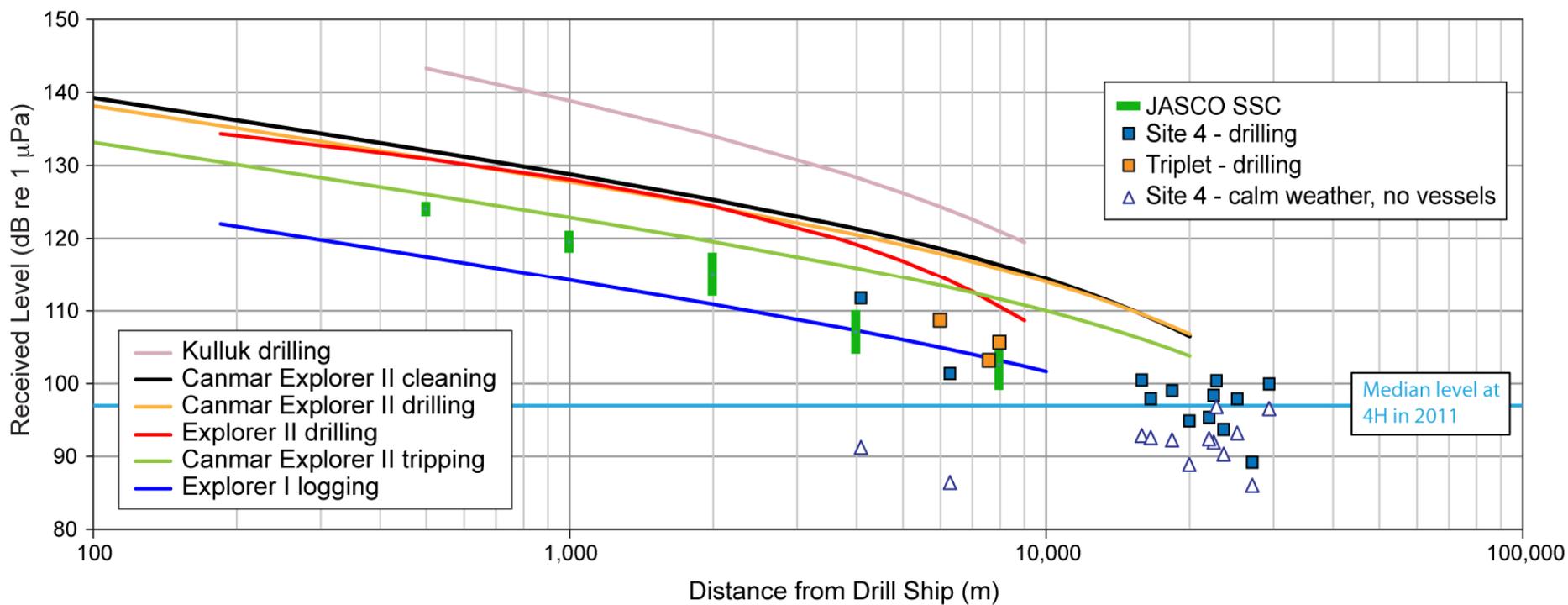
- connecting Kulluk to anchors
- drilling
- background levels on a quiet day



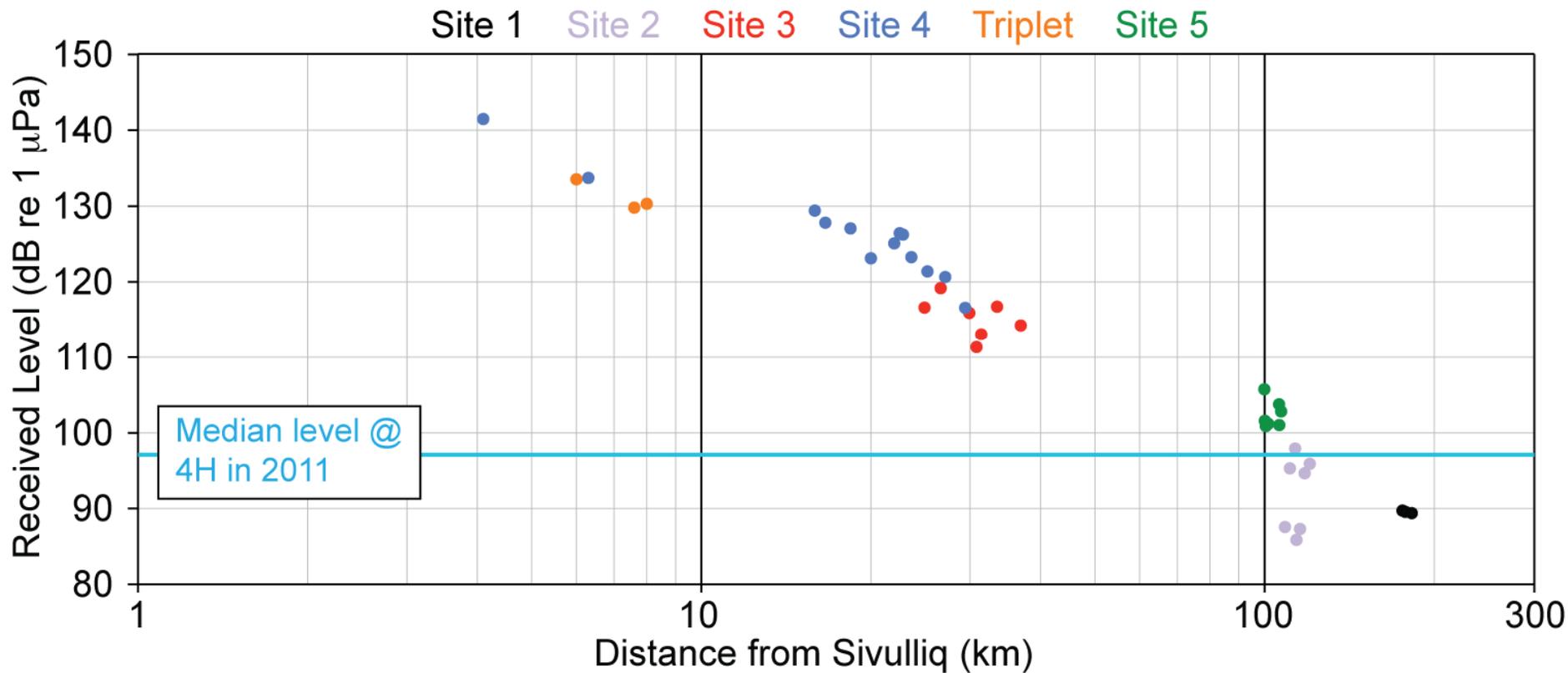
■ Drilling sounds: historical measurements



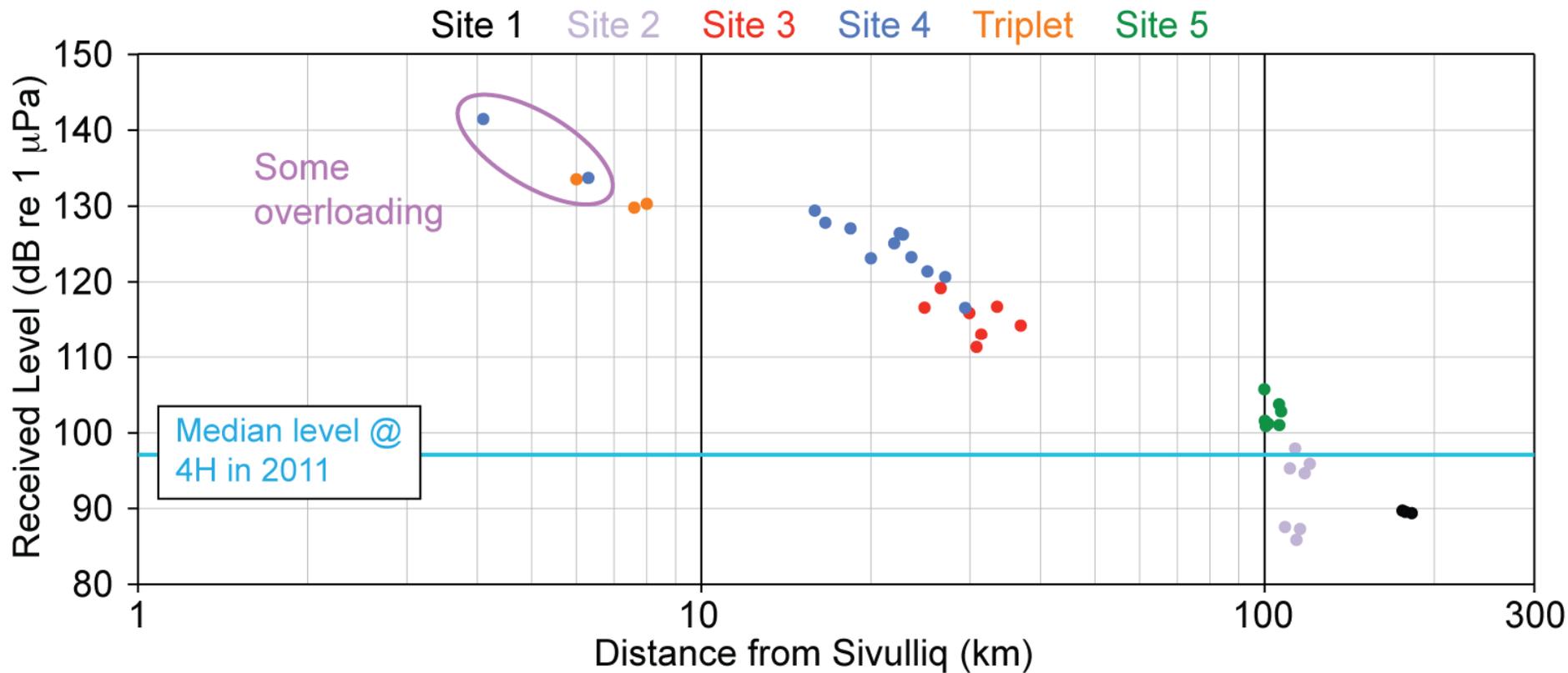
■ Drilling sounds: our measurements compared to the historical measurements



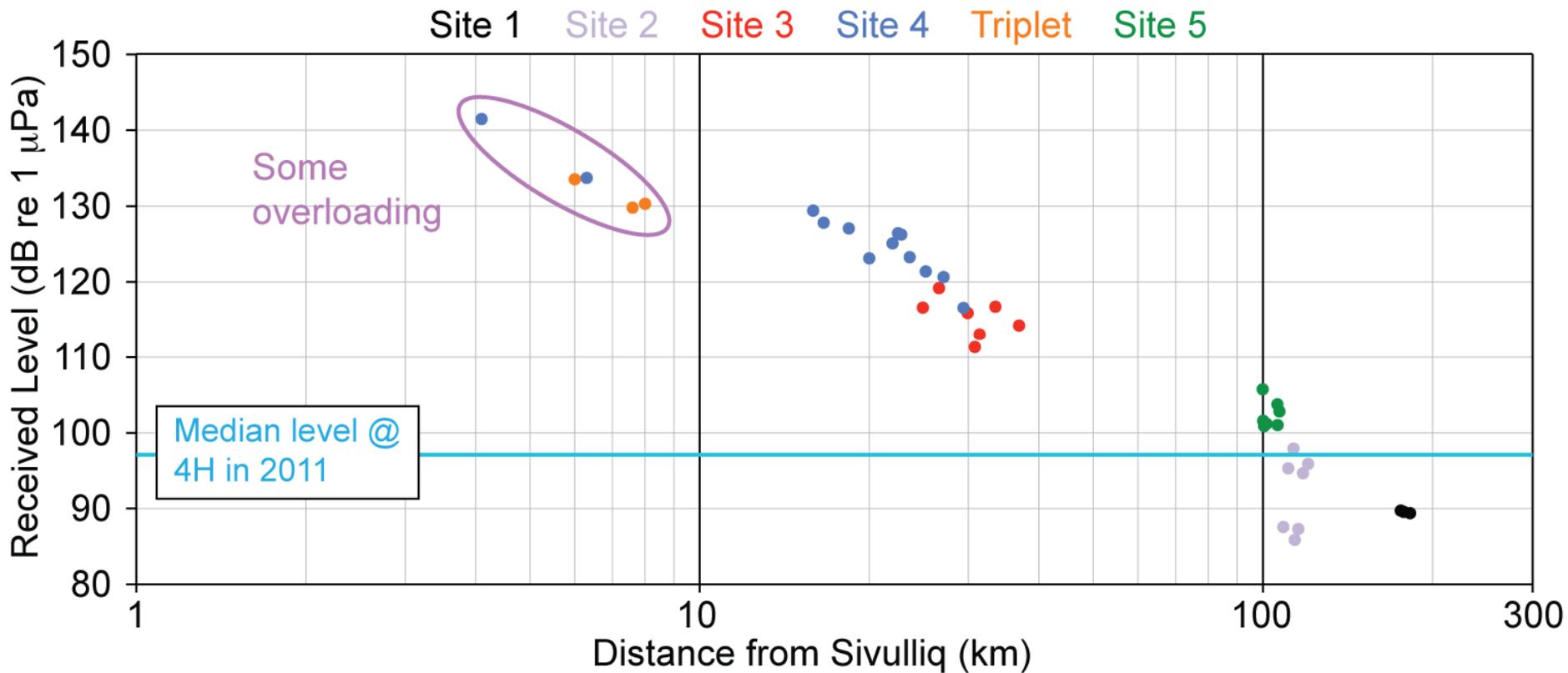
■ Anchor hook-up sounds: some of the highest recorded levels



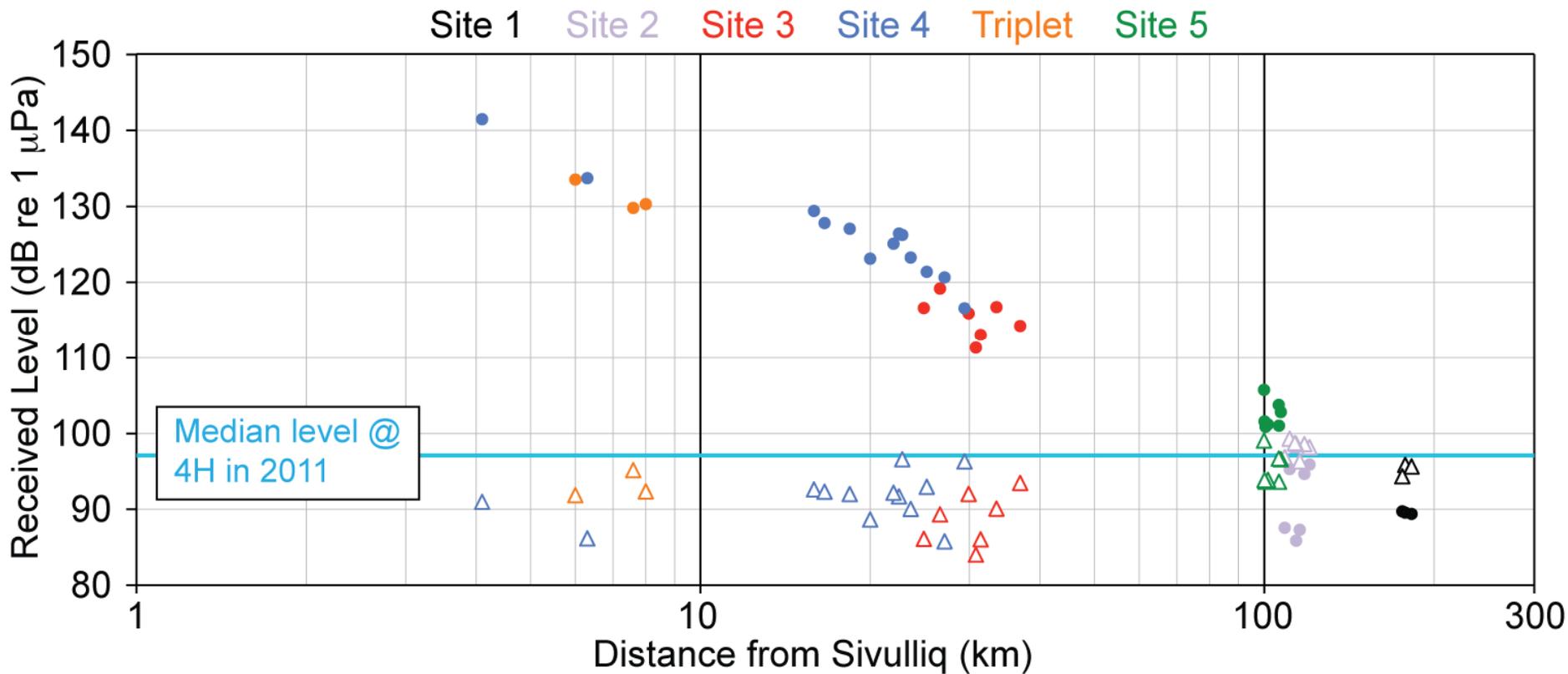
■ Anchor hook-up sounds: some of the highest recorded levels



■ Anchor hook-up sounds: some of the highest recorded levels

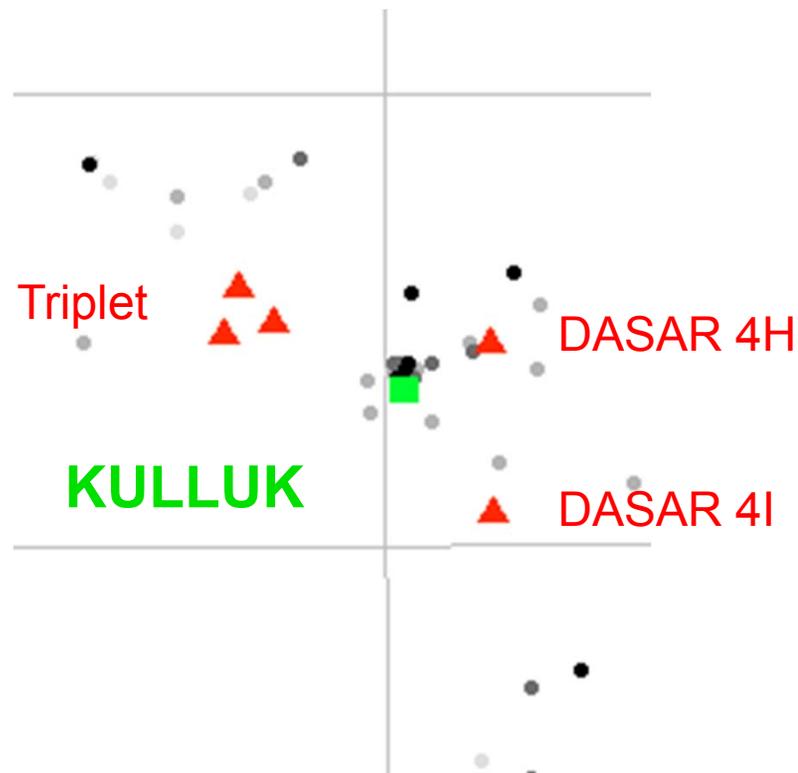


■ Anchor hook-up sounds: some of the highest recorded levels



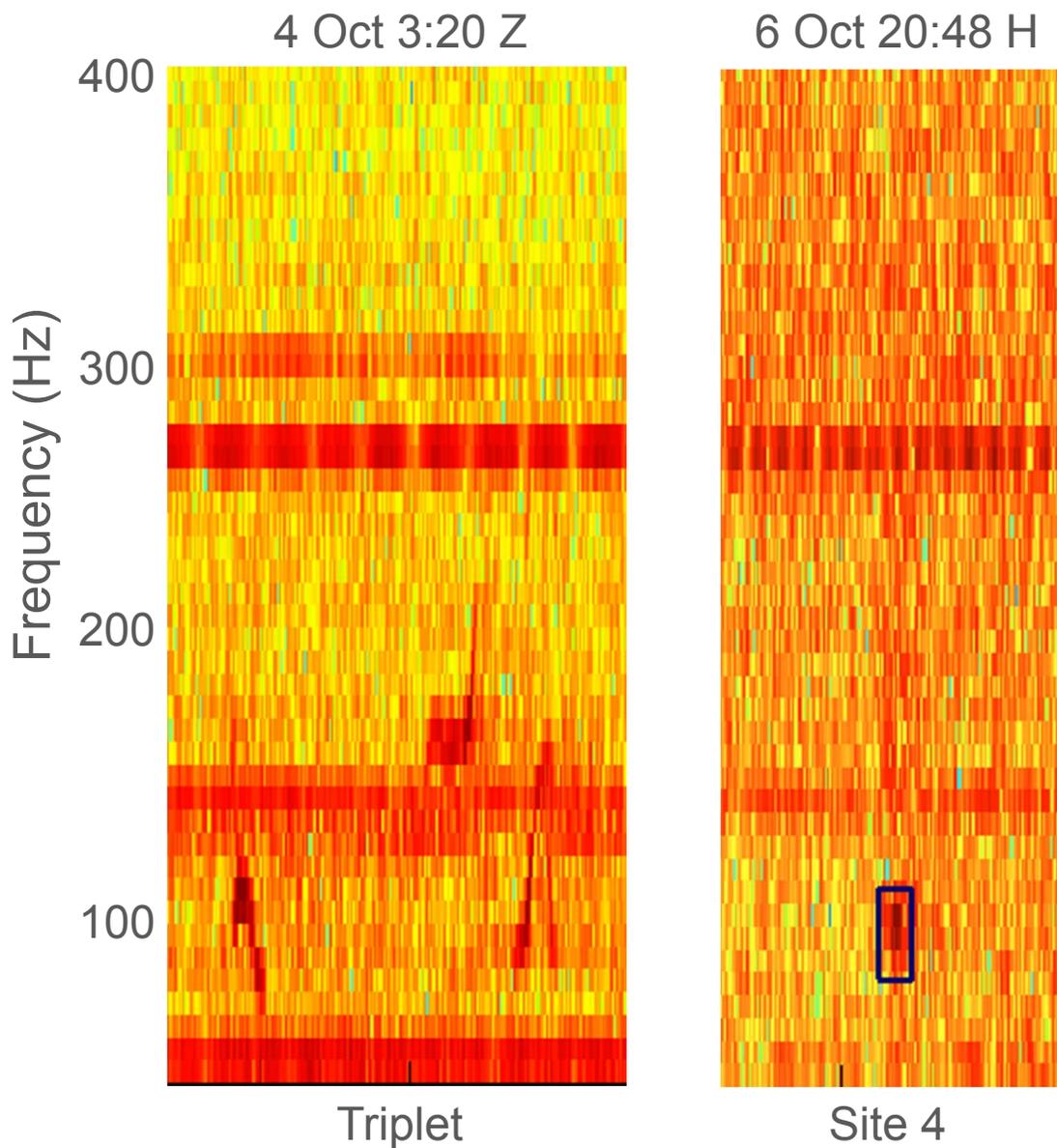
■ MOVIE TIME!

Automated call detector triggered by some industrial sounds (vessels) in 2012.

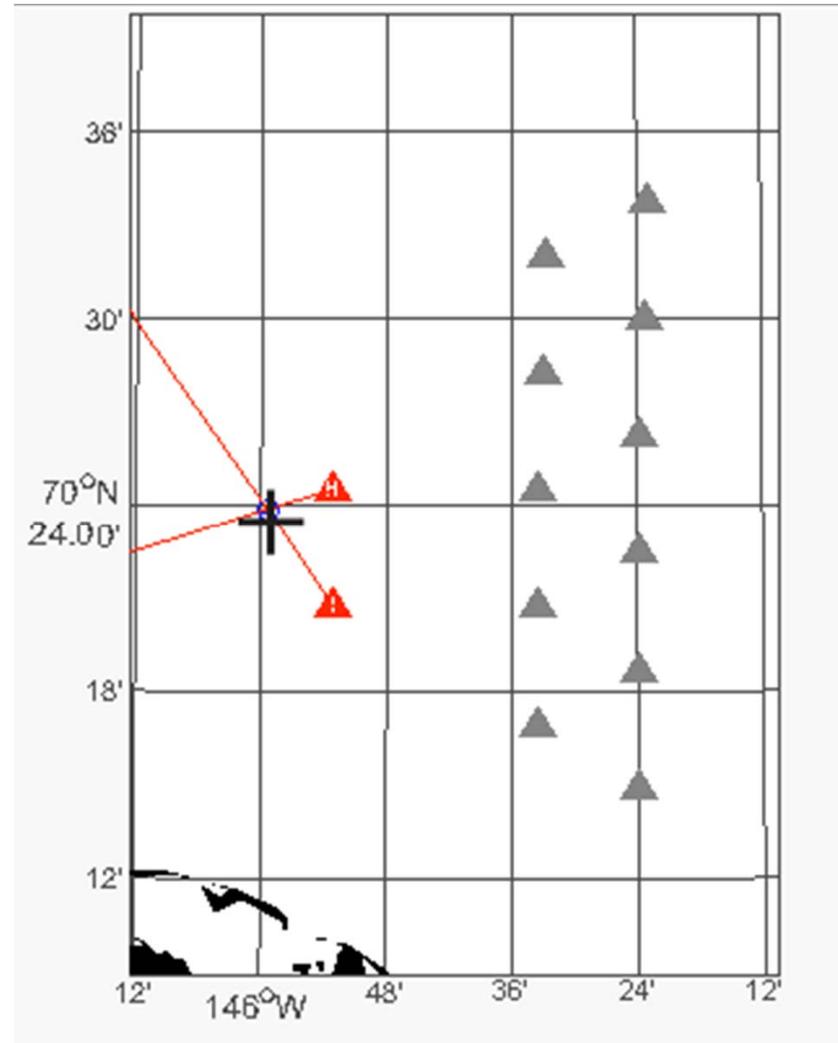
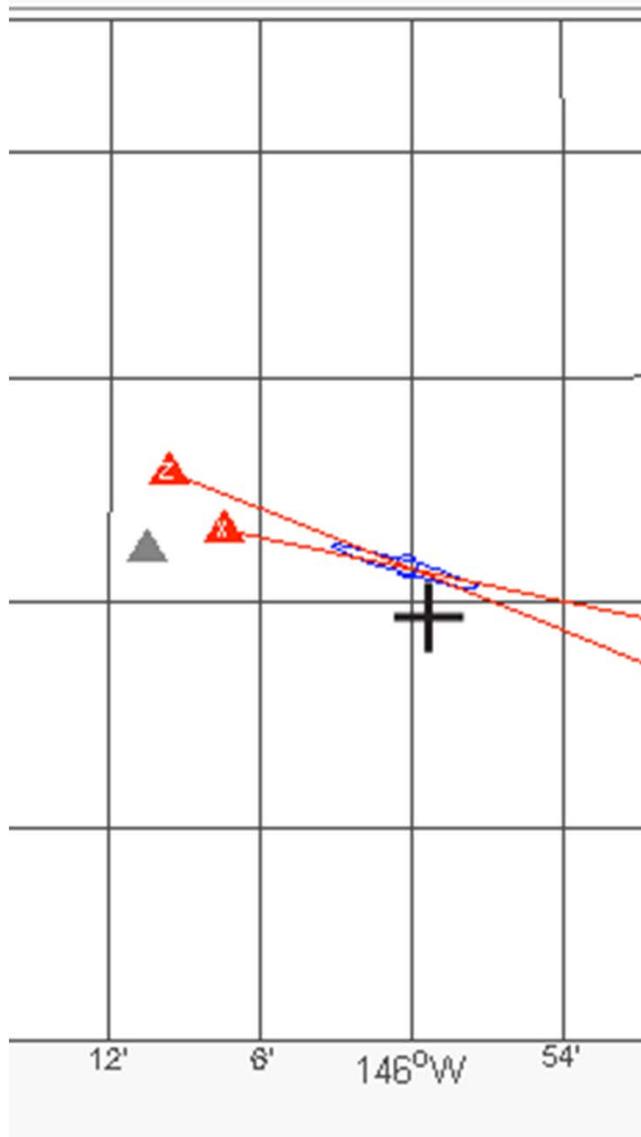


Of those we have checked,
1/10 - 1/15 are whale calls.

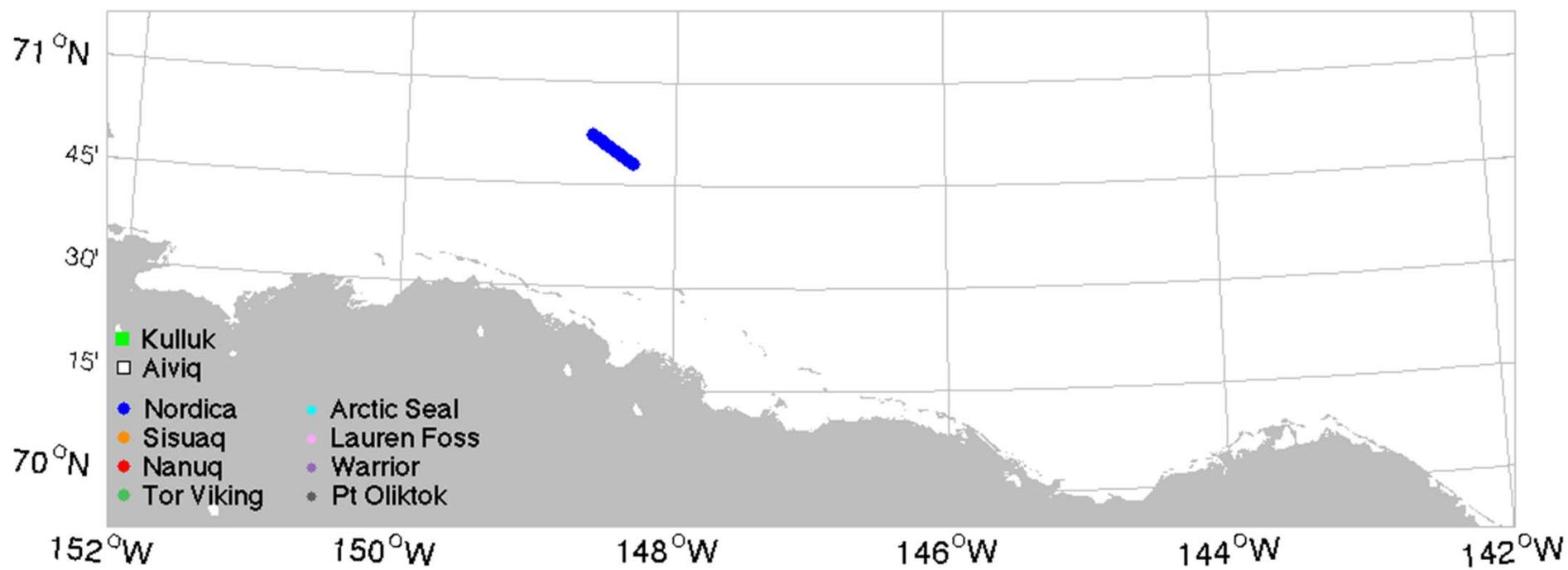
- Bowhead calls close to the Kulluk while ongoing operations?



- Bowhead calls close to Sivulliq while operations are ongoing?



16-Aug 00:00





Shell's 2012 Aerial Surveys



John Brandon
Greeneridge Sciences, Inc.

Beaufort Sea Aerial Surveys: Outline

- Background
 - Fall Bowhead Migration through Area
 - Previous Observations of Whales During Drilling
- Survey Design
- Summary of Effort and Sightings
- Observed Variability in the Migration

Fall Migration Through Alaskan Beaufort

- Typically encountered starting in late Aug through Oct
- Migration is pulsed in nature
- Some segregation by age and size
- Influenced by ice and dynamic availability of prey
- In addition to variability in the migration, there is variability in aerial survey effort (can't fly every day due to weather etc.)

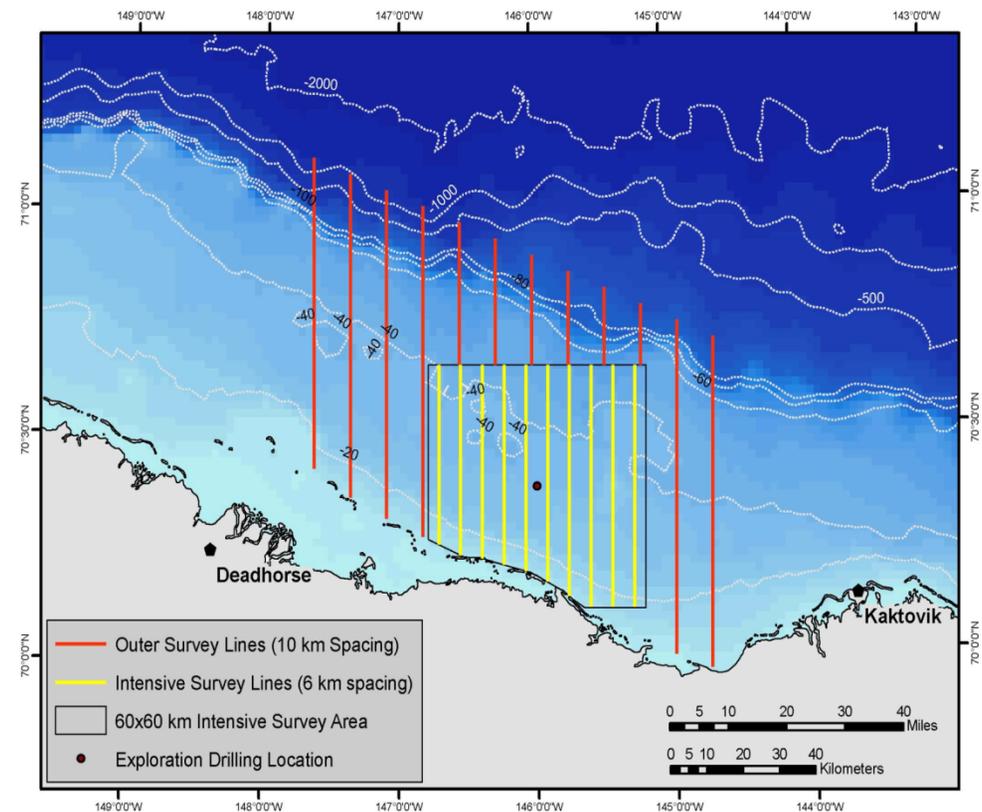


Background: Bowheads and Drilling

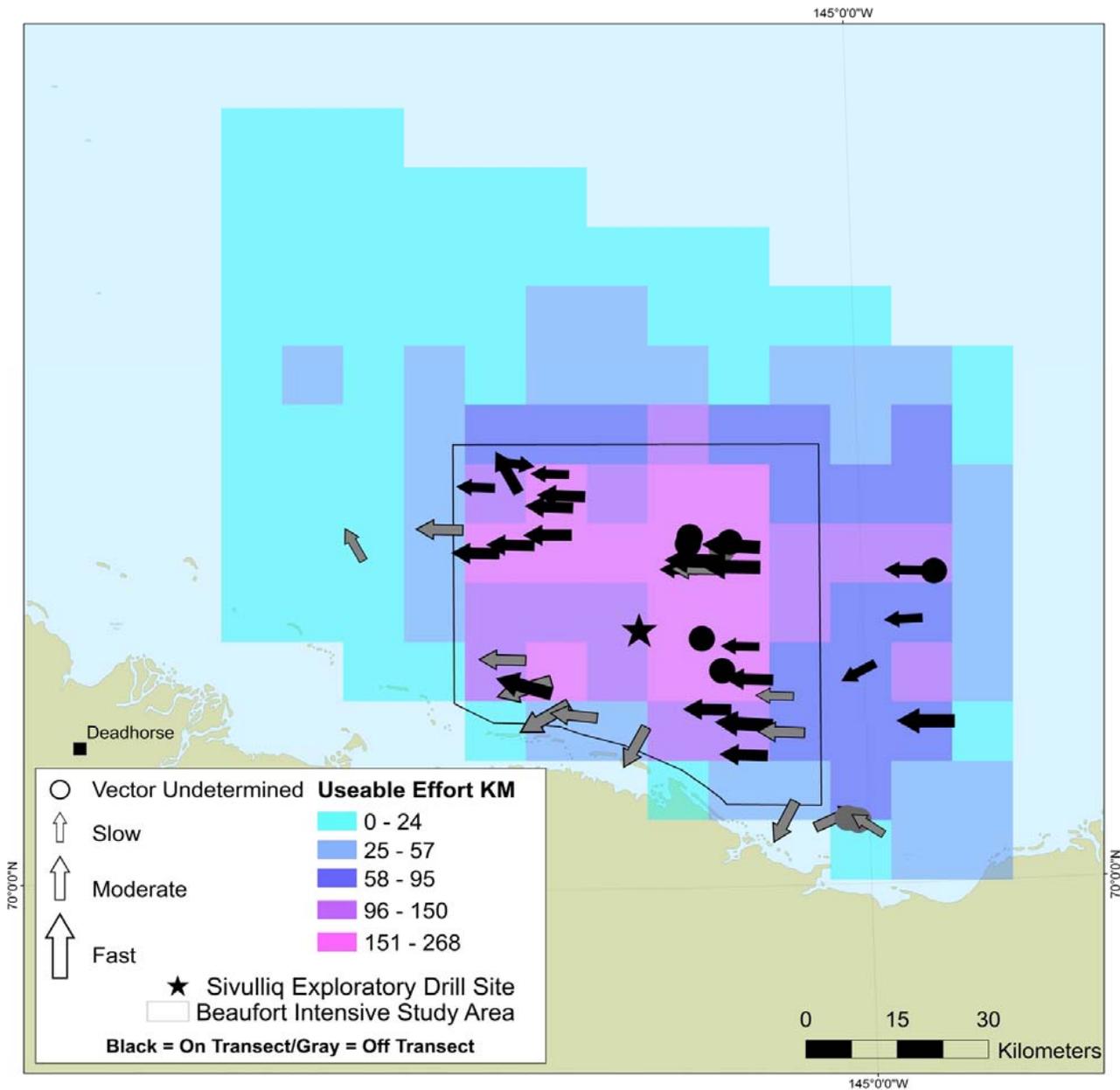
- Variable responses have been observed
- Localized changes in behavior (surfacing and headings) observed during sound playback experiments (Richardson 1995)
- At least some whales diverted around previous drilling at distances of 20+ km (12+ mi) (Davis 1987)
- Observed responses have not been uniform however, and may depend on activity states and individual tolerance (e.g. if feeding, more tolerant).

2012 Beaufort Sea Aerial Surveys

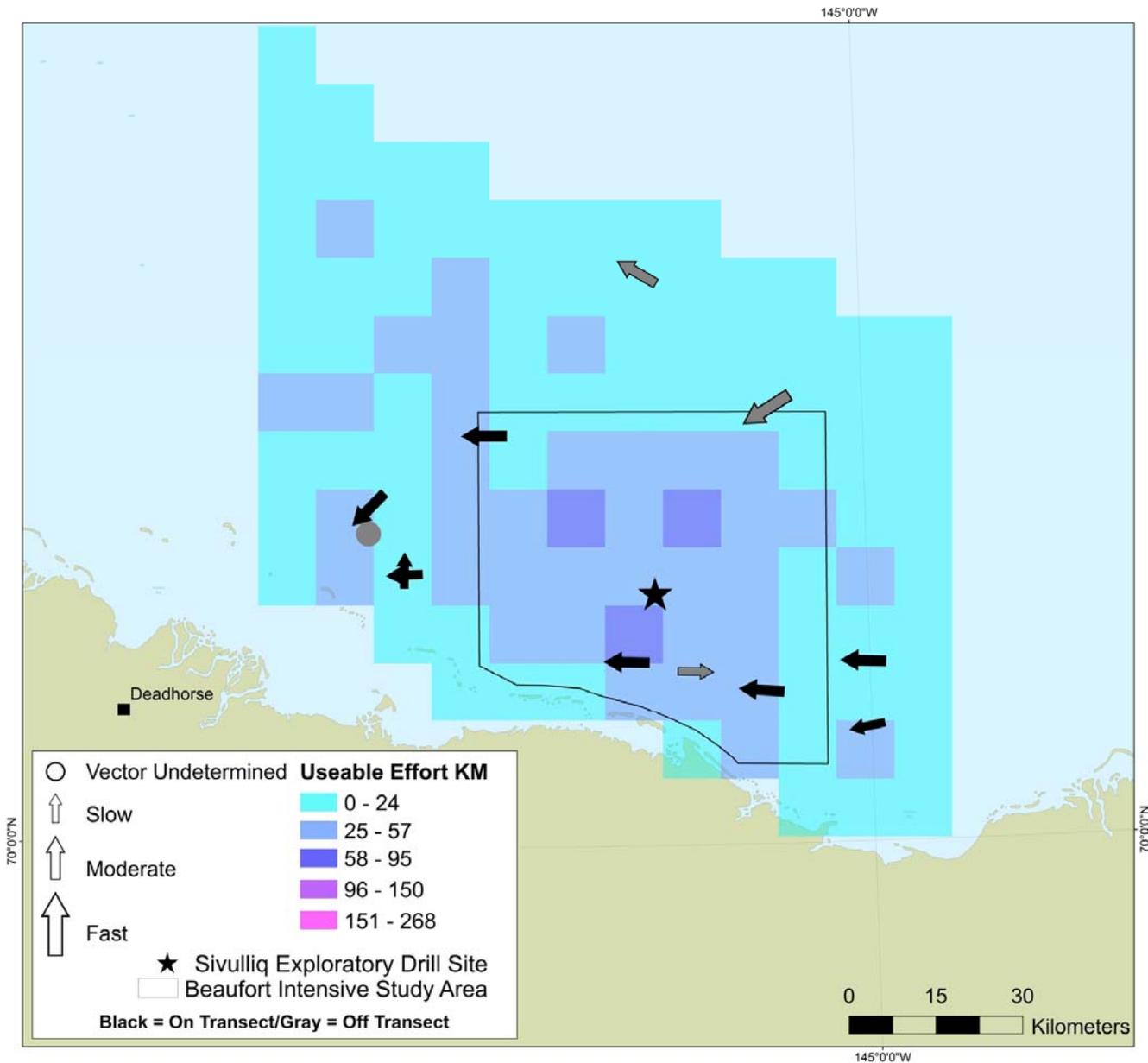
- Beaufort surveys flown with PSOs and camera system
- Survey grid based on power analysis
 - Maximizes probability of detecting potential deflection
- Surveys flown from 15 August – 3 November, 2012
- 24 surveys flown
 - 9122 km total effort
- Total of 197,411 images taken with camera system.
- 82 hours of video



Aerial Effort and Bowhead Sightings Pre-Drilling



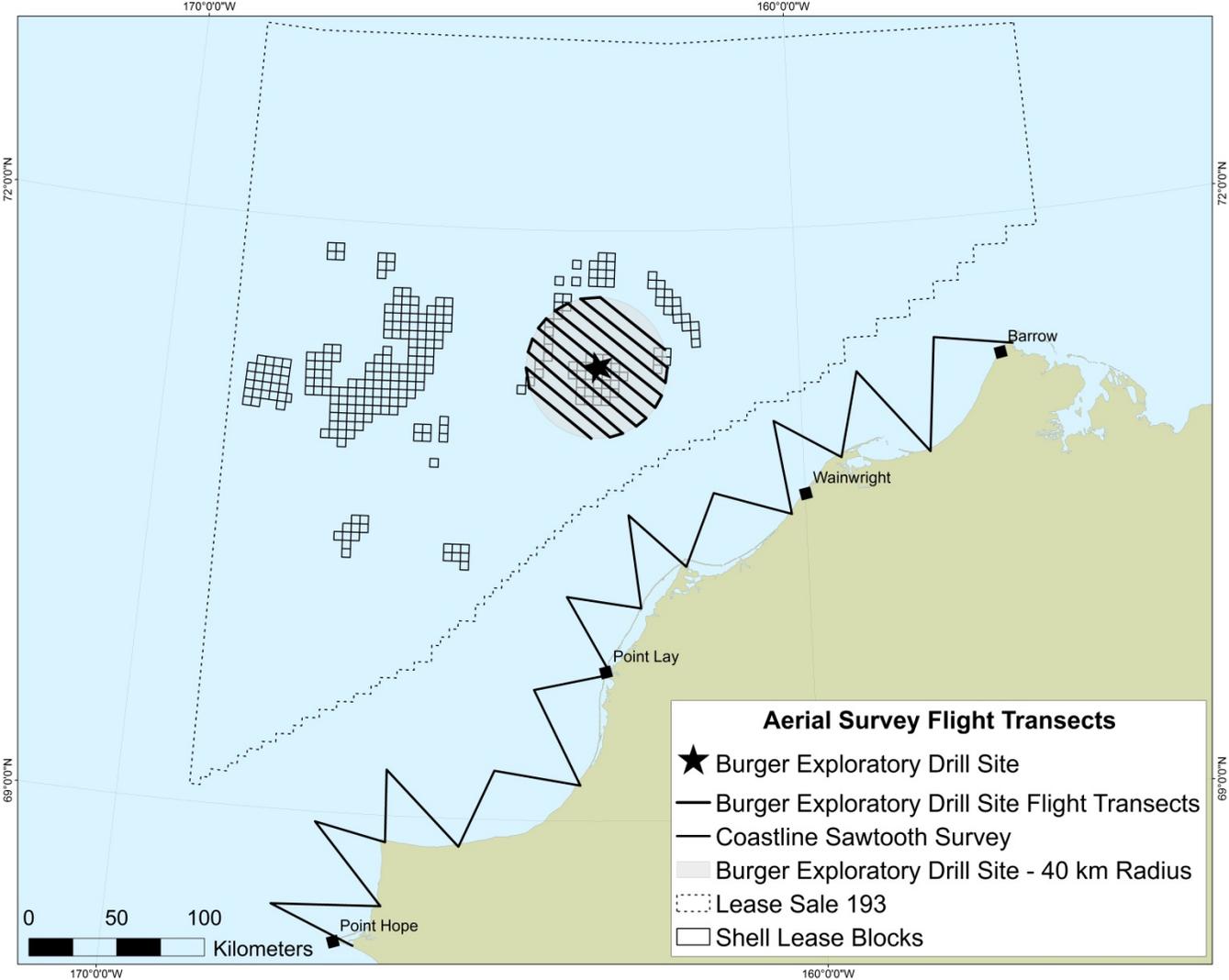
Aerial Effort and Bowhead Sightings During Drilling



Beaufort Summary

- Drilling season was relatively short (~3wks) and hence survey effort during drilling was limited by opportunity
- Late Aug through late Sep (peak migration) bowheads observed traveling in directed manner
- Late Sep into Oct sightings shifted more near-shore
 - Swim speeds were slower and headings more variable
- Observed behavior consistent with foraging
 - But also consistent with response to playback experiments

Chukchi Aerial Surveys – Survey Areas

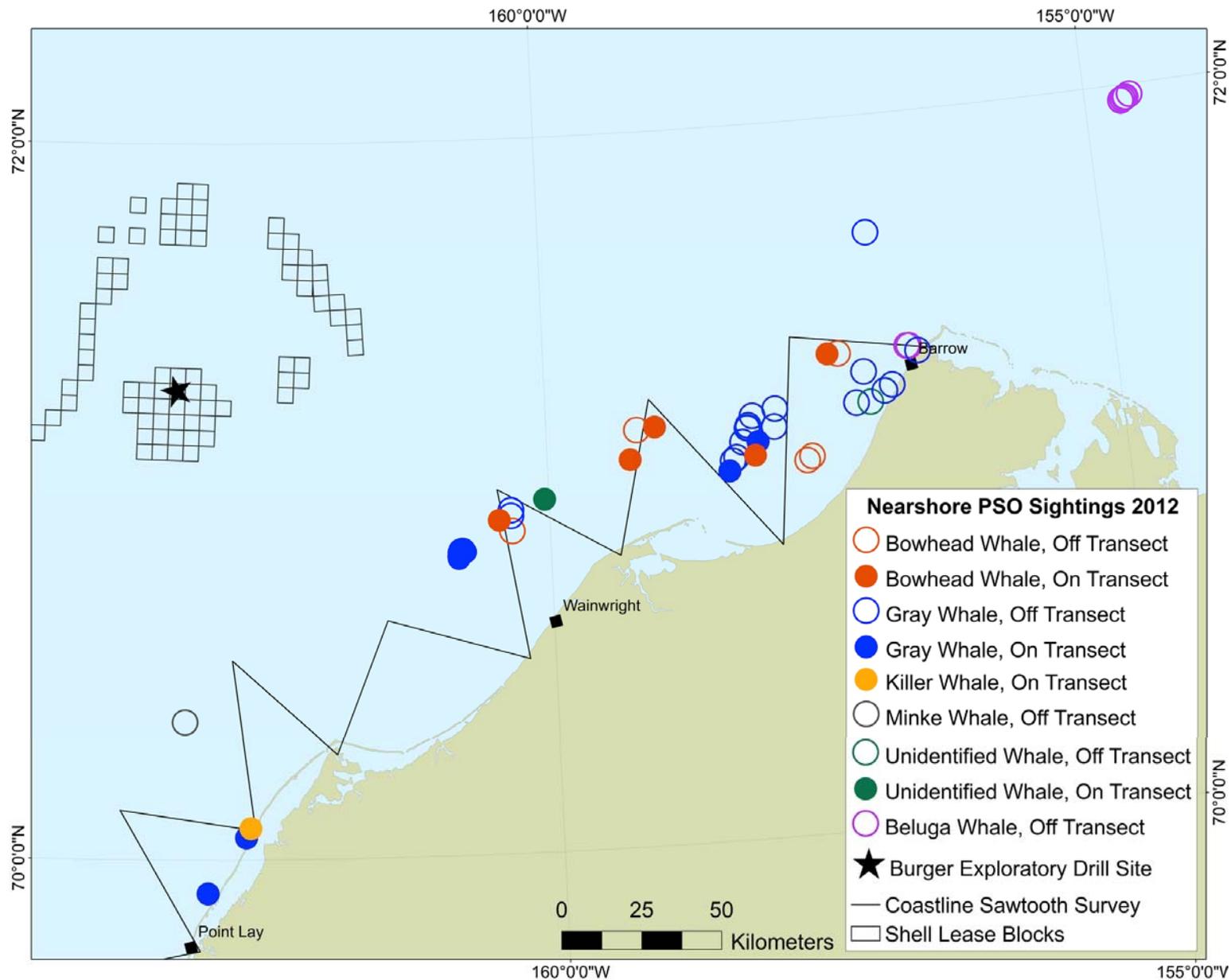


PSO Cetacean Nearshore Sightings

Nearshore aerial survey effort (km) & numbers of cetacean sightings (# individuals) in the Alaskan Chukchi Sea, 2012.

Date in 2012	Survey No.	On-transect Effort	Gray Whale	Bowhead Whale	Killer Whale	Unknown Whale
23-Aug	1	1011	9 (12)	0	1 (3)	0
15-Sep	2	311	0	0	0	1 (1)
26-Sep	3	226	1 (1)	1 (1)	0	0
28-Sep	4	816	0	4 (4)	0	0
24-26 Oct	5	523	0	0	0	0
Total		2887	10 (13)	5 (5)	1 (3)	1 (1)

Chukchi Nearshore Surveys – Cetacean Sightings

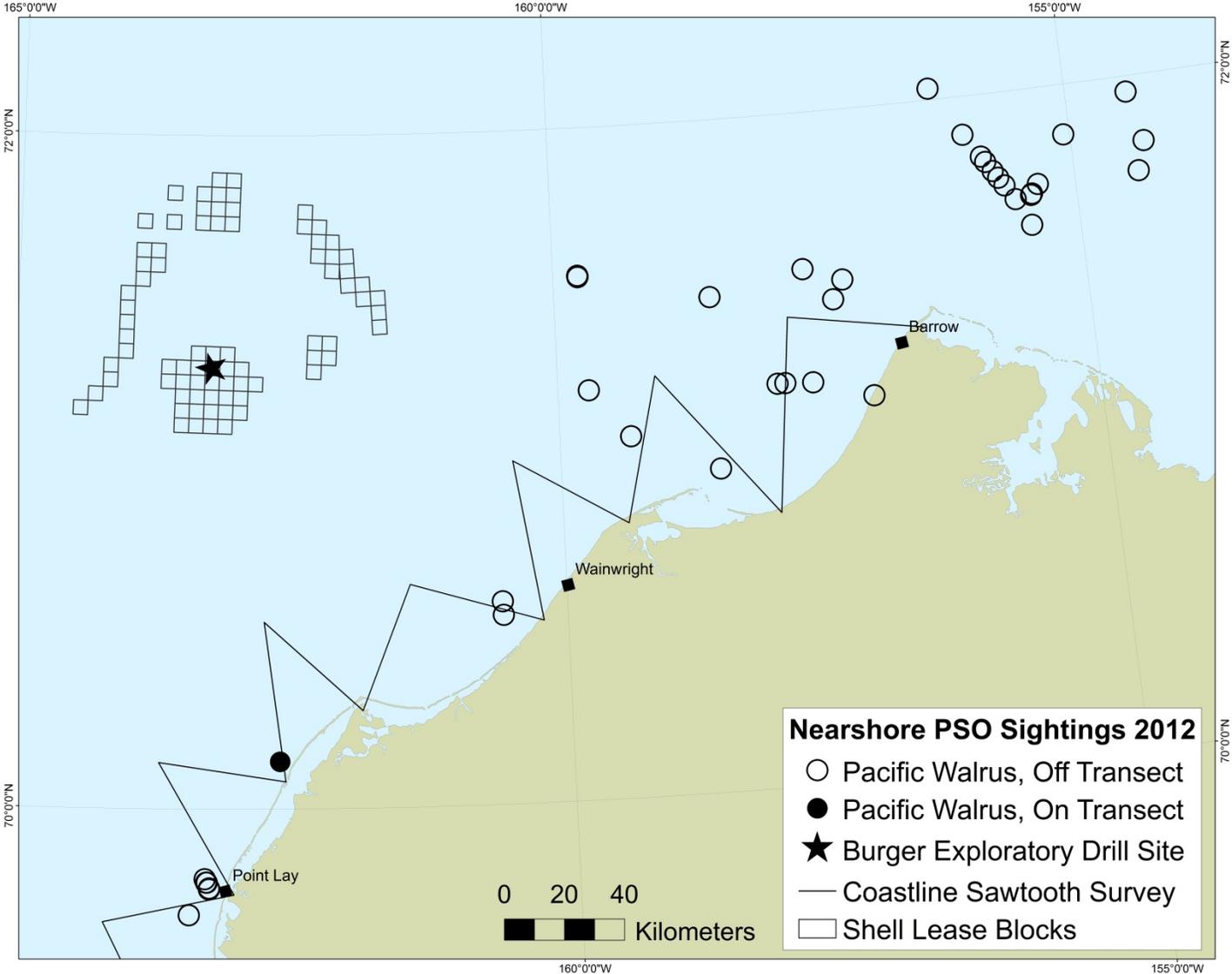


PSO Pinniped Sightings

Nearshore aerial survey effort (km during *bf* 0-2) & number of pinniped sightings (# individuals) in the Alaskan Chukchi Sea, 2012.

Date in 2012	Survey No.	On-transect Effort	Walrus	Bearded Seal	Ringed Seal	Unknown Seal	Unknown Pinniped
23-Aug	1	801	0	14 (15)	1 (1)	27 (36)	0
15-Sep	2	243	1 (2)	11 (11)	0	4 (4)	1 (1)
26-Sep	3	0	0	0	0	0	0
28-Sep	4	0	0	0	0	0	0
24-26 Oct	5	90	0	0	0	2 (3)	0
Total		1134	1 (2)	25 (26)	1 (1)	33 (43)	1 (1)

Nearshore Walrus Sightings

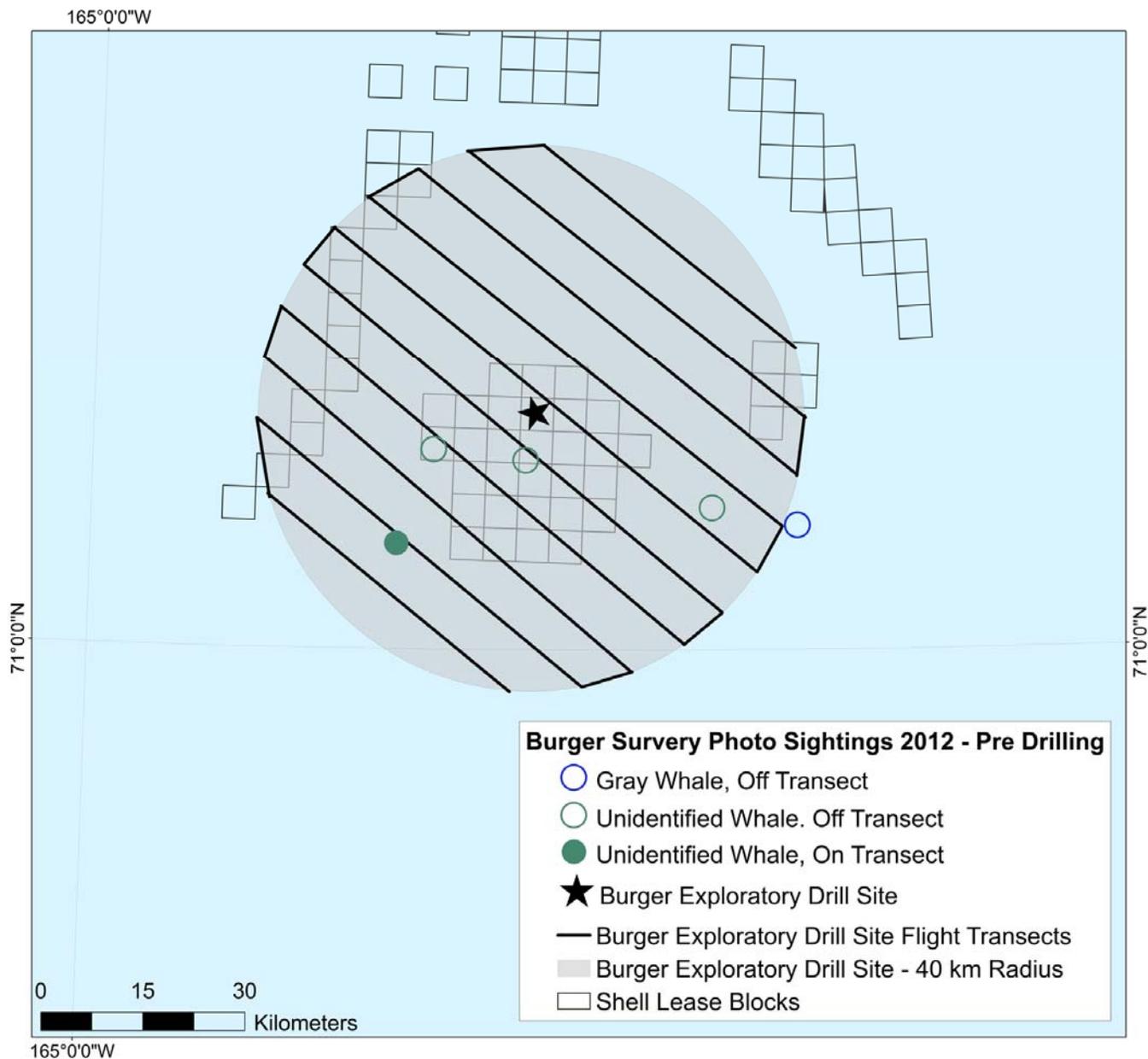


Burger Sightings during Quick Review

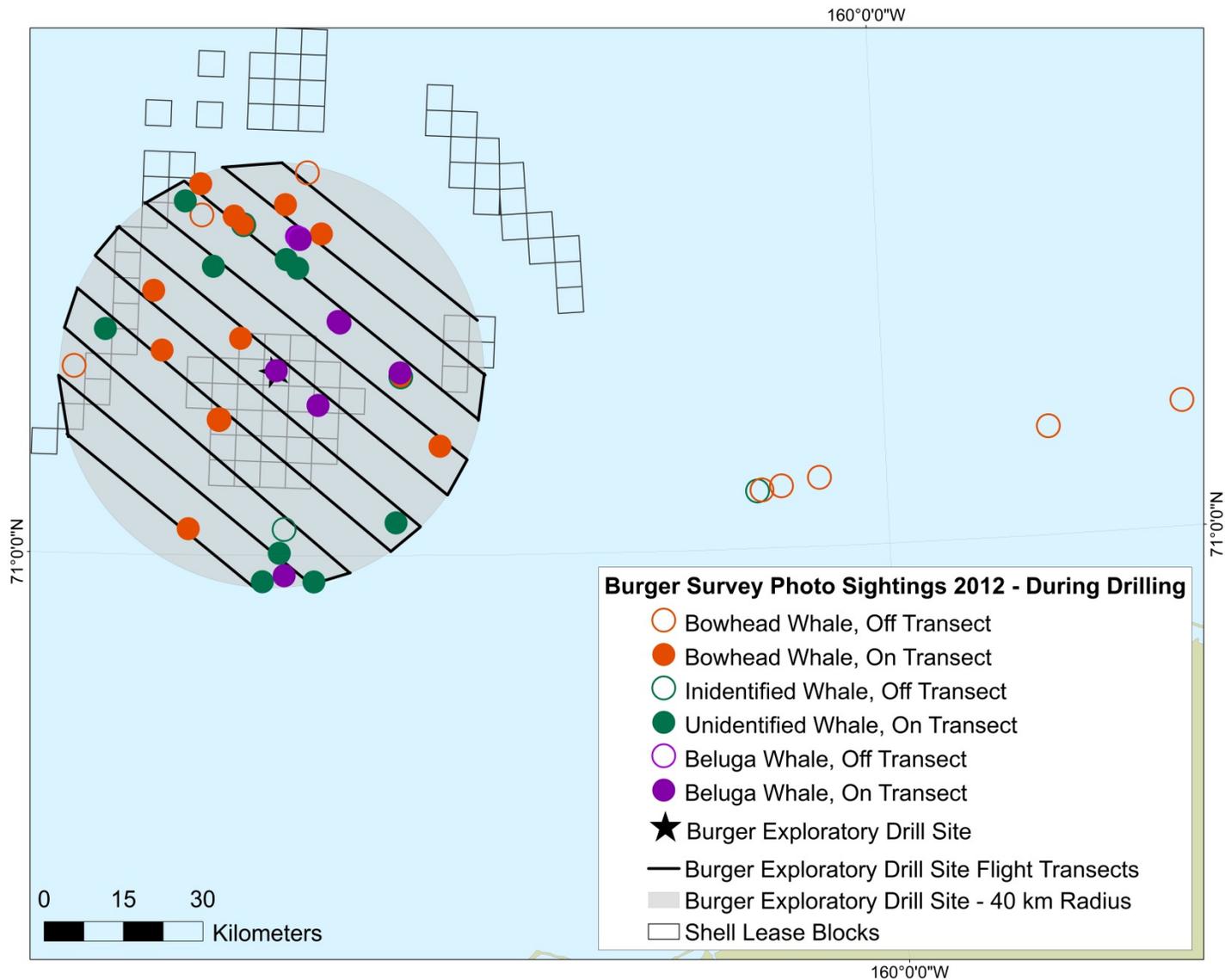
Aerial survey effort (hr) & number of cetacean sightings (# individuals) during photo surveys of the Burger Prospect

Date in 2012	Survey No.	On-transect Effort	Bowhead Whale	Beluga Whale	Unknown Whale
19-Aug	1	1.98	0	0	0
21-Aug	2	0.93	0	0	0
28-Aug	3	2.17	0	0	0
7-Sep	4	1.31	0	0	0
8-Sep	5	2.53	0	0	0
9-Sep	6	1.94	0	0	1 (1)
10-Sep	7	2.21	0	0	0
26-Sep	8	0.34	0	0	0
29-Sep	9	2.89	2 (3)	0	4 (5)
30-Sep	10	0.42	0	0	1 (1)
6-Oct	11	2.53	5 (6)	0	1 (1)
12-Oct	12	2.57	1 (1)	0	0
15-Oct	13	2.33	1 (1)	0	1 (1)
18-Oct	14	2.95	2 (2)	5 (8)	1 (1)
19-Oct	15	1.53	1 (1)	0	0
22-Oct	16	0.03	0	0	0
23-Oct	17	2.80	0	6 (6)	1 (1)
27-Oct	18	0.55	1 (1)	0	0
Total		31.99	13 (15)	11 (14)	10 (11)

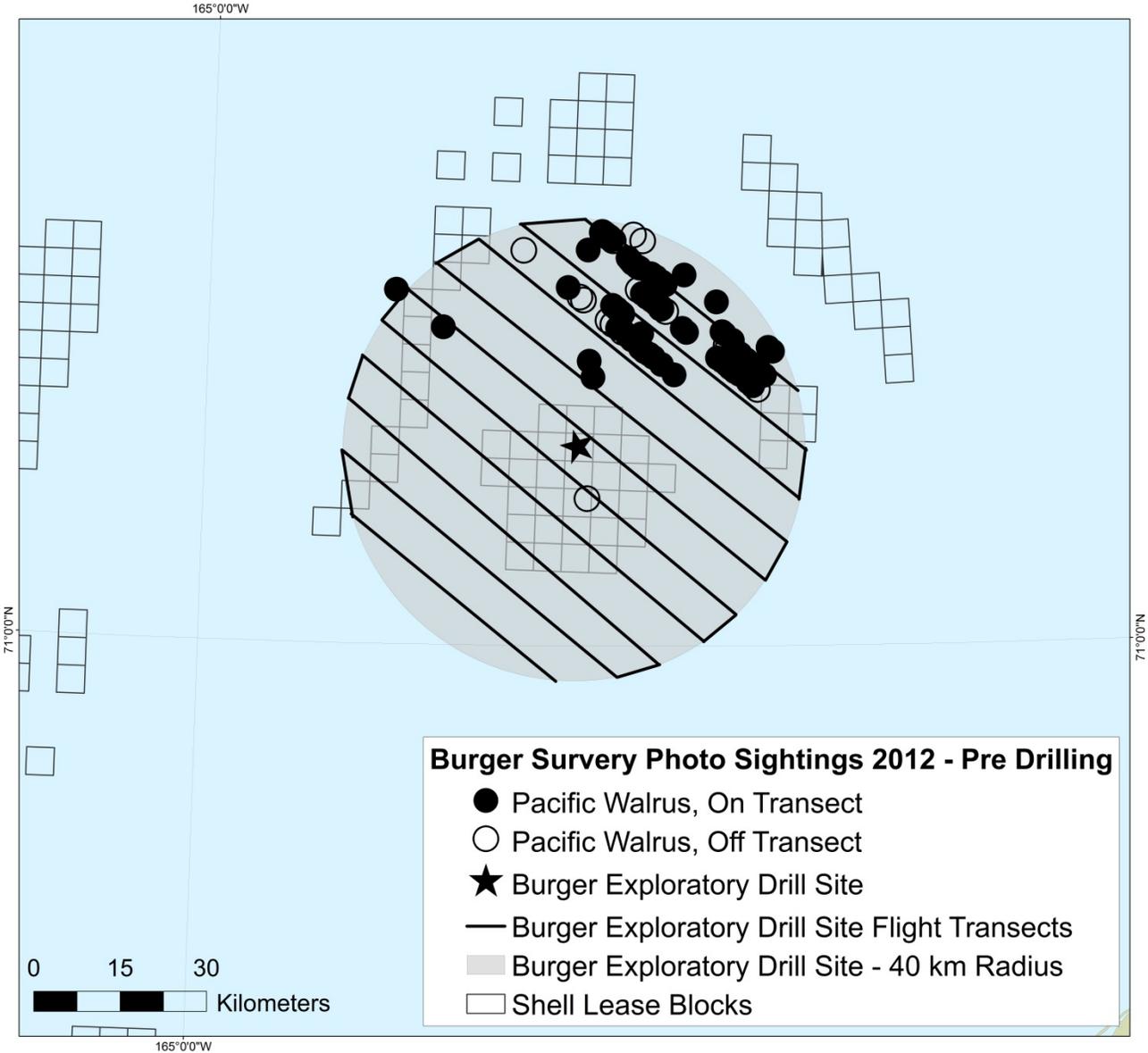
Chukchi Offshore Surveys – Cetaceans Pre-drilling



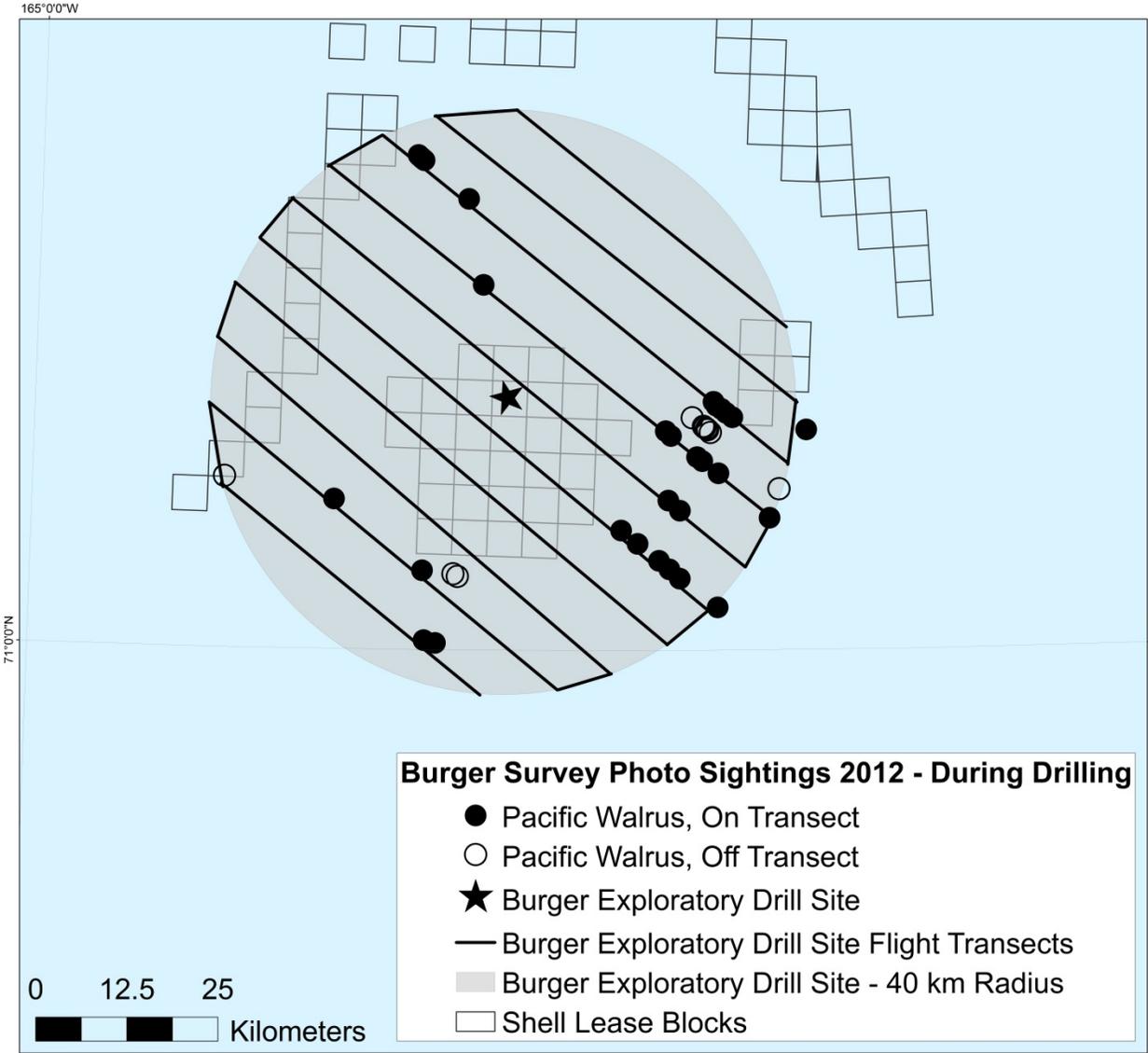
Chukchi Offshore Surveys – Cetaceans during Drilling



Offshore Walrus Sightings Pre-drilling



Offshore Walrus Sightings during Drilling



Chukchi Aerial Summary

- Relatively high numbers of bowheads were sighted during near-shore surveys to the southwest of Barrow
- Walrus were observed in offshore study area throughout season
 - No haul-outs observed on-shore
- Photo review is ongoing; preliminary results appear very promising
 - For walrus hauled out on ice, images will provide better estimates of numbers than PSOs
 - Cetaceans can be detected, and appear to have been relatively abundant in offshore survey area later in season

Thank you / Quyanaqpak

