



NOAA
FISHERIES

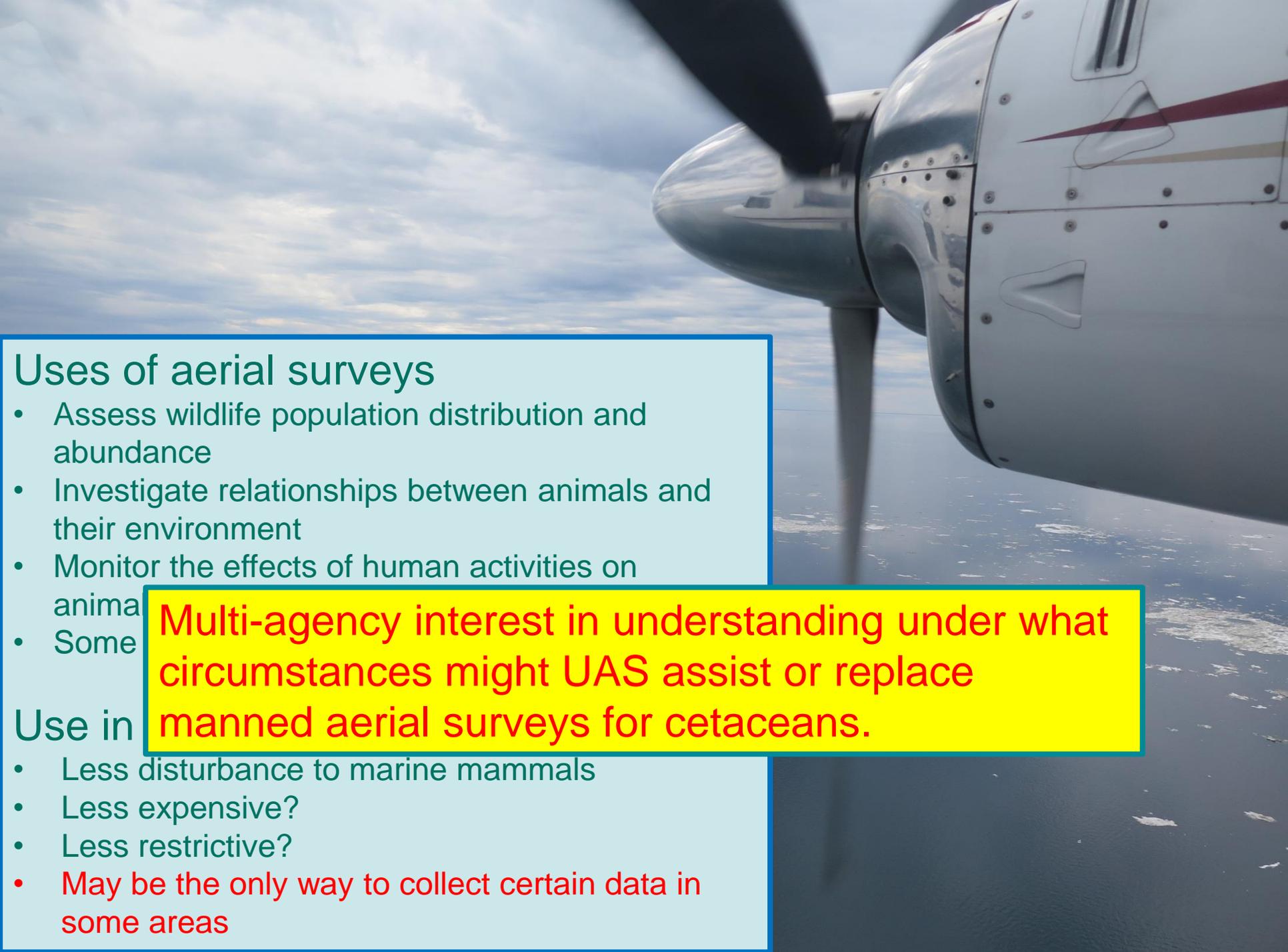
AFSC

**Marine Mammal
Laboratory**

Manned vs unmanned aerial surveys of cetaceans in the Arctic: Operations and preliminary results

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* Analytical lead
10/25/16



Uses of aerial surveys

- Assess wildlife population distribution and abundance
- Investigate relationships between animals and their environment
- Monitor the effects of human activities on animals
- Some

Multi-agency interest in understanding under what circumstances might UAS assist or replace manned aerial surveys for cetaceans.

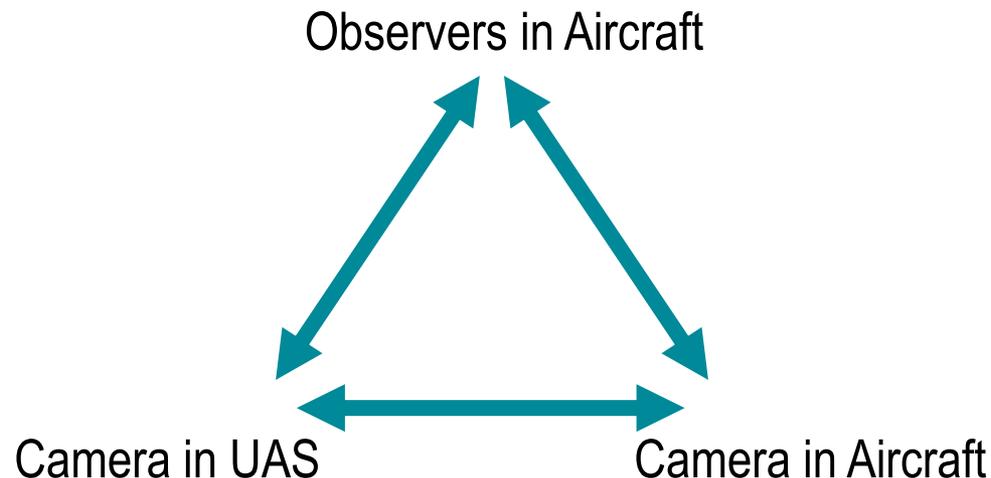
Use in

- Less disturbance to marine mammals
- Less expensive?
- Less restrictive?
- May be the only way to collect certain data in some areas

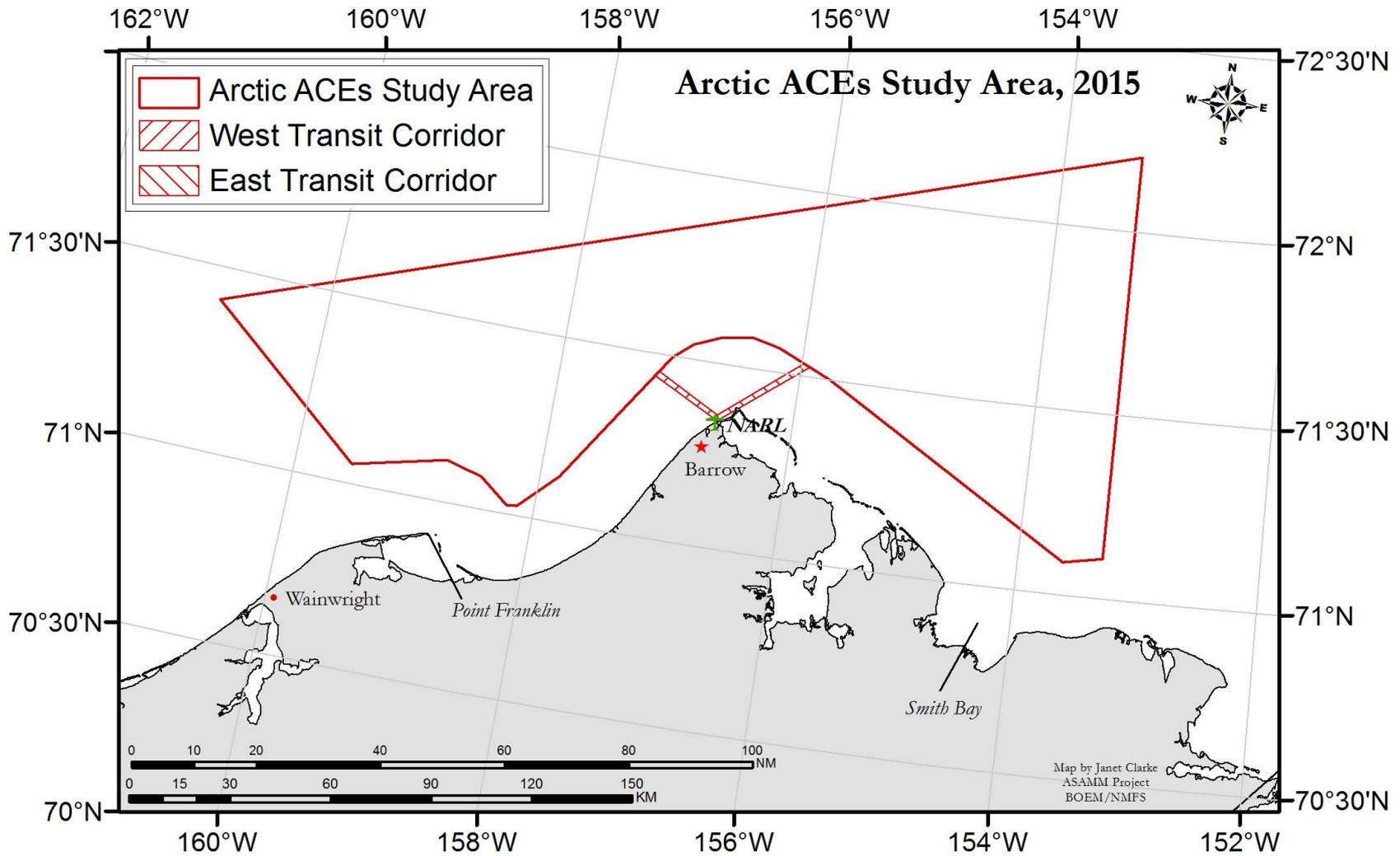
Arctic Aerial Collaboration Experiment: Overarching Goal

Conduct a 3-way comparison among:

- Observers in the manned aircraft
- Digital photographs from cameras mounted to the manned aircraft
- Digital photographs from cameras mounted to the unmanned aerial vehicle (UAV)



Study Area – North of Barrow, Alaska

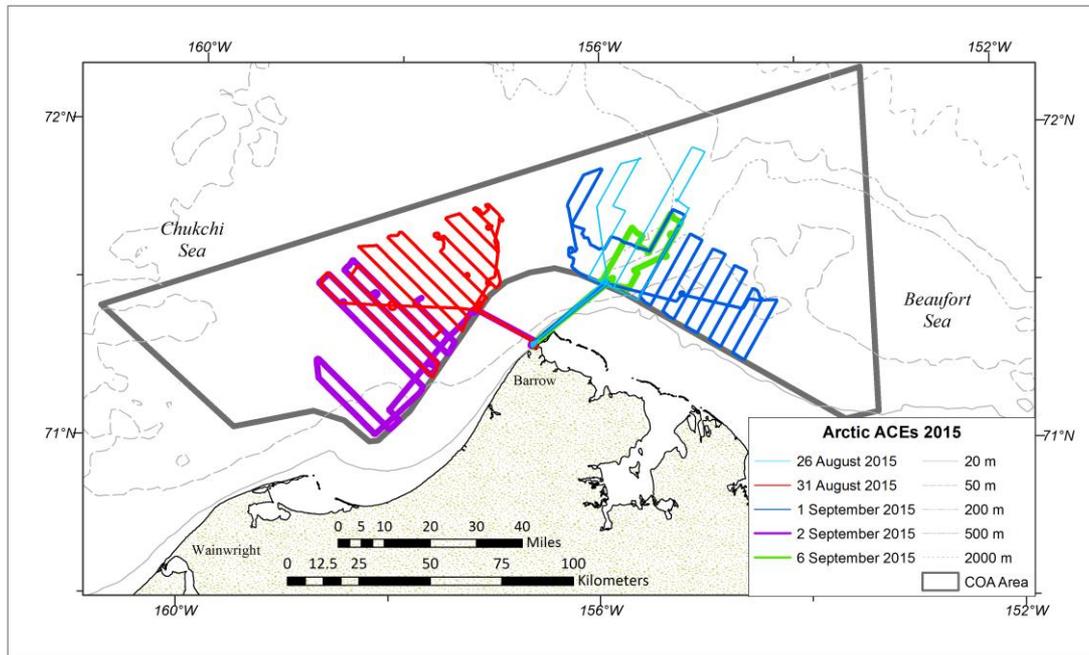


Unmanned Aerial System: Insitu ScanEagle®

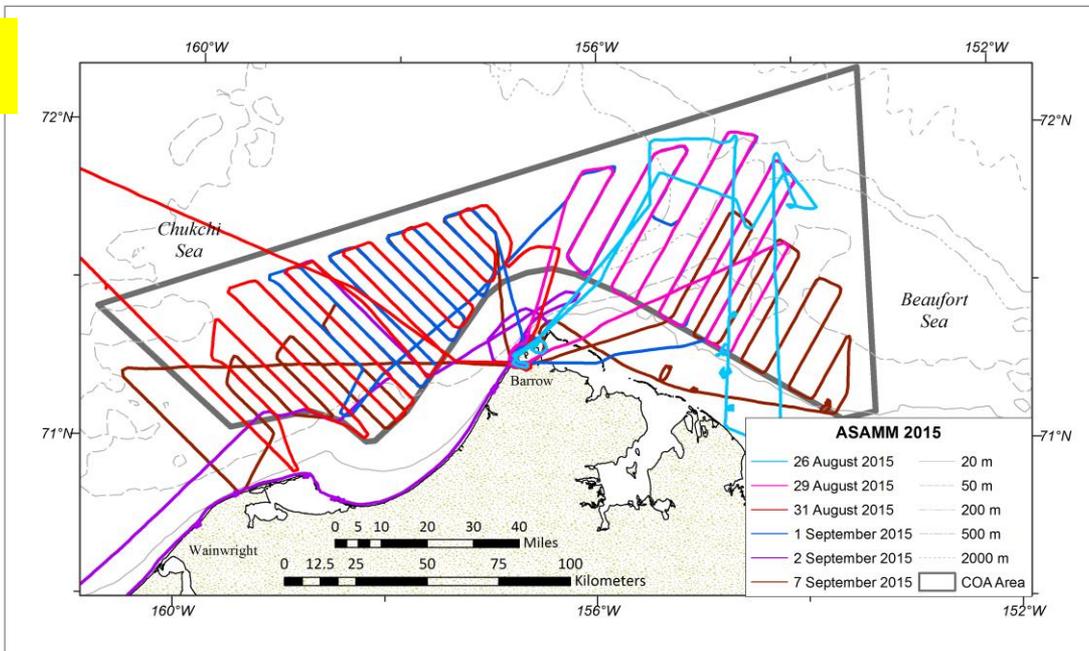


Other equipment: PEMDAS sensor, portable weather station, WebAdapt and Nowcasting

UAV flights



Manned flights





BOEM
Bureau of Ocean Energy Management



Attention North Slope Pilots: Unmanned Aircraft Activity in the Area

- UAS flight operations will be based out of Barrow and conducted during daylight hours between 0800 and 2200 local time. Flight ops will maintain VFR Class E weather minima (3 statute miles visibility, 500 ft. below, 1000 ft. above, and 2000 ft. horizontally from clouds).
- Up to two ScanEagle® UAS will be flying at a time. The ScanEagles® will be controlled by Ground Control Stations located at the Naval Arctic Research Lab (NARL) airstrip (5 statute miles NE of the Barrow airport) and aboard the NOAA RV Fairweather stationed offshore. The UAS will be flown beyond visual line-of-sight.
- The UAS will transit through corridors from shore to the research area, which is located greater than 12 nmi from the coast. Transit through the corridors will be at 400 ft MSL. Inside the study areas, the UAS will fly pre-determined linear transects at altitudes between 500-2000 ft MSL.
- The UAS pilots will communicate and coordinate with other airspace users and FSS personnel before and during field operations. A detailed communications plan is available online at <http://www.afsc.noaa.gov/nmml/cetacean/uas.php>.

Photographer: Amy Williams
NOAA/NMFS/AFSC/NMML
NOAA Permit No. 14245

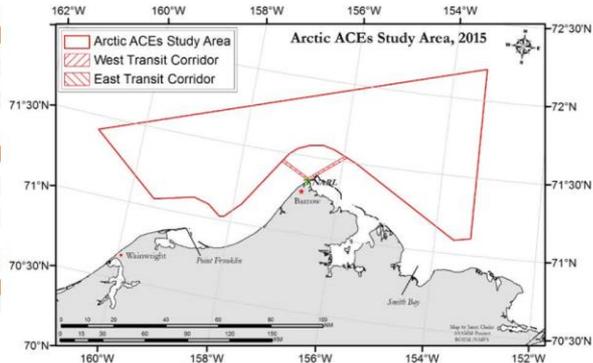
Photographer: Leah Crane
NOAA/NMFS/AFSC/NMML
NOAA Permit No. 14245



The Arctic Aerial Calibration Experiments (Arctic ACEs) project will be conducting an Unmanned Aerial survey and sharing the data within a 60 nmi radius offshore of Barrow, Alaska, from August 18th to 30th, 2015. Arctic ACEs was designed for two purposes: 1) to test meteorological sensors recording atmospheric conditions to improve prediction of air frame icing; and 2) to conduct a 3-way comparison of whale data collected via observers in a manned aircraft, digital photographs from a camera mounted to a manned aircraft, and digital photographs from a camera mounted to a ScanEagle® UAS. The project is a collaboration among the Bureau of Ocean Energy Management (BOEM), US Navy, National Oceanic and Atmospheric Administration (NOAA), and Shell.

Flight Area Positions

Research Area		West Transit Corridor		East Transit Corridor	
Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
71° 32.0 N	159° 32.2 W	71° 21.1 N	156° 30.7 W		
71° 24.7 N	160° 54.0 W	71° 26.4 N	157° 12.1 W		
72° 12.2 N	153° 18.4 W	71° 27.1 N	157° 10.5 W		
71° 6.5 N	153° 18.0 W	71° 21.7 N	156° 37.9 W		
71° 5.3 N	153° 37.4 W				
71° 30.1 N	155° 44.5 W				
71° 33.9 N	156° 12.2 W				
71° 35.0 N	156° 26.5 W	71° 21.0 N	156° 36.5 W		
71° 34.2 N	156° 41.3 W	71° 31.6 N	155° 55.7 W		
71° 32.4 N	156° 55.4 W	71° 32.0 N	155° 58.6 W		
71° 29.8 N	157° 4.9 W	71° 21.7 N	156° 37.9 W		
71° 20.1 N	157° 25.0 W				
71° 7.5 N	157° 50.2 W				
71° 1.6 N	158° 9.4 W				
71° 1.4 N	158° 13.4 W				
71° 5.2 N	158° 28.3 W				
71° 6.9 N	158° 46.4 W				
71° 6.9 N	158° 46.4 W				
71° 3.2 N	159° 32.2 W	71° 20.3 N	159° 58.2 W		



If you have any questions, comments, or concerns, please contact:

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Key Operational Results

- Successfully received all FAA, NMFS and NSB permits for the project
- Platforms conducted flights in approx. the same weather conditions and for approx. the same number of flight hours.
- Conducting UAS & manned flights safely in close proximity and at the same altitude becomes challenging even when technical and procedural methods for deconfliction are available.
- The Turbo Commander flew approximately twice as fast as the ScanEagle → larger area covered over a similar time period.
- Experienced positive interactions with Barrow community organizations and individuals

Manual image processing and analysis took 332.5 hours

- 6.9 hrs to process every 3rd image from one hour of flight time
- Total number of cetaceans in images: 37 sightings; 44 individuals

Flight data and numbers of cetaceans observed – all effort types

Flight data	Manned aircraft		UAS
Number of flights	5		5
Number of flight hours	26.7		21.8
Area (km ²) covered by	Humans: 11,221.6	Images: 1291.9	Images: 973.9

Total number of cetaceans observed using each method (fewer on transect)

Species	Observers in manned aircraft	Images from manned aircraft	Images from UAS
Bowhead whale	61	8	15
Beluga	54	16	6
Gray whale	9	0	3
Unidentified large whale	48*	0	0

*Only 1 unidentified cetacean observed close to transect line

Small sample size for UAS imagery

Calculated need of 50 flight hours with the UAS based on expected density of whales in area in previous years

Whale density may have been higher than expected due to well-studied oceanographic conditions that are known to concentrate prey and cetaceans

Flew the expected number of days, but not the expected number of hours per good flight day

Will we have sufficient observations in images to conduct statistically powerful comparisons? **TBD; methods for estimating variance are challenging and are being peer reviewed prior to release**

Initial Conclusions: Analysis

- The achieved image resolution (>10cm) was sufficient for distinguishing bowhead and gray whales at 1000 ft altitude, but better resolution is preferred for areas with higher species diversity or smaller target animals.
- Post-field season data processing is a significant challenge. Manual analysis of every image collected during one hour of flight time takes ~20 hours. **NOT VIABLE!** Automated solutions to reduce analytical time are being pursued.
- Human observers view more km² and saw more whales than were detected in either imagery dataset.

Comparison of Estimated Costs

	Land-based UAS Strip Transect (2015)	Manned Aircraft Line Transect (2015)	Shipboard UAS Strip Transect (Future)	Land-based UAS Strip Transect (Future)
Total Fieldwork & Planning Expenses	\$1280 K	\$200 K	\$1070 K	\$1240 K
Total In-kind Contributions	\$830 K		\$330 K	\$830 K
Total Post-fieldwork Expenses	\$230 K	\$10 K	\$230 K	\$230 K
Total Project Costs	\$2340 K	\$210 K	\$1630 K	\$2300 K

2015 UAS project expenditures were reduced by:

- In-kind contribution of 21 sea days aboard NOAA ship *Fairweather*
- In-kind contribution of NALO C130 flight from Dahlgren, VA, to Barrow, AK
- Base project in Barrow instead of Wainwright

Future similar UAS project expenditures can be reduced by:

- Base project entirely from a ship
- Load UAS equipment aboard a ship in a contiguous U.S. port (assuming NALO unavailable)
- Use UAS that does not require bulky launch and recovery equipment (if shore-based)
- Automating detection of whales in images

Next Steps

- First round of peer review of analytical methods under way
- Derive uncertainty estimates based on Fewster's (2011) triplet estimator
- Derive model-based estimates of density and associated uncertainty
- Present preliminary results to various groups (UAS workshop, AEWC, ABWC)
- Complete the review of additional images from the aircraft to improve sample size for comparing observer data to images from manned aircraft
- Confirm review of “every third” image is sufficient (i.e., no animals missed)
- Investigate automatic image analysis options (LGL, Navy)
- Draft reports to funding agencies
- Publications

- Funding was provided by Bureau of Ocean Energy Management Alaska Outer Continental Shelf Region, NOAA UAS Program, NOAA Office of Science and Technology, and Office of Naval Research Marine Mammals and Biology Program
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- In-kind support provided by Shell Oil
- Conducted in collaboration with the North Slope Borough Department of Wildlife Management
- Key participants: Phil Hall, Van Helker, Bob Lynch, Amy Willoughby, Van Helker, Amelia Brower, Janet Clarke, Todd Sformo, Christy Sims, Brenda Rone, Cynthia Christman, Corey Accardo, Jen Gatzke, Vicki Beaver, Suzie Hanlan, Lisa Barry, Marjorie Foster, Laura Ganley, Leah Crowe, Karen Vale, Heather Foley, and Jess Taylor

