

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

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\* Analytical lead

A close-up, low-angle shot of a propeller aircraft's engine and propeller, viewed from the side. The aircraft is flying over a vast, blue ocean under a sky filled with soft, white clouds. The propeller is in motion, creating a slight blur. The aircraft's fuselage is white with a red and yellow stripe.

## Uses of aerial surveys

- Assess marine mammal population distribution and abundance (routinely used for whales, some species of porpoise, some seals/sea lions)
- Investigate relationships between animals and their environment
- Monitor

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

## Concerns

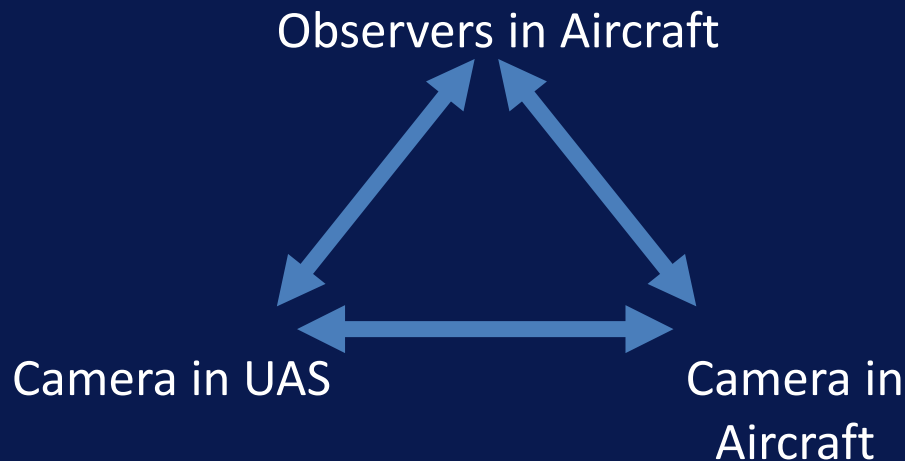
- Observer fatigue
- Safety in very remote areas
- Potential disturbance to wildlife

# Arctic Aerial Collaboration Experiment: Overarching Goal

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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)



# Funding agencies, collaborators, and in-kind contributions

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## Funding agencies:

Bureau of Ocean Energy Management  
Office of Naval Research  
UASPO

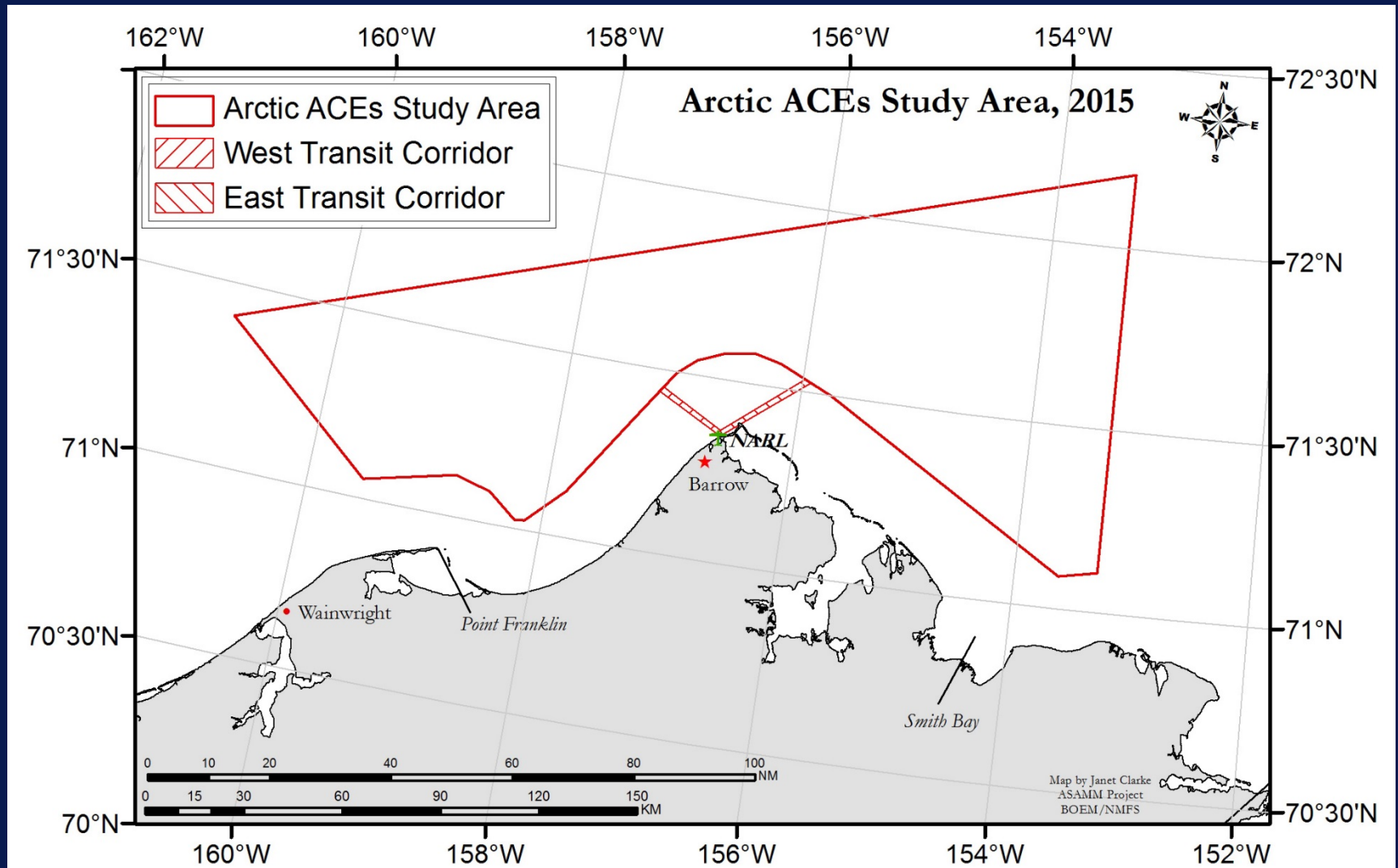
## Collaborators:

Shell Oil  
North Slope Borough  
LGL, Inc

## In-kind support:

Project management, field preparation, access to airspace, community outreach (before and after project), marine mammal permitting, land use permitting, analysis, publications  
NOAA R/V Fairweather ship time  
C130 transportation

# Study Area – North of Barrow, Alaska

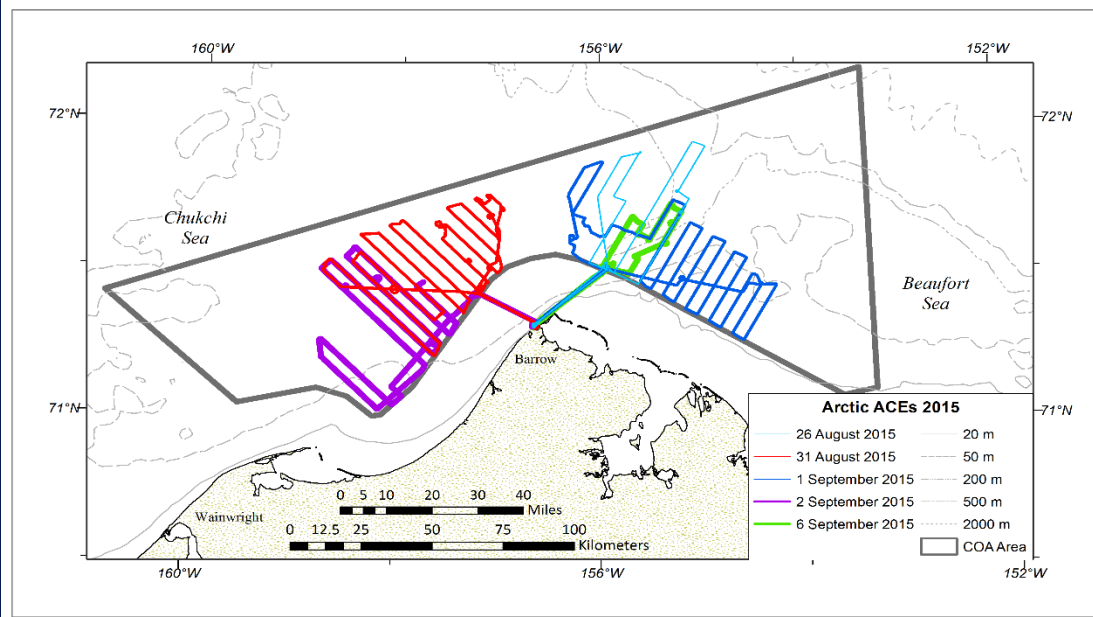


# Unmanned Aerial System: Insitu ScanEagle®

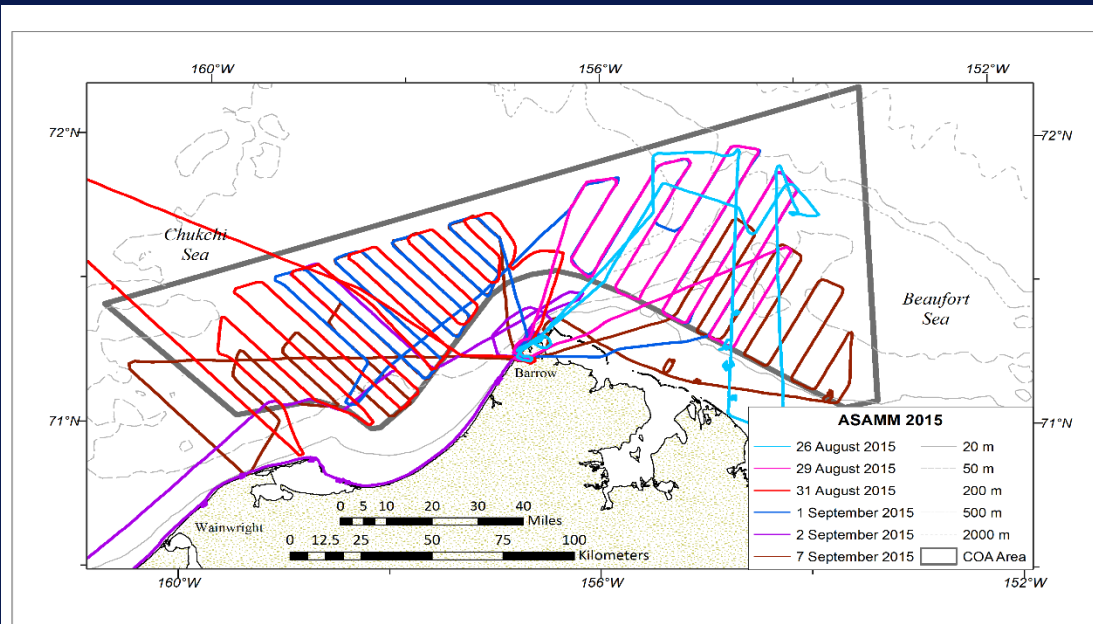


Other equipment: PEMDAS sensor, portable weather station, WebAdapt and Nowcasting, access to FAA system

# UAV flights



# Manned flights



# Key operational accomplishments

- Successfully received all FAA, NMFS and NSB permits for the project.
- Conducted routine beyond line-of-sight flights with a UAS.
- 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.
- Experienced positive interactions with Barrow community organizations and individuals
- Many lessons learned regarding operations in the Arctic
- Angliss et al 2016. Operating UAS in the Arctic: Comparing manned and unmanned surveys of cetaceans. Poster presented at the Alaska Marine Science Symposium, Jan 2016.
- Angliss et al 2016. <https://www.onr.navy.mil/reports/FY15/mbanglis.pdf>

## 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 0900 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 ScanEagle® 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/mmml/ocean/uas.php>.

Photograph: 4-10-16, NOAA Fairweather, NOAA Permit No. 10595



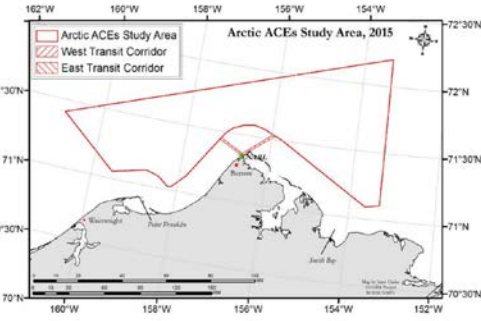
Photograph: 1-16-16, NOAA Fairweather, NOAA Permit No. 10595



The Arctic Aerial Calibration Experiments (Arctic ACEs) project will be conducting an Unmanned Aircraft survey and observing operations within a 60 nmi radius offshore of Barrow, Alaska, from August 15th to 30th, 2015. Arctic ACEs was designed for two purposes: (1) to test meteorological sensors recording atmospheric conditions to improve prediction of air temperature and ID to conduct a direct comparison of air temperature 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 others.

### Flight Area Positions

Research Area	West Transit Corridor		East Transit Corridor	
Latitude	Longitude	Latitude	Longitude	
71°3'2"N	150°32'2"W	71°21'1"N	150°39'7"W	
71°24'7"N	150°54'0"W	71°28'4"N	150°32'1"W	
71°12'2"N	150°12'4"W	71°27'1"N	150°33'8"W	
71°4'5"N	150°15'0"W	71°23'7"N	150°37'3"W	
71°5'9"N	150°30'4"W			
71°25'1"N	150°44'5"W			
71°30'8"N	150°12'2"W			
71°25'0"N	150°28'5"W	71°21'0"N	150°36'5"W	
71°34'2"N	150°43'3"W	71°31'6"N	150°35'7"W	
71°32'4"N	150°55'4"W	71°30'0"N	150°38'6"W	
71°28'8"N	150°3'9"W	71°21'7"N	150°37'3"W	
71°21'1"N	150°25'0"W			
71°7'5"N	150°50'2"W			
71°1'8"N	150°4'4"W			
71°1'4"N	150°13'4"W			
71°5'2"N	150°28'3"W			
71°6'9"N	150°48'4"W			
71°6'9"N	150°48'4"W			
71°3'2"N	150°32'2"W			



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

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## Manual image processing and analysis took 332.5 hours

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

# Flight data and numbers of cetaceans observed on transect

Flight data	Manned aircraft		UAS
Number of flights	5		5
Number of flight hours	26.7		21.8
Area (km <sup>2</sup> ) covered by	Humans: 11,221.6	Images: 999.2	Images: 756.9

## Total number of cetaceans observed on transect using each method

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

# Preliminary Analytical Results

	East survey area				West survey area			
	Images		Humans		Images		Humans	
	UAS	Cmdr	Historical* ESW	ACEs ESW	UAS	Cmdr	Historical * ESW	ACEs ESW
<b><u>Bowhead whales</u></b>								
# whales detected	6	4	12	12	3	2	9	9
Area covered (km <sup>2</sup> )	448.5	645.9	5231.8	3257.7	525.4	646.0	5989.8	3729.7
Est. total # whales	69	32	36	51	35	29	27	40
CV (whales)	.53	.45	.34	.41	.77	.71	.46	.51

\*Historical ESW was based on data from 2009-2015. ACEs ESW was limited to data from ACEs flights.

Cost of manned aerial line transect survey + analysis: \$208K

Cost of UAS strip survey + analysis: \$2,221K

# Key scientific and technical challenges

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- Lower sample size than expected.
  - Flew the expected number of days, but not the expected number of hours per good flight day → variance in abundance is higher than we expected
  - Variance goal would have been met if we had ~2x the flight hours on the UAS
- The achieved image resolution (>10cm) was sufficient for this project, but better resolution is preferred for areas with higher species diversity or smaller target animals.
- 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.**

# Summary of key science accomplishments

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## **Accomplished to date:**

- Manual processing of ~77,000 images
- Able to estimate whale density using data from UAS for comparison to density estimated using line transect and strip transect methods from manned aircraft. (note higher CVs)
- Compared cost of ScanEagle to manned operations and identified many options for reducing expenses
- Ferguson et al. 2017. Comparing estimates of Arctic cetacean density derived from manned and unmanned aerial surveys. Poster presented at the Alaska Marine Science Symposium, Jan 2017.

## **Planned for completion by mid-FY18:**

- Publication comparing density estimates from evaluated platforms
- Evaluation of software for automated image analysis

# Technology Readiness Level

Project feature	Initial TRL	Final TRL	Comments
ScanEagle platform; launch/retrieval equipment	9	9	ScanEagle chosen deliberately because of it's long history of successful use
ScanEagle ops in Arctic	7	8	SE is a sophisticated system that was tested in the Arctic
Camera mount	4	6	Mounts worked in VA; failed in AK, possibly due to temperature
Camera system	9	9	Camera system was proven and worked well
Review of imagery data	2	6	Understanding of image analysis, data management, greatly improved
Use of imagery data to assess whale density	2	5	Preliminary density estimates available for the limited area; new analytical procedures developed. Manuscript in prep.
Automated image processing	2?	TBD	Ongoing
PEMDAS sensor	?	?	?
NOWCAST	?	?	?

- 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
- UAS support provided by Naval Surface Warfare Center Dahlgren Division
- 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

