NOAA FISHERIES

AFSC

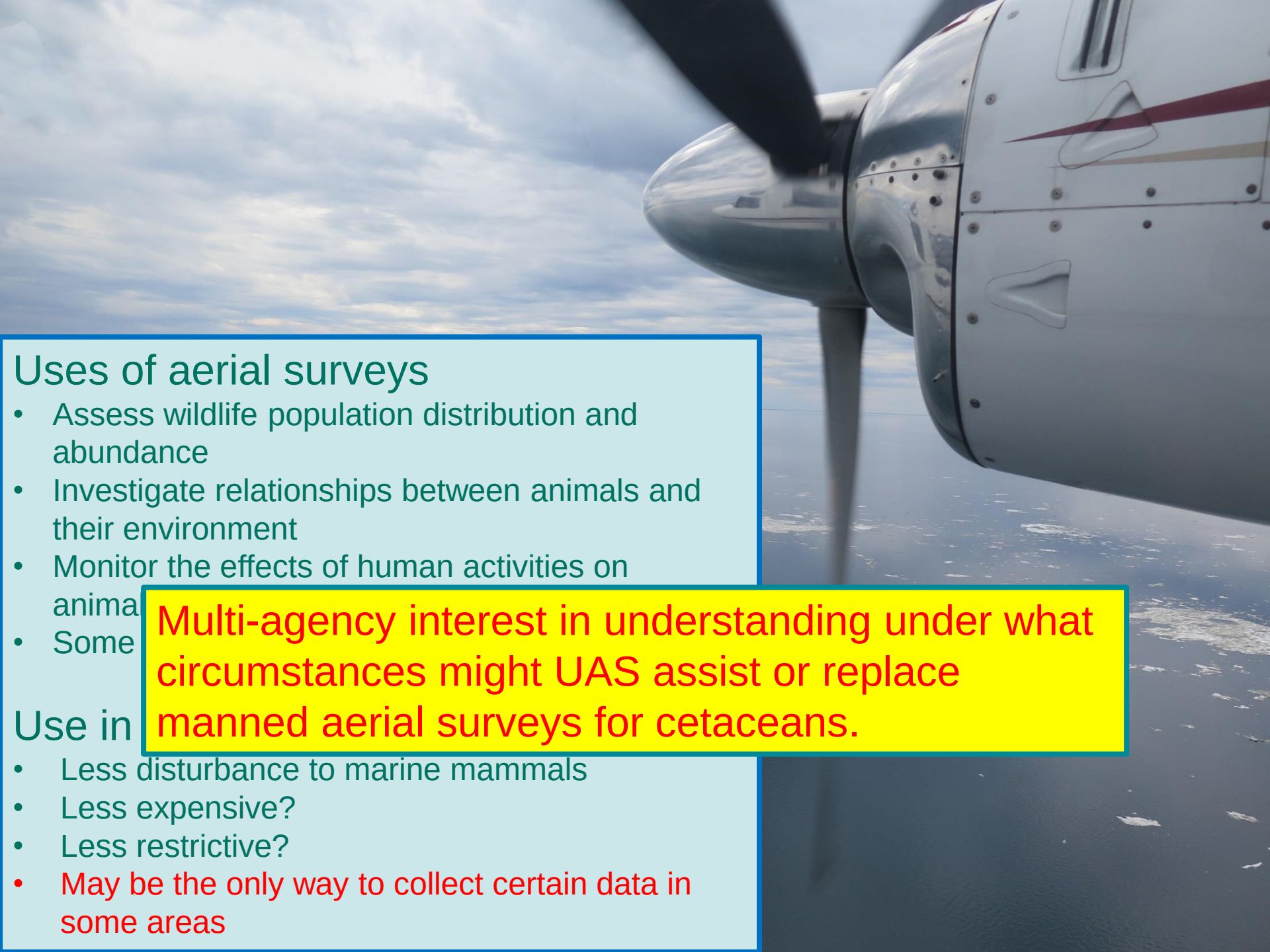
Marine Mammal Laboratory

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

Robyn Angliss, Megan Ferguson* & Amy Kennedy

* 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 anima
- Some

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

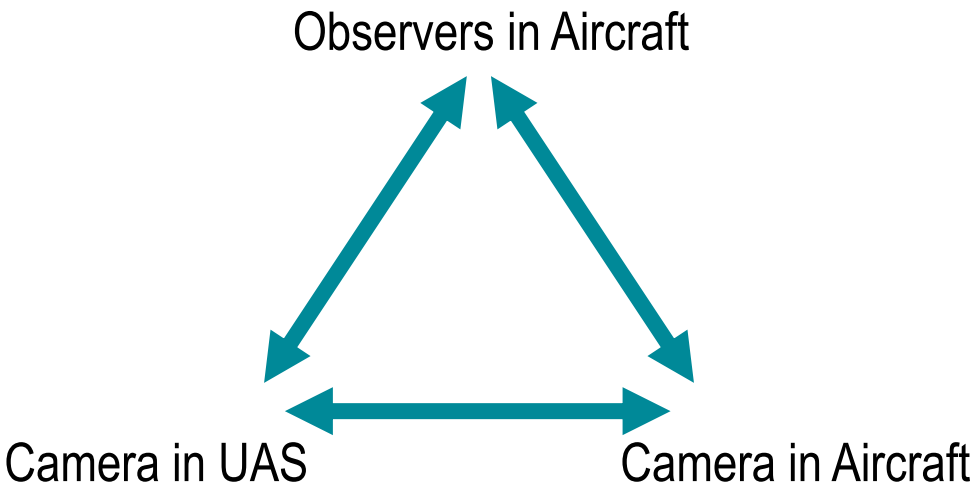
Use in

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

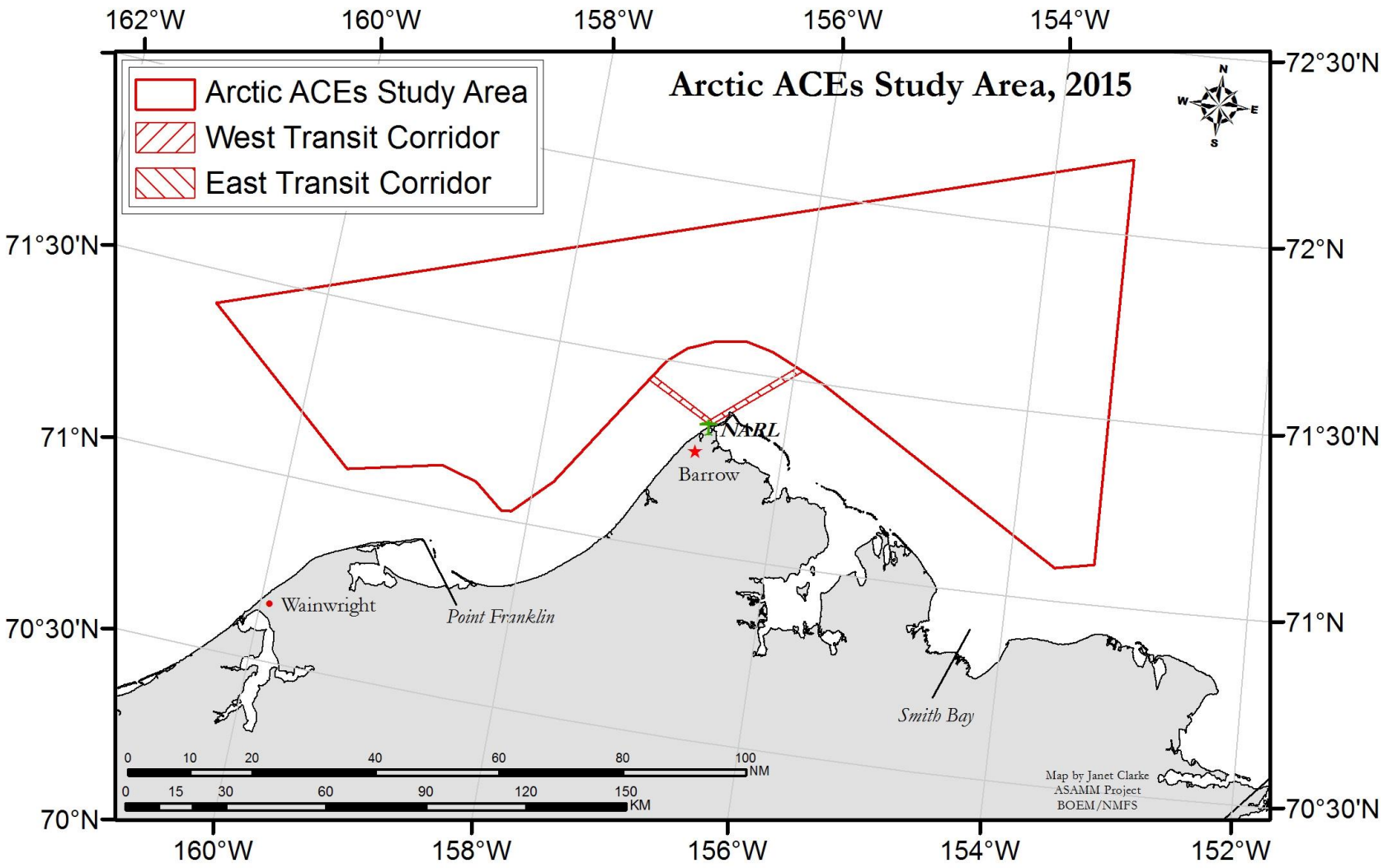
Arctic Aerial Collaboration Experiment: Overarching Goal

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

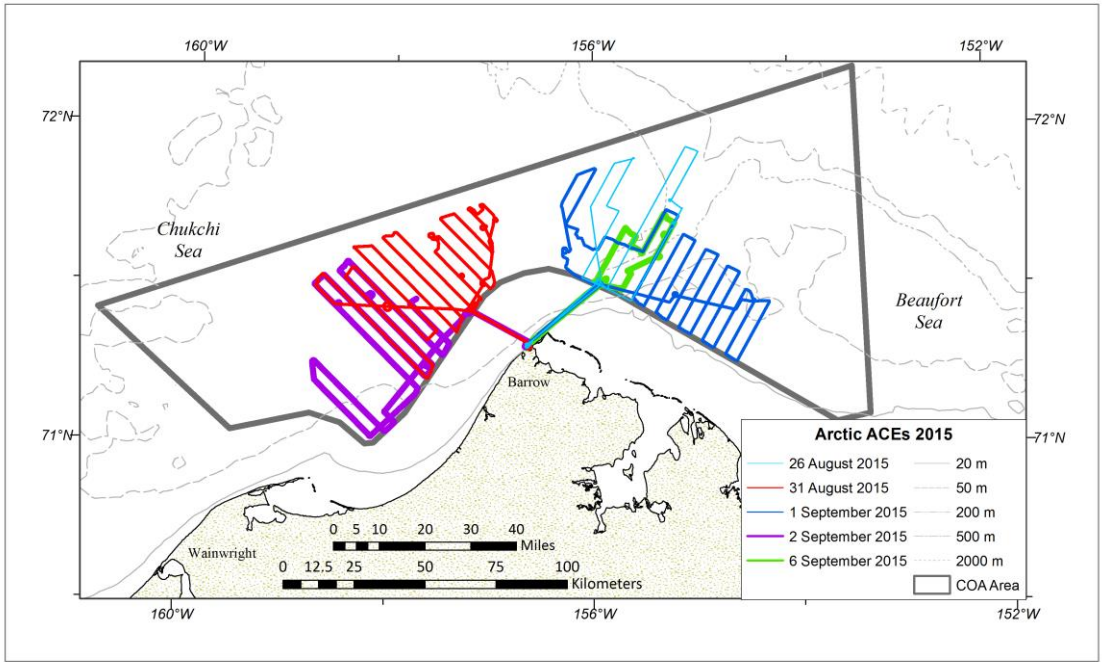


NOAA FISHERIES

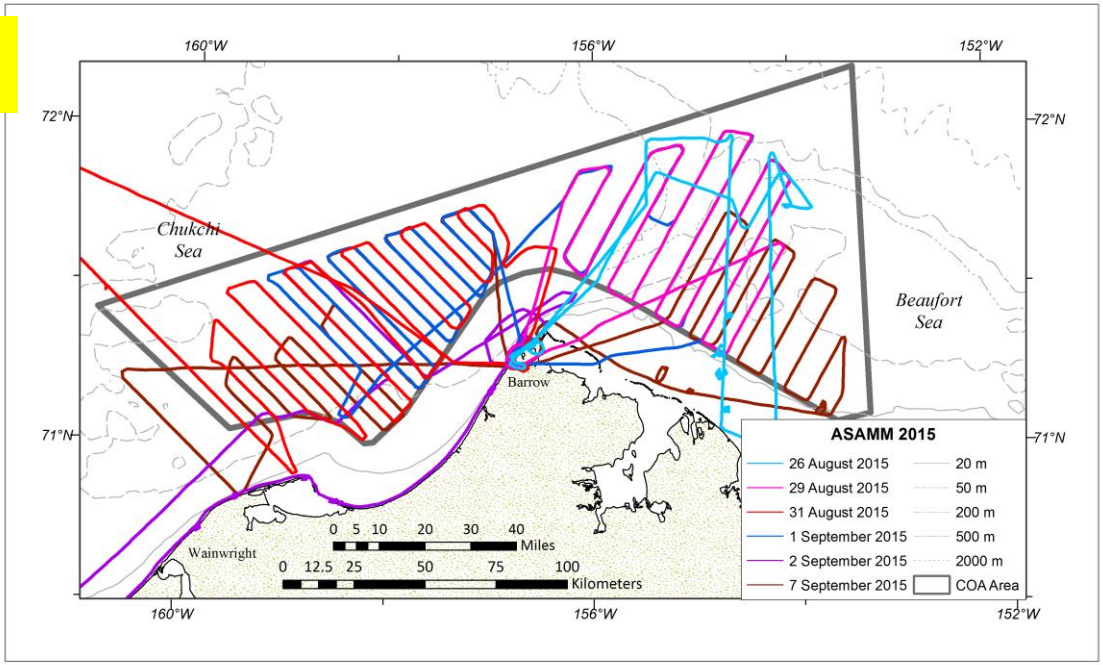
Unmanned Aerial System: Insitu ScanEagle®

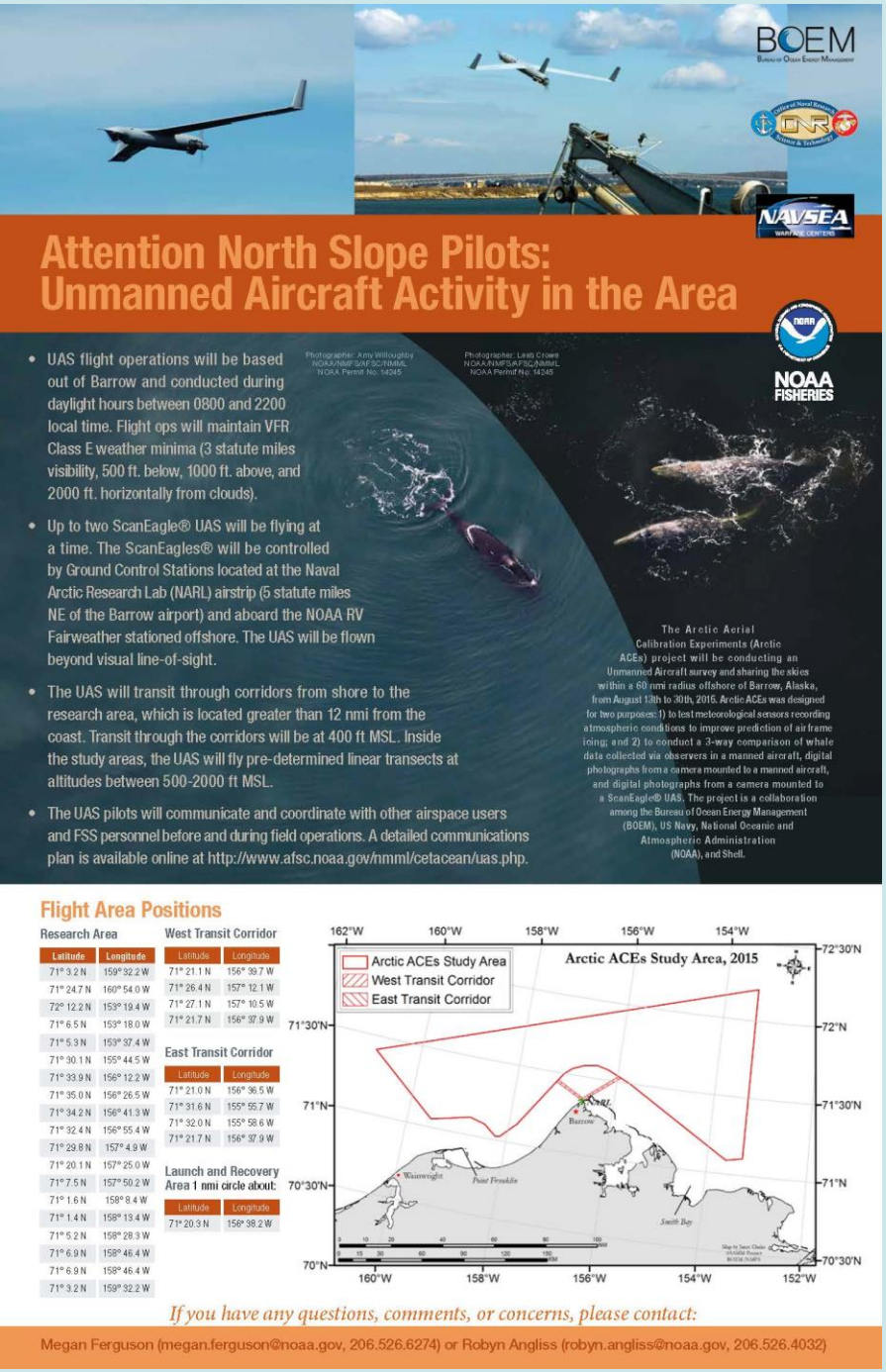
Other equipment: PEMDAS sensor, portable weather station, WebAdapt and Nowcasting

UAV flights



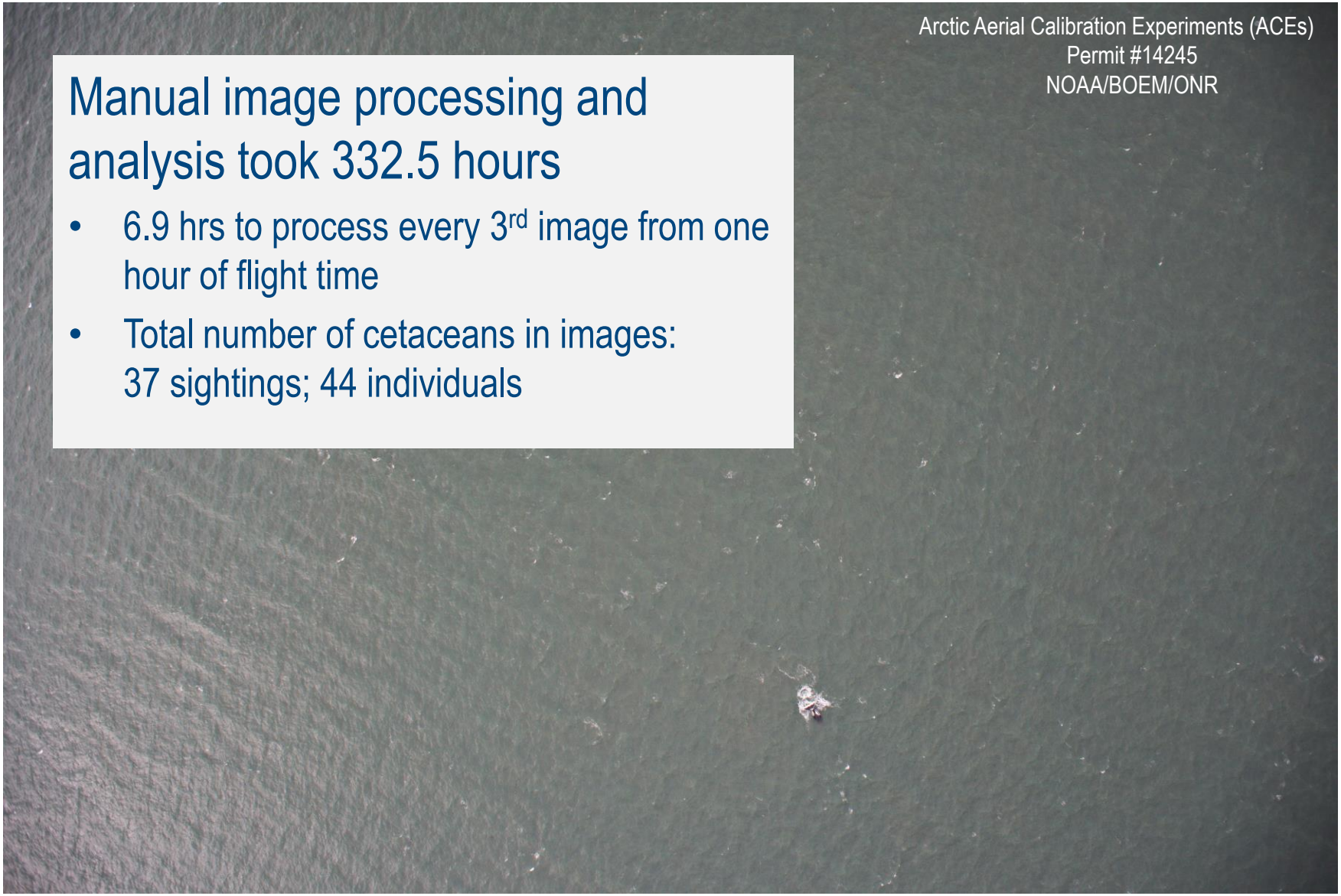
Manned flights





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 deconflication 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 km^2 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) striplet 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

- 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

Corey Accardo
NOAA/NMFS/AFSC/MML
Funded by BOEM, (IA Contract No. M16PG00013)