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

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* Analytical lead

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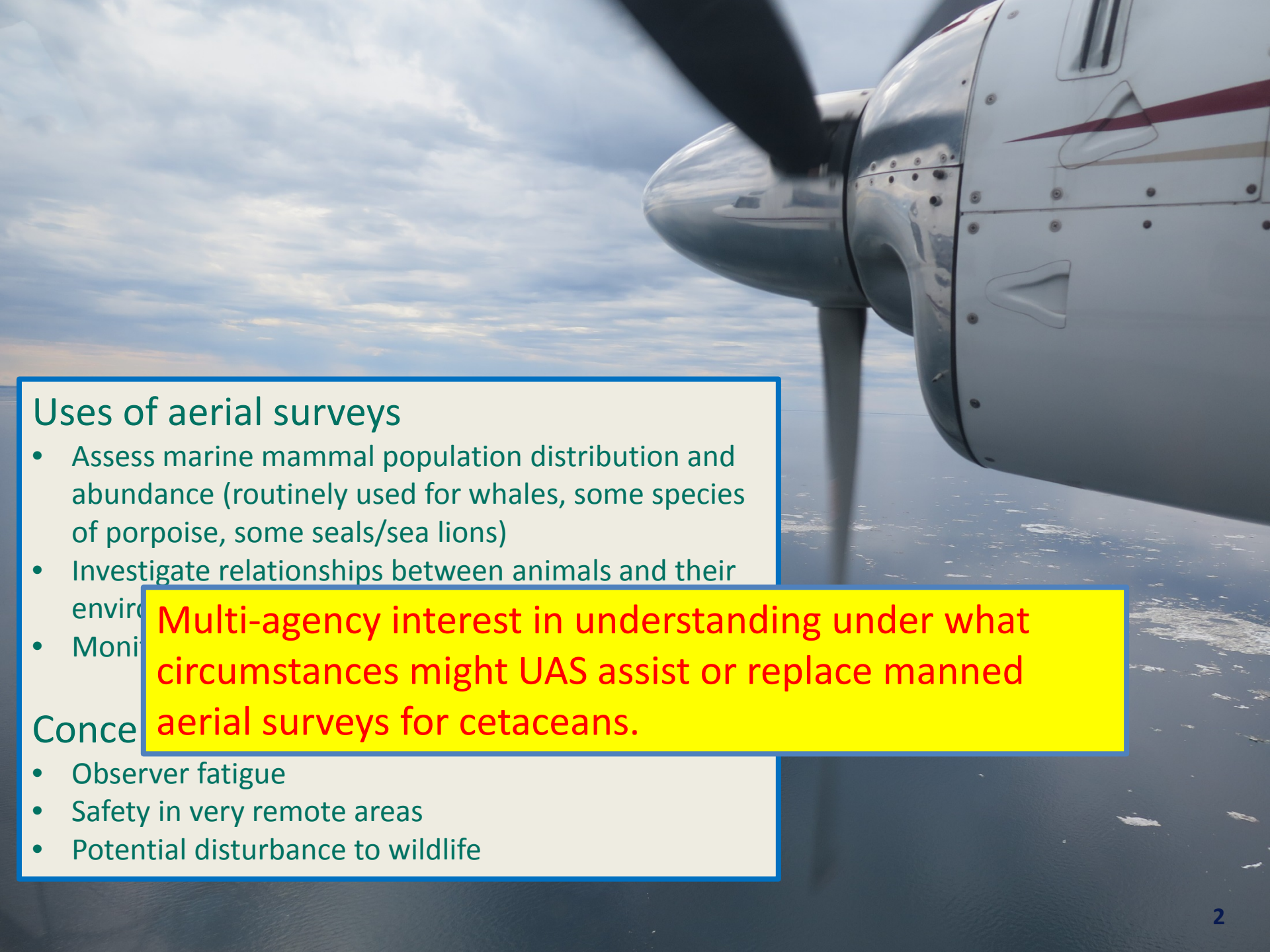


Uses of aerial surveys

- 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 envir
- Moni

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

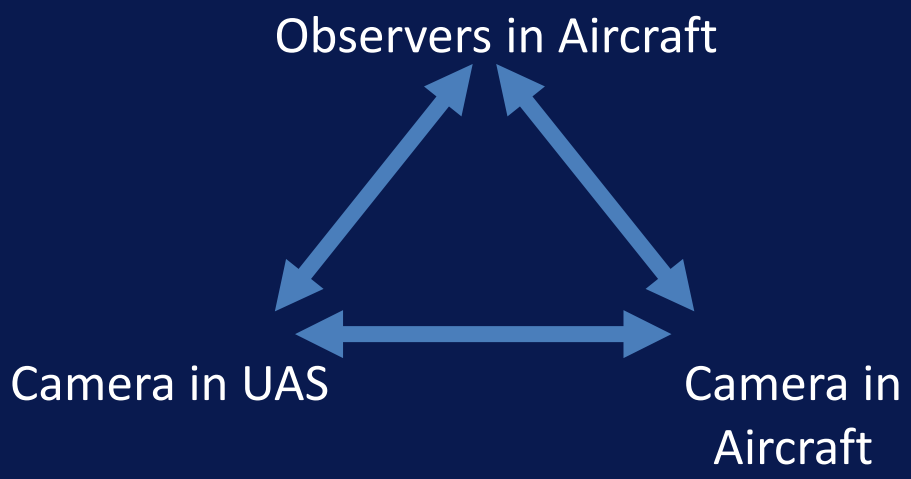
Conce

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

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)



Funding agencies, collaborators, and in-kind contributions

Funding agencies:

Bureau of Ocean Energy Management

Office of Naval Research

UASPO

Collaborators:

Shell Oil

North Slope Borough

LGL, Inc

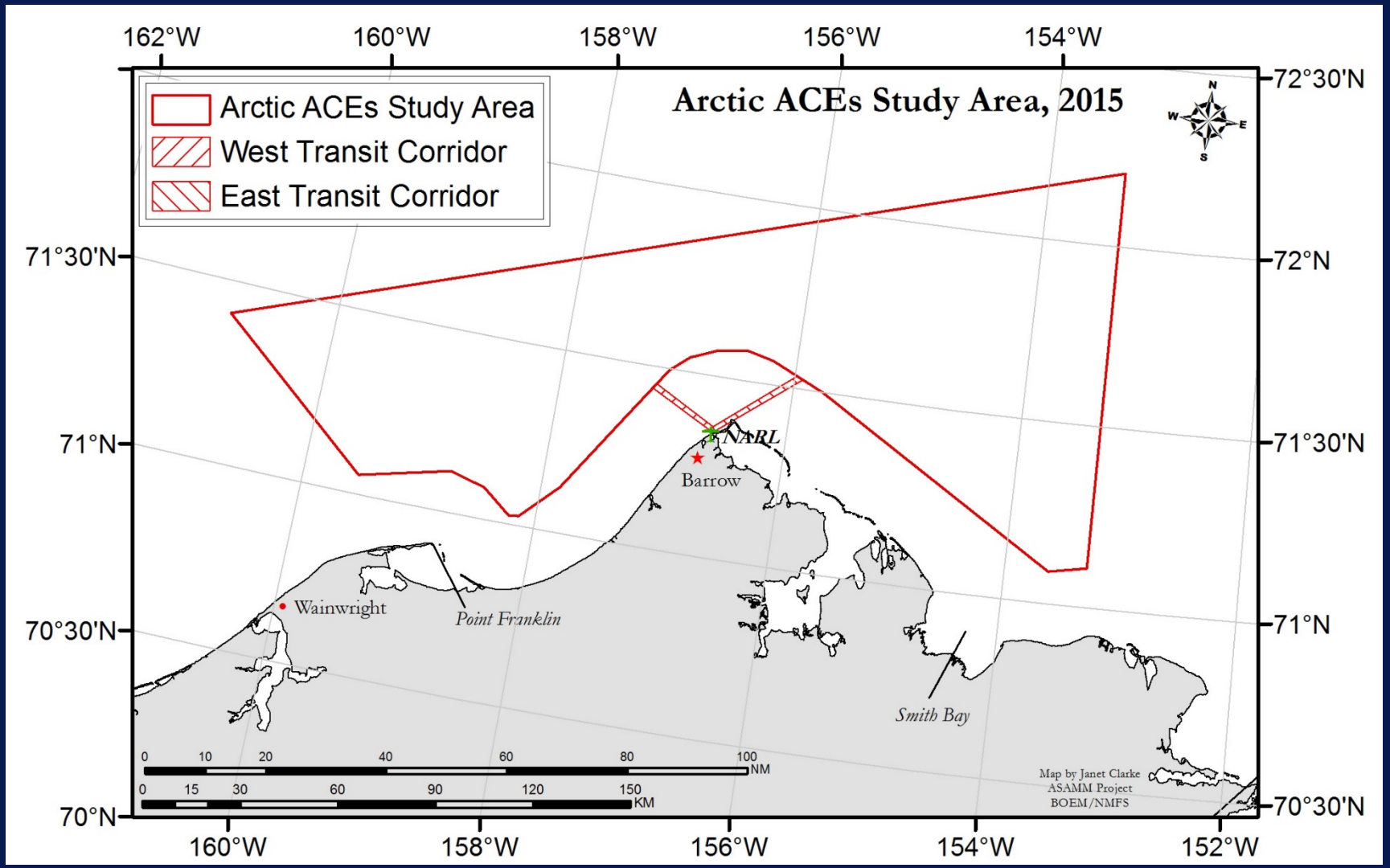
In-kind support:

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

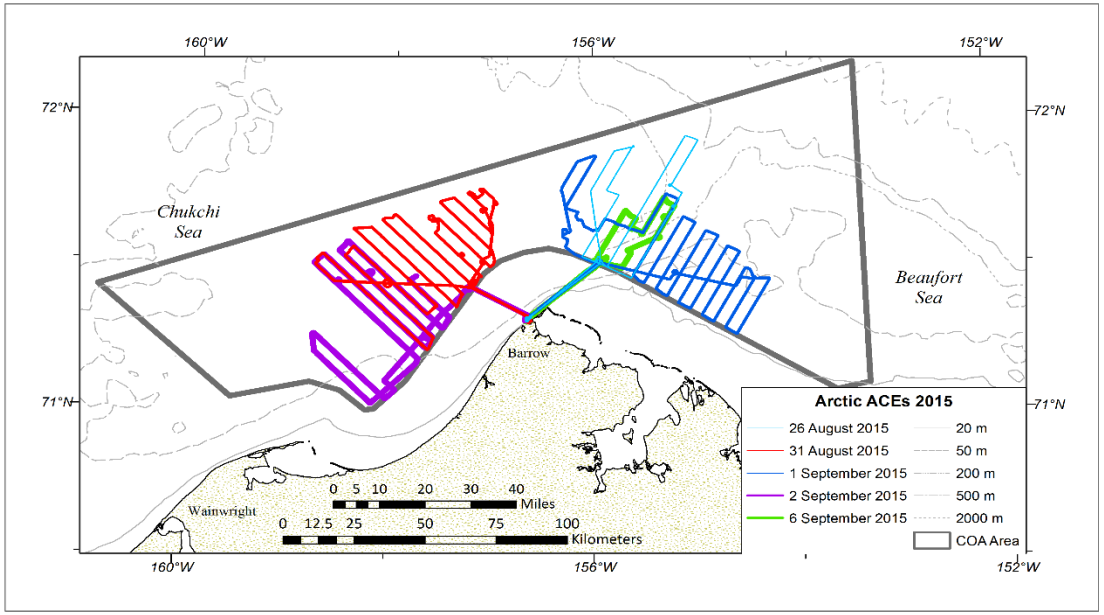
Study Area – North of Barrow, Alaska



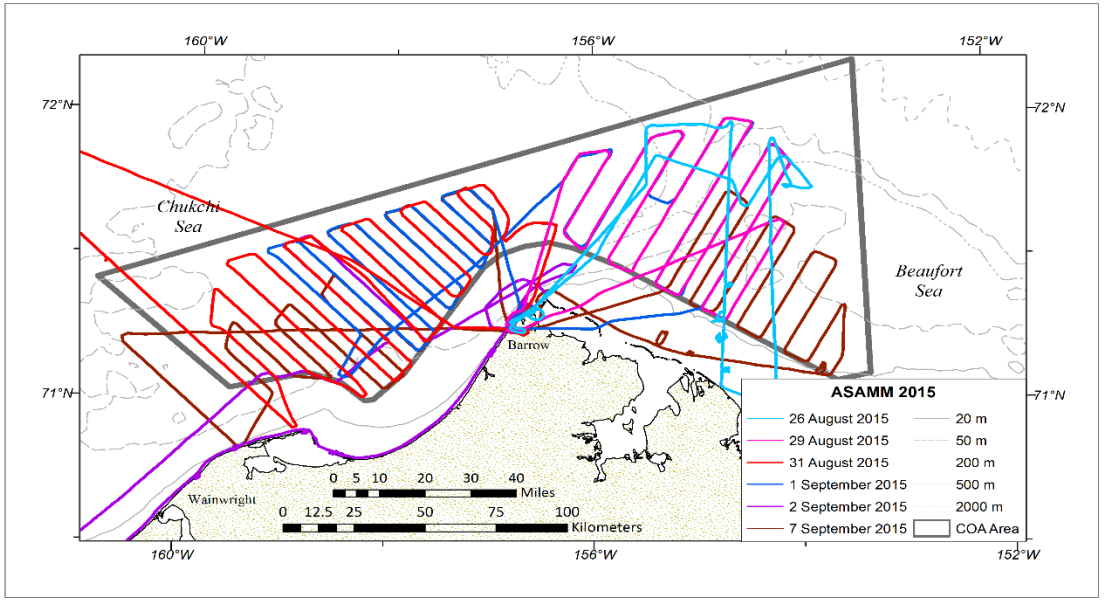
Unmanned Aerial System: Insitu ScanEagle®

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

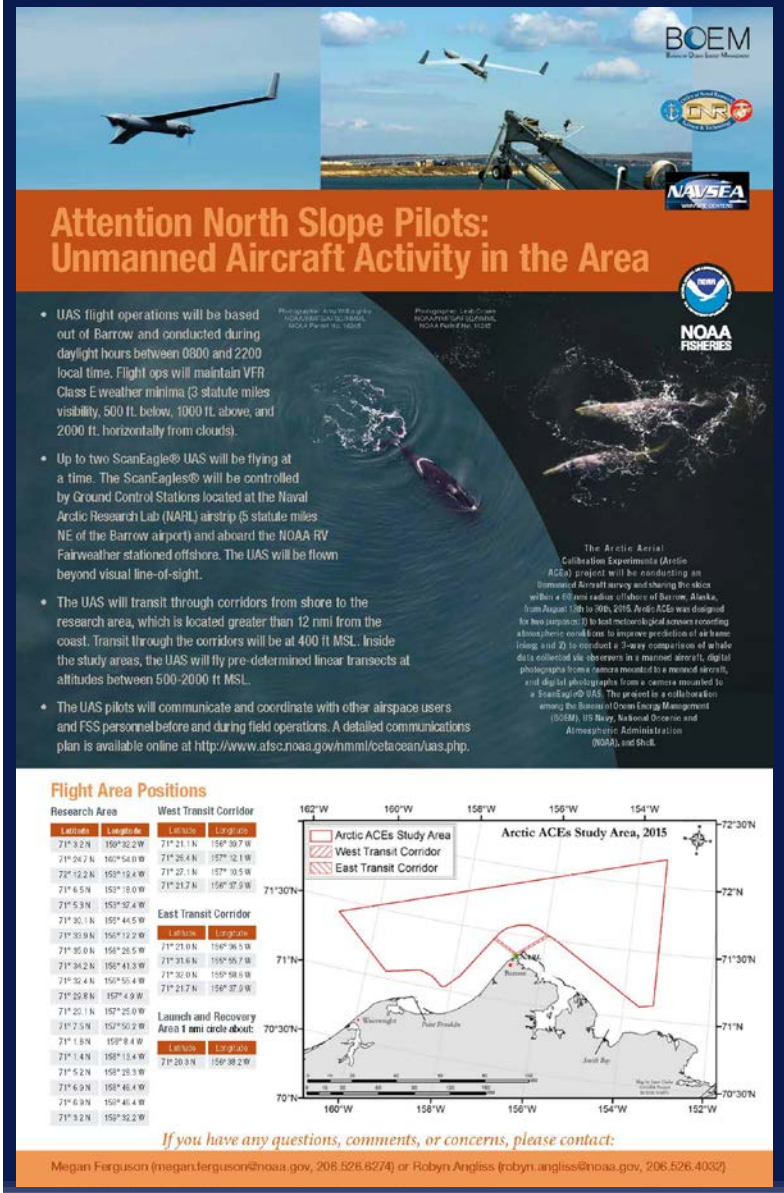
UAV flights



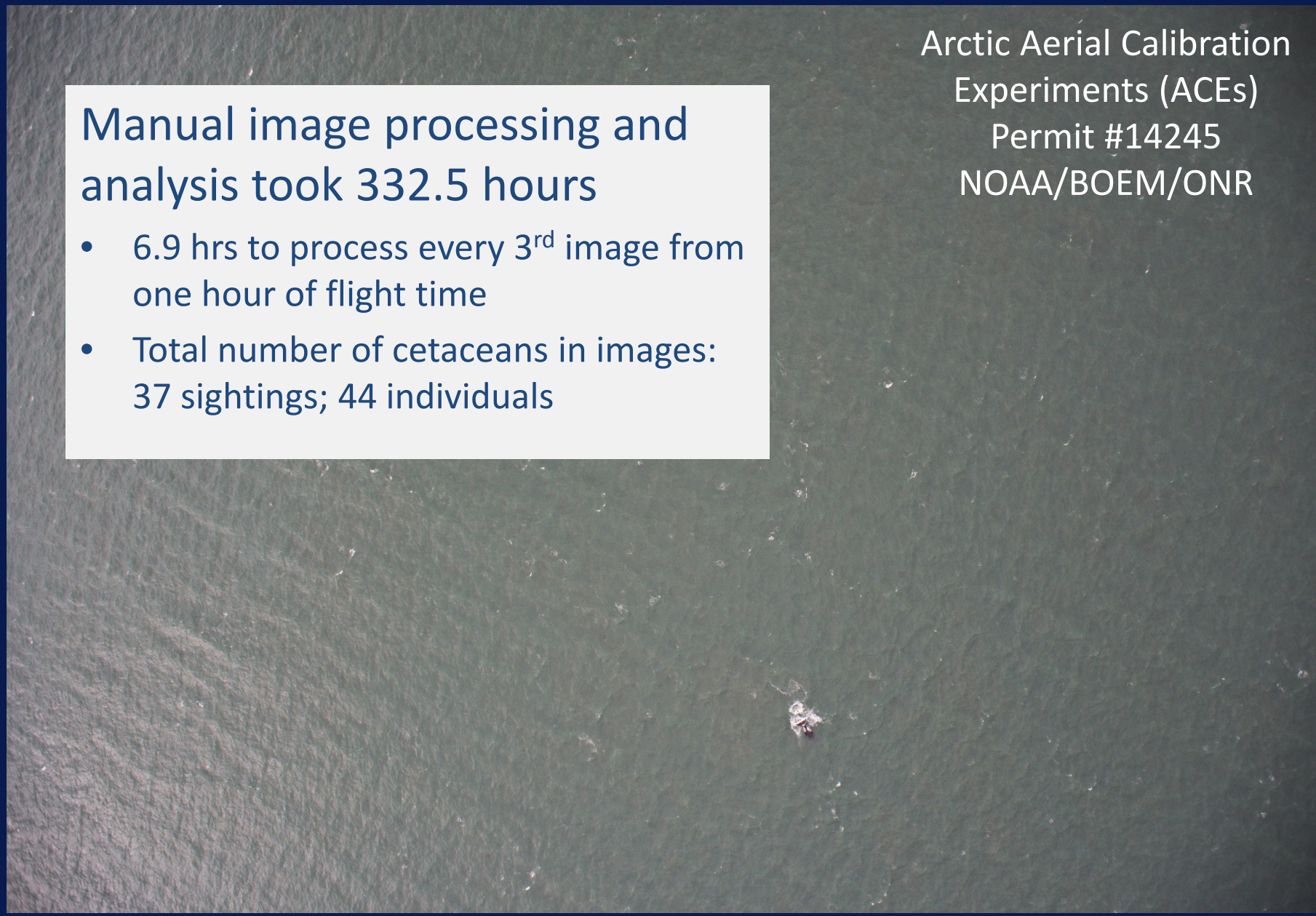
Manned flights



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



Arctic Aerial Calibration Experiments (ACEs)
Permit #14245
NOAA/BOEM/ONR

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 on transect

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: 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
Bowhead whales								
# whales detected	6	4	12	12	3	2	9	9
Area covered (km^2)	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

- 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

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	?	?	?

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- 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

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