Operating UAS in the Arctic: Comparing Manned and Unmanned Surveys of Cetaceans

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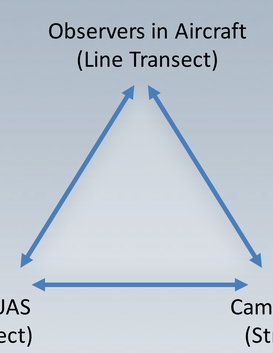
Abstract

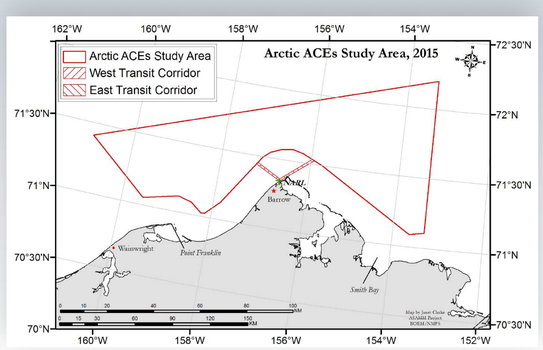
Manned aerial surveys are routinely used to collect data to infer cetacean distribution and density. Unmanned aerial systems (UAS) have been identified as a technology that could augment or replace manned aerial surveys for cetaceans. To understand what research questions can be addressed using current technology, a direct comparison of data collected by manned and UAS surveys are necessary. NOAA Fisheries' Alaska Fisheries Science Center led a collaborative effort that included the Bureau of Ocean Energy Management, US Navy, and Shell to conduct manned and unmanned aerial surveys for cetaceans near Barrow, Alaska. Field operations occurred from August 21 to September 7, 2015, using a twin engine Turbo Commander operated by Clearwater Air, Inc. and a ScanEagle® UAS operated by the Naval Surface Warfare Center Dahlgren Division. The ScanEagle® was operated under a Certificate of Authorization from the Federal Aviation Administration (FAA) that allowed beyond visual line-of-sight flights. The study design involved a three-way comparison among data collected by observers aboard the Turbo Commander, imagery collected by a Nikon D810 camera system on the Turbo Commander, and imagery collected by a similar camera system on the ScanEagle®. The platforms each conducted 5 flights. Weather varied dramatically over small spatiotemporal scales, limiting flights by both platforms. Harsh environmental conditions increased the maintenance required for ScanEagle® operations. Technology that directly contributed to the ability to conduct UAS flights in the study area included: software that provided a direct link to the FAA's radar system, which enabled de-confliction with local aircraft; temperature and humidity sensors on the ScanEagle®; software that provided near-term forecasts of cloud cover and precipitation; and a portable weather station. Recommended changes for conducting long-range UAS surveys in the Arctic are discussed. To determine whether a particular UAS is an appropriate tool to meet a specific scientific objective, it will be critical to understand the logistic requirements, cost, and whether the expected data will adequately address the research question.

Overarching goal

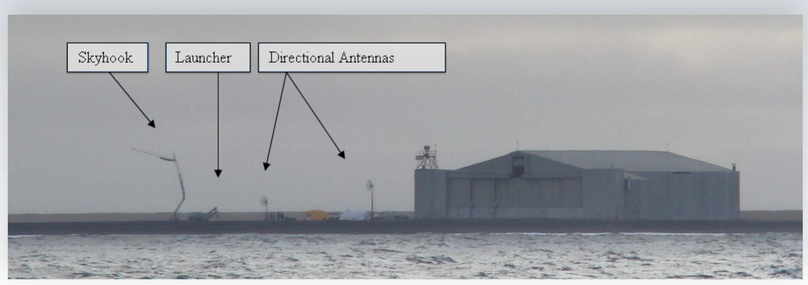
Conduct a 3-way comparison of data and derived statistics from the following:

- 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).





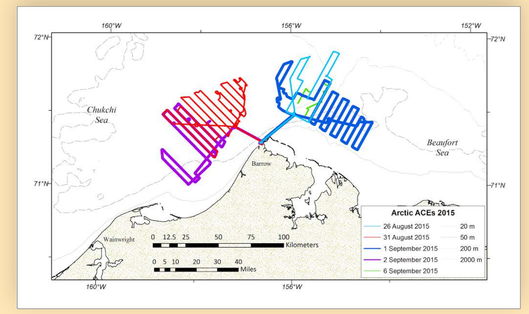
May delete this & just add a few more pics – can see the flight area
From the plots of the tracklines.



Methods

Field preparations, January – August 2015

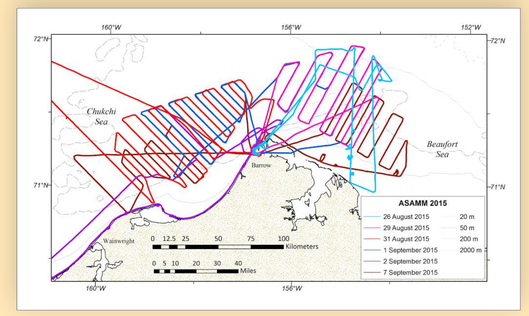
- Partnered with UAS team at the Naval Surface Warfare Center Dahlgren Division
- Conducted outreach to communities, organizations, and local pilots
- Applied for appropriate permits issued under the Marine Mammal Protection Act, applied for a Certificate of Authorization from the FAA, and a land use permit from the North Slope Borough
- Tested camera system; flew calibration target



Flights of the UAV during the ACEs project.

Field work, August 21 – September 7, 2015

- Conducted flights using a ScanEagle® and collected images using a Nikon D810
- Conducted traditional manned aerial survey flights using an Turbo Commander and a team of expert marine mammal observers
- Collected imagery from a Nikon D810 in the AeroCommander for comparison with imagery collected from the UAS



Flights of the manned aerial survey during the ACEs project.

Next steps

- Image review began in October 2015
- Estimate and compare species density using data from observers, imagery data from the UAV, and imagery data from the manned aircraft
- Evaluate at least one automated image analysis system to reduce image review workload for future projects
- Evaluate key metrics, such as:
  - Ability to identify species
  - Ability to identify cow/calf pairs
  - Ability to estimate group size
  - Cost comparison

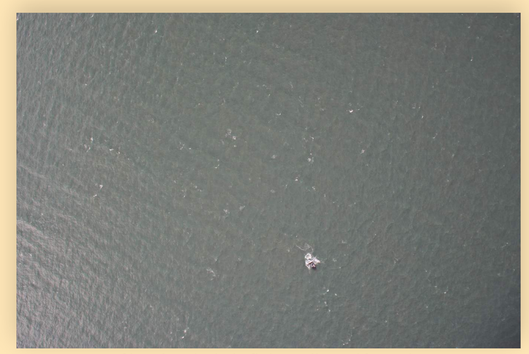


Image of bowhead whale fluke, collected from the UAV at approximately 303m (1000ft). NMFS permit 14245.

Results

Key results of the field effort:

- Conducted routine, successful, beyond visual line-of-sight surveys.
- No lost aircraft; no lost communications.
- UAV and manned aircraft limited by weather on the same days.
- UAV successfully operated in carburetor icing conditions.
- Developed multiple recommendations for improving successful coordination of manned and UAV flights occurring at close proximity in time and space, and at the same altitude.
- Successfully integrated the project into a North Slope Borough village.

Operational features that directly enhanced data collection, safety, or both:

- Remote internet access.
- Sensor that detects temperature and humidity and plots it in a user-friendly way for use by UAV pilot.
- Access to air traffic awareness tool.
- On-site portable weather station.

Operational changes that would have resulted in collecting more images:

- Operate off a vessel.
- Ensure equipment kept in a temperature-controlled area.

Data collected using the UAS and the manned aircraft.

	UAS flight		Manned flight		
Date	Flight Hours	# of Images	Flight Hours	# of Images	Comments
26 Aug	3.7	3,407	3.2	6,341	Successful hand-off of UAS from shore-based to ship-based team.
29 Aug	-	-	3.2	6,100	
30 Aug	-	-	3.0	5.940	Manned flights attempted 2x but aborted due to low ceilings and poor observing conditions.
31 Aug	6	6,818	5.0	9,277	Camera mount damaged on retrieval.
1 Sept	5.5	6,246	4.8	5,330	
2 Sept	5	6,176	4.5	8,494	Most manned aircraft flight time outside of survey area due to poor conditions.
6 Sept	1.6	1,952	-	-	Manned aircraft conducted reconnaissance to assess conditions for UAV flights; retrieval of the UAS broke the boom on the skyhook.
7 Sept	-	-	6.2	11,624	UAS team returned to Dahlgren & Seattle; manned survey team completed all transects in the study area.
Total	21.8	24,599	29.9	53,106	

Initial Conclusions

- The ScanEagle® and Turbo Commander platforms were able to conduct flights in approximately the same arctic weather conditions, and for approximately the same number of flight hours.
- The physical footprint and personnel needs of the ScanEagle® UAS require substantial advance planning; transportation of equipment may be cost-prohibitive for many projects.
- Conducting UAS and manned aerial flights safely in close proximity and at the same altitude is challenging even when technological and procedural methods for deconfliction are available.
- Post-field season data processing is a significant challenge. Based on initial reviews, manual analysis of images for one hour of flight time takes 40 hours to review for cetaceans. Automated solutions to reduce analytical time are being pursued.
- An image resolution > 10 cm is 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.

Acknowledgments

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The recommendations and general content presented in this poster do not necessarily represent the views or official position of the Department of Commerce, the National Oceanic and Atmospheric Administration, or the National Marine Fisheries Service.