Assessing an Unmanned Aircraft Vehicle as a Tool for Researching Sub-Arctic Ecosystems

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Introduction

In the sub-Arctic ecosystem of the Cape Churchill Peninsula, growing lesser snow goose (*Anser caerulescens caerulescens*) populations are having detrimental impacts on their ecosystem through increased grazing pressures. Unmanned aircraft vehicles (UAVs) may offer a solution to data collection needs in remote regions, and are thought to be a less invasive method than traditional survey techniques (e.g., ground-based surveys, manned aircraft flights, etc.). As use of these tools increases, there remains a growing need to evaluate any behavioural impacts introduced by UAVs. Further, comparisons between ground-based and UAV data collection are required to estimate accuracy and sources of error in UAV based research to establish best practices and survey protocols.

The objectives of this research are to:

1) **Quantify the behavioural response of nesting lesser snow geese to UAV surveys.**
2) **Estimate the impact of hyper-abundant geese on vegetation communities by use of UAV imagery.**

Methods

- Conducted UAV surveys along Cape Churchill Peninsula, within Wapusk National Park, Manitoba, Canada.
- Flew a fixed-wing Trimble UX5 (Fig. 1).
- Camera: Sony NEX-5R 16.1 MP camera (RGB imagery).

Fig. 1: Trimble UX5 (colour: black, wingspan: 100cm, weight: 2.5kg, speed: 80km/h).

Evaluating Snow Goose Behavioural Responses

- 25 Snow goose nests were monitored using video nest cameras to evaluate the amount of time birds spent on behaviours (Fig. 3: Resting, Nest Maintenance, Low Scan, High Scan, Head-Cock, and Off Nest).
- Groups of nests were flown at 75, 100 and 120m above ground level (AGL), and another group was not flown over (control).
- Constructed generalized linear mixed models and ranked models using AICc:
    1. Evaluated differences based on the day of flight operations (day before with no surveys, and days with surveys) and group (flown birds vs controls).
    2. Evaluate the relative importance of treatment group, period within flight operations (before, during, and after flight), survey altitude, and launch distance from birds on behavioural responses.

Estimating Snow Goose Habitat Impact

- 5 study plots consisting of 92 square cells (50m^2) were surveyed by researchers on the ground using linear transects.
- 2 diagonal transects were walked in each cell and landcover was classified each meter as either: barren, graminoid, or shrub.
- The same plots/cells were surveyed with the UAV at 75, 100, and 120m AGL.
- Imagery was mosaicked using Pix4Dmapper Pro and loaded into ArcGIS 10.4 for unsupervised classification of plot imagery.
- Estimates for proportion landcover were made by constructing generalized linear mixed models for each method of data collection in each cell across all plots (fixed effect: method, random effect: cell_id(plot), distribution = beta).
- Accuracy assessment based on classified image vs. visual inspection of imagery.

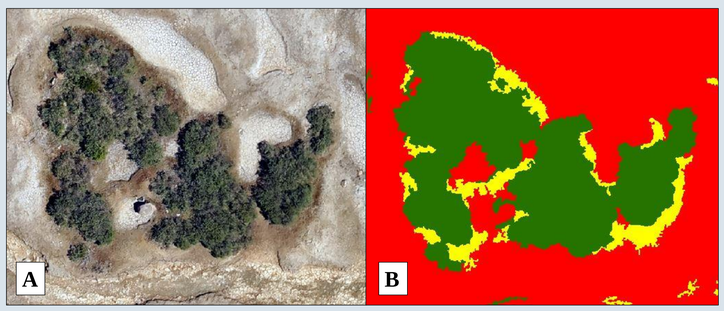

Fig. 2: A) UAV imagery (RGB) of snow goose habitat degradation B) classified imagery where red= barren, yellow= graminoid and green=shrub.

Results

Snow Goose Behaviours

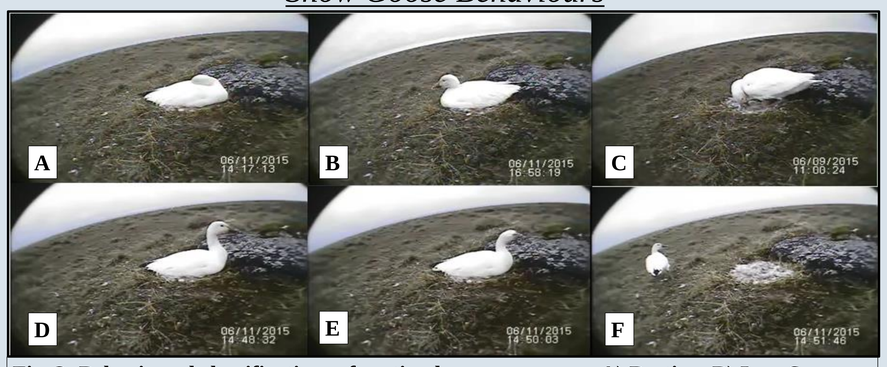

Fig. 3: Behavioural classifications of nesting lesser snow geese A) Resting, B) Low Scan, C) Nest Maintenance, D) High Scan, E) Head-Cock and, E) Off Nest

- On UAV flight days, snow geese generally **decreased** resting while **increasing** all other behaviours (Fig. 4).
- On UAV flight days, *group x period* were best predictors of behaviours.
- When the UAV was in flight, exposed birds had higher proportion of vigilance behaviours to those not flown over (0.003 vs. 0.0056).

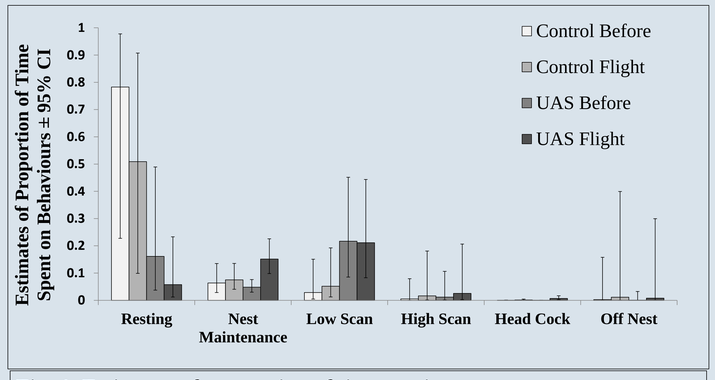

Fig. 4: Estimates of proportion of time nesting snow geese spent on individual behaviours within treatment groups (Control vs UAV) and between days (Before vs Flight). Nests n=25, UAV flights n=13.

Snow Goose Habitat Impact

- Unsupervised classifications were more accurate at higher altitudes (100 and 120m), than lower altitude (75m) (Table 1).
- Model estimates from ground and UAV data were significantly different for each landcover type (Fig. 5: barren P<0.0001, graminoid P<0.0001, shrub P<0.0001).

Table 1: Unsupervised classification results of UAV imagery for each landcover class collected at 75, 100, and 120m AGL.

	UAV Flight Altitude		
	75 m	**100m**	**120m**
Proportion Barren	0.756	0.762	0.744
Proportion Graminoid	0.036	0.032	0.050
Proportion Shrub	0.207	0.204	0.205
Overall Accuracy	72.0%	81.3%	81.3%
Kappa Coefficient	0.58	0.72	0.72

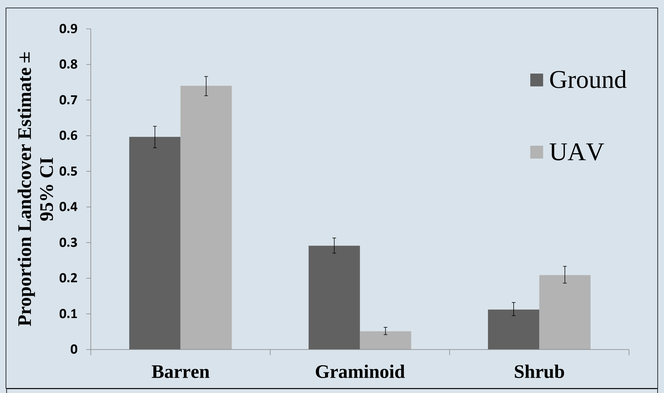

Fig. 3: Model estimates of proportion landcover type from ground based linear transects and classified UAV imagery.

Discussion and Future Directions

- Birds notice the UAV, but biological implications such as fitness consequences are unclear.
- Future studies should evaluate responses with different styles of UAV to inform tradeoffs between data requirements and behavioural responses.
- UAVs can collect data much quicker than ground based linear transects. Ground surveys took 3 researchers 3 days to complete, while a single UAV flight covered the entire area in 26 minutes (120m AGL), **but have additional computer processing time.**
- High accuracy in image classification and differences in landcover estimates by method may reflect lack of variation captured by linear transects. **Implications for future monitoring!**

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