Using collar-mounted data loggers to investigate wolverine behaviors associated with snow cavities

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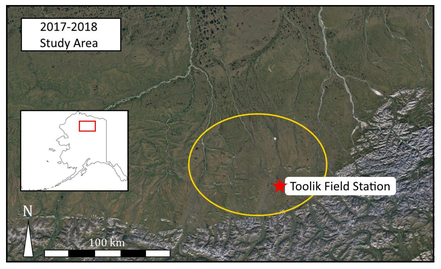
1 Introduction

Collar-mounted data loggers are useful tools for investigating behavioral patterns associated with den and burrow use among cryptic species. Wolverines (*Gulo gulo*) use cavities excavated in snow for parturition and neonatal care, as well as food preservation, behavioral thermoregulation, and predator avoidance. Verifying wolverine use of intra- and sub-nivean cavities currently relies on labor-intensive field visits to sites used by wolverines.

Our model uses data from collar-mounted light loggers, temperature loggers, and accelerometers to classify wolverine resting sites as inside versus outside of snow holes. Our work showcases the application of biologging as a way to improve our understanding of the behavioral interaction between wolverines and snow.

2 Methods



1) Deploy accelerometers (A) and light/ temperature loggers (B) on GPS-collared wolverines.
2) Document the use of surface beds versus snow holes.
   Surface bed: depression in snow with hardened ice layer, indicating that the animal spent enough time to soften and refreeze the snow.
   Hole: excavation in the snow deep enough that the animal would be removed from direct sunlight, with no surface bed present.
3) **Develop models based on biologged data and field visits to classify unvisited wolverine resting periods as inside versus outside of snow holes.**

3 Results

- Fitted six wolverines with GPS collars, accelerometers, and light- and temperature-loggers.
- Identified 1,136 resting periods among the six animals using accelerometer data.
- Visited the locations of 166 resting periods to verify the use of holes versus surface beds.

Inputs

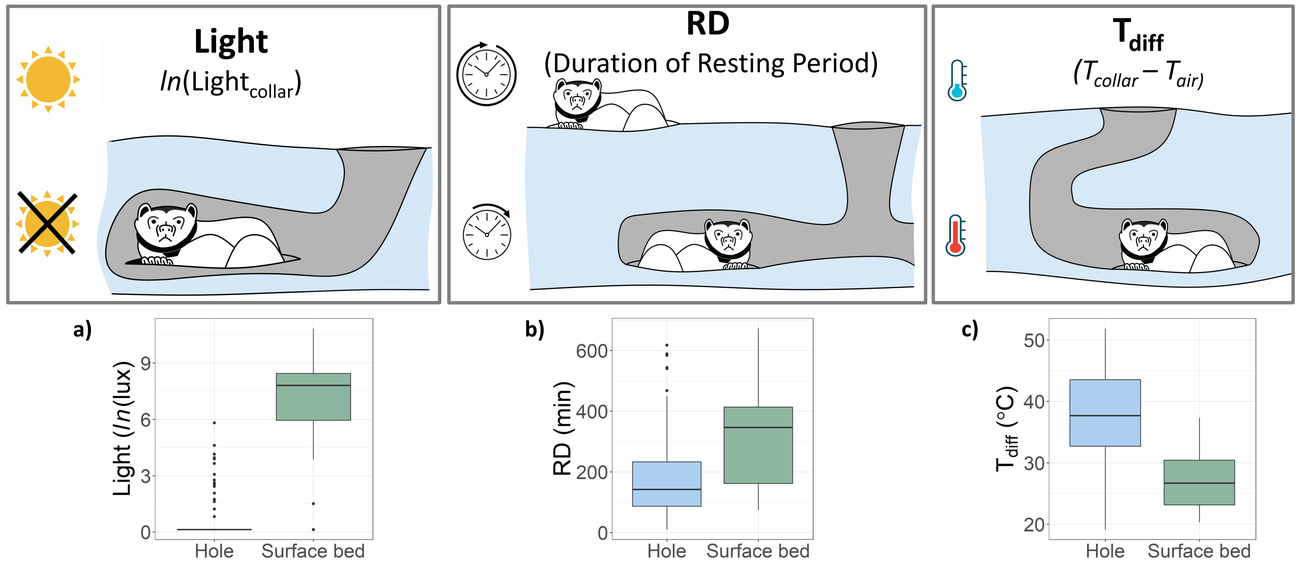


Figure 1. Field-verified hole versus surface bed use. a) Median light (*ln*(lux)) level during resting periods, b) resting duration (minutes), and c) the difference between median ambient air temperature and median collar temperature (˚C) during resting periods.

Model

Model	Explanatory variables	ΔAIC	R^2
A	Light + T_{diff} + RD	0	0.84
B	Light + RD	4.6	0.78
C	T_{diff} + RD	57.0	0.34
D	RD	82.8	0.10

Logistic regression model with the response variable: log-odds of a resting period being a surface bed. Not all explanatory variables were available for all resting periods (e.g. no light data during nighttime rests). Therefore, to create a predictive algorithm for unvisited resting periods, the model used depended on the data available for that resting period, following the sequence:
Model A > Model B > Model C > Model D

Predictions

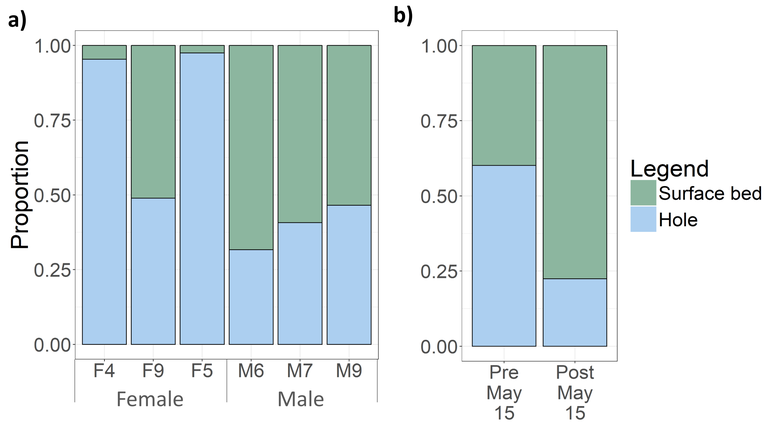


Figure 2. Predicted hole use by a) individual (pre-May 15 only), and b) season.

The complete model sequence, using all explanatory variables in combinations determined by the available data, predicts 95.7% of visited resting sites correctly, while models B, C, and D alone have prediction accuracies of 96.4%, 88.5%, and 89.1% respectively.

4 Conclusions

- Use of snow holes versus surface beds for resting can be inferred using collar-mounted light and temperature loggers.
- The best model includes light, T_{diff}, and RD.
- T_{air} accounts for most of the difference in T_{diff}; wolverines use holes more when ambient temperatures are low.
- Absent light data, nighttime hole use can be predicted with a 6.4% decrease in accuracy using only collar-mounted temperature loggers and air temperature.
- Wolverines using non-snow cavities (e.g. in rock, earth, or organic material) may limit the model's ability to predict snow-hole use.
- Two of the female wolverines, F4 and F5, both non-reproductive, used holes considerably more than the other four animals. A small pack of wolves was in close proximity to both animals during the study period (including at resting sites), possibly accounting for their higher use of holes.

5 Acknowledgements

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