Laforge, M.P., M. Bonar & E. Vander Wal. Tracking snowmelt to jump the green wave: Phenological drivers of migration in a northern ungulate. Ecology.

**Appendix S1: Study area, representative phenology, and migration routes**

A close up of a map

Description automatically generated

Fig. S1: Map of our study area, the island of Newfoundland, Canada, showing the location of our five replicate caribou (*Rangifer tarandus*; *n* = 94) herds.

A screenshot of a cell phone

Description automatically generated

Fig. S2: Phenology of snowmelt and green-up at a representative pixel in our study area. Blue points represent proportional total snow cover based on MODIS normalized difference snow index data and estimated using the formula presented by (Salomonson and Appel 2004) fitted with a logistic curve (blue line). Green points represent raw normalized difference vegetation index (NDVI) values, also from MODIS satellite data. Points that were prior to snowmelt (based on the quality band of NDVI) were set to the 3rd percentile value of all snow-free locations at that pixel for the duration of our study. The solid green line is the fitted NDVI curve scaled from 0–1, and the dashed green line represents the instantaneous rate of green-up (IRG; the first derivative of NDVI). Small blue and green lines on the bottom of the plot represent the dates of snowmelt and peak IRG, respectively.

**A close up of a map

Description automatically generated**

Fig. S3: Curves showing proportion of the landscape covered in snow through time for each of our five replicate caribou (*Rangifer tarandus*) herds in Newfoundland, Canada. We plotted the progression of snowmelt for each year with reliable MODIS data (2001–2020). Thick red lines are years included in our study; thinner black lines represent other years. Proportion snow cover was estimated from normalized difference snow index values and estimated using the formula presented in (Salomonson and Appel 2004).

**A close up of a map

Description automatically generated**

Fig. S4: Fidelity of migration routes across all collared individuals in each population for each of our five caribou (*Rangifer tarandus*) populations in Newfoundland, Canada. We generated 99.99% Brownian bridges around all individuals in each year. Colors represent the degree of overlap between migration routes across years, with darker colors indicating areas used multiple years, and lighter colors representing areas used in fewer years. Panel A represents data from the Buchans herd (14 individuals over 6 years of data, 44 ID-years total), panel B – Grey River herd (13 individuals over 6 years of data, 40 ID-years total ), panel C – Lapoile herd (18 individuals over 6 years of data, 50 ID-years total), panel D – Middle Ridge herd (34 individuals over 4 years of data, 59 ID-years total), and panel E – Topsails herd (15 individuals over 5 years of data, 23 ID-years total). Calving areas correspond to areas with the highest inter-annual overlap in ranges.

**Correlation between focal and neighboring pixels**

When preparing our raw NDVI models for curve-fitting, we replaced any pixels that were missing (either due to cloud cover or unreliable data) with the mean NDVI value of pixels in a 5 × 5-pixel grid surrounding the focal pixel. To ensure that this procedure did was not biased and resulted in pixels that were inaccurate due to differences in phenology with neighboring pixels, we calculated the correlation between the NDVI value of the pixel and the pixels in this 5 × 5-pixel grid. We extracted these values for a sample of 5000 locations within our study area for each NDVI image throughout our study period from February 10th to September 29th (30 total images, for a total of 150,000 records). We found that the NDVI at focal pixels was highly correlated with surrounding pixels (Spearman correlation coefficient: 0.9903, R2 = 0.9808). After these data were filled in, NDVI curves through time were also subjected to a 3-observation moving median filter to further reduce any bias associated with this filling procedure.

**Literature cited:**

Salomonson, V. V., and I. Appel. 2004. Estimating fractional snow cover from MODIS using the normalized difference snow index. Remote Sensing of Environment 89:351–360.