

Snowscape Ecology: Linking Snow Properties to Wildlife Movements and Demography



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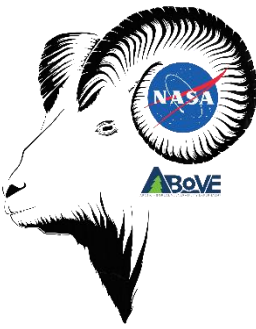
Peter Mahoney, UW

Kelly Sivy, UW

Glen Liston, Colorado State University

Anne Nolin, Oregon State University

Snowscape: a landscape covered in snow

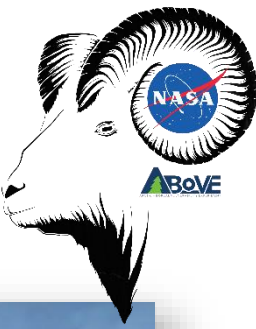


Wrangell Mountains, Alaska

- Snow covers up to 1/3 earth surface
- Strong impacts on hydrology, vegetation, and wildlife

NASA

Multiple effects of snowscapes



Hibernacula & subnivean conditions



Arctic ground squirrel



Hoary marmot



Polar bear cubs



Collared lemming



Meadow voles

Barbaralymne

Multiple effects of snowscapes



Movements & Foraging



Red fox



Dall sheep



Muskox

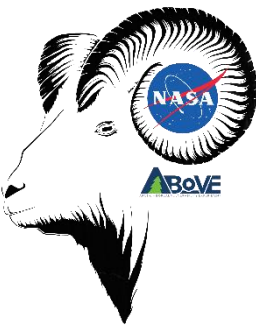


Canada lynx & snowshoe hare



Caribou

Multiple snowscape properties



- Cover (extent, duration)
- Depth
- Density & hardness
- Rain-on-snow, icing events

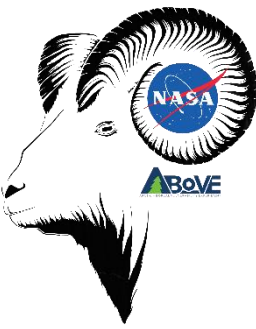
Rain on Snow: Little Understood Killer in the North



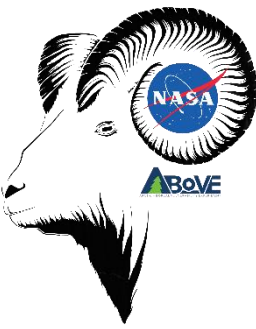
Putkonen et al. 2009, *Eos*
20,000 muskox
killed in 2003, Banks
Island



Changing snowscapes: a critical link

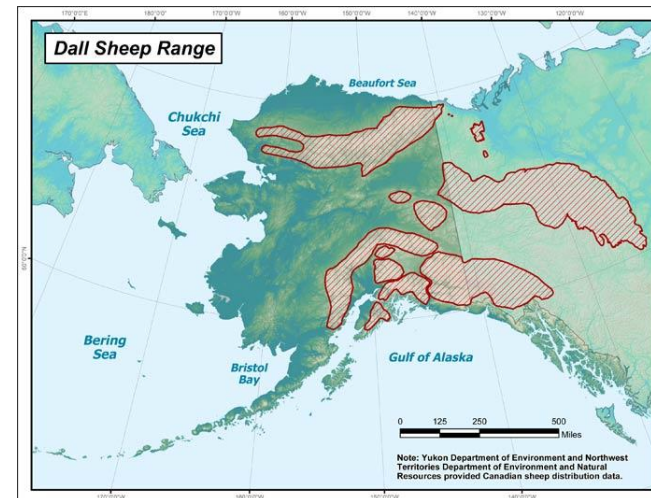


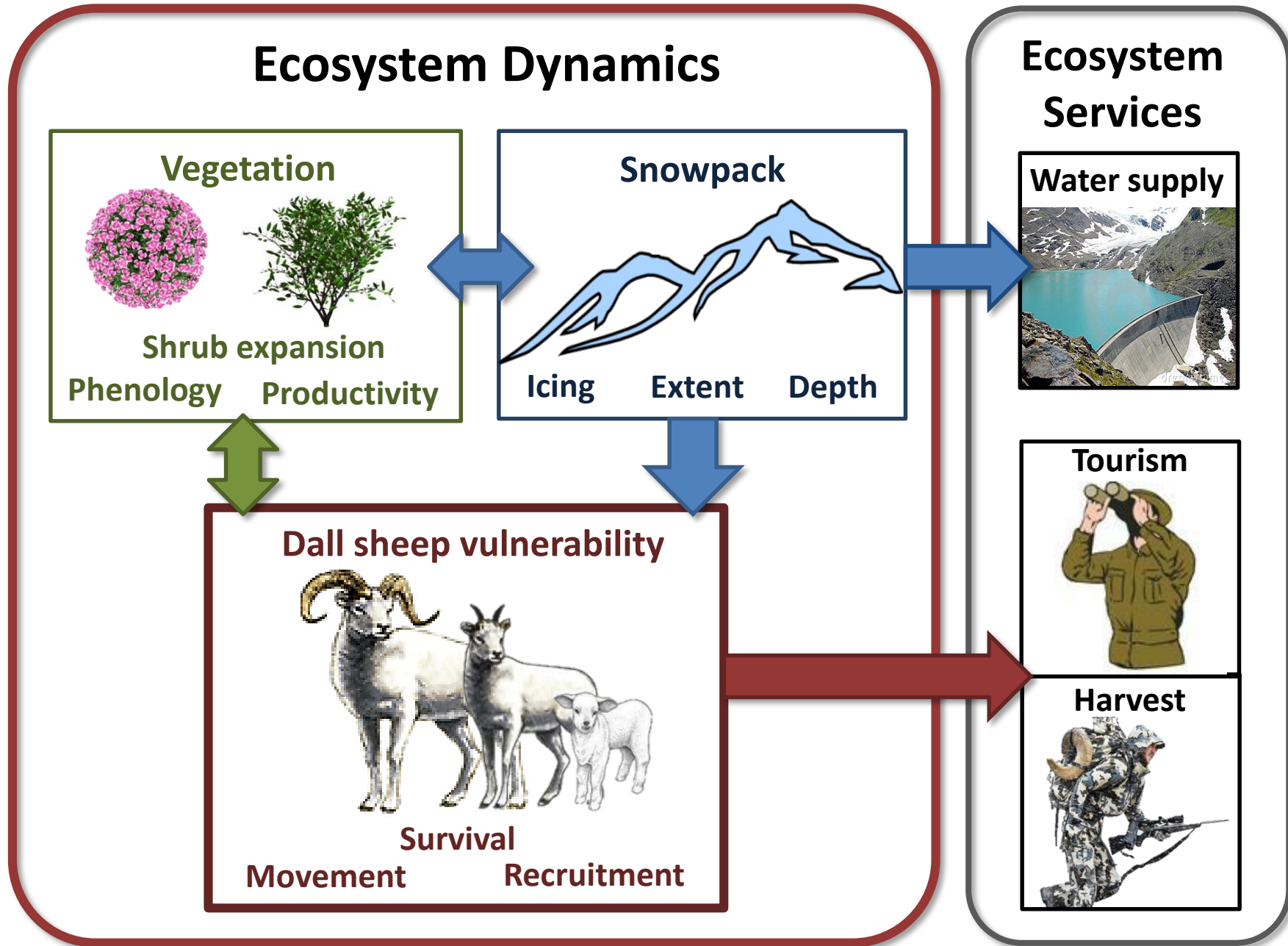
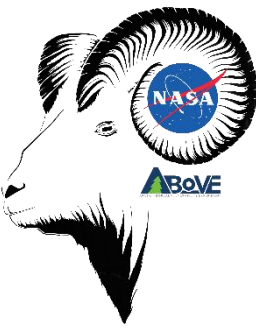
Dall Sheep as Sentinels of Climate Change Impacts in Mountains



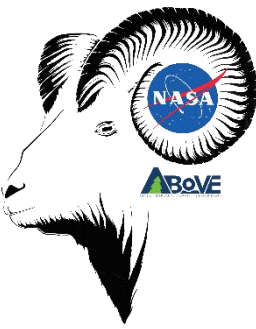
Steve Arthur

- Double whammie: High latitude and high elevation
- Populations declined 26% in past 20 years
- Indicators of alpine ecosystem health
- Changing snow properties may affect alpine wildlife more than other climate factors







Spring Snow Cover

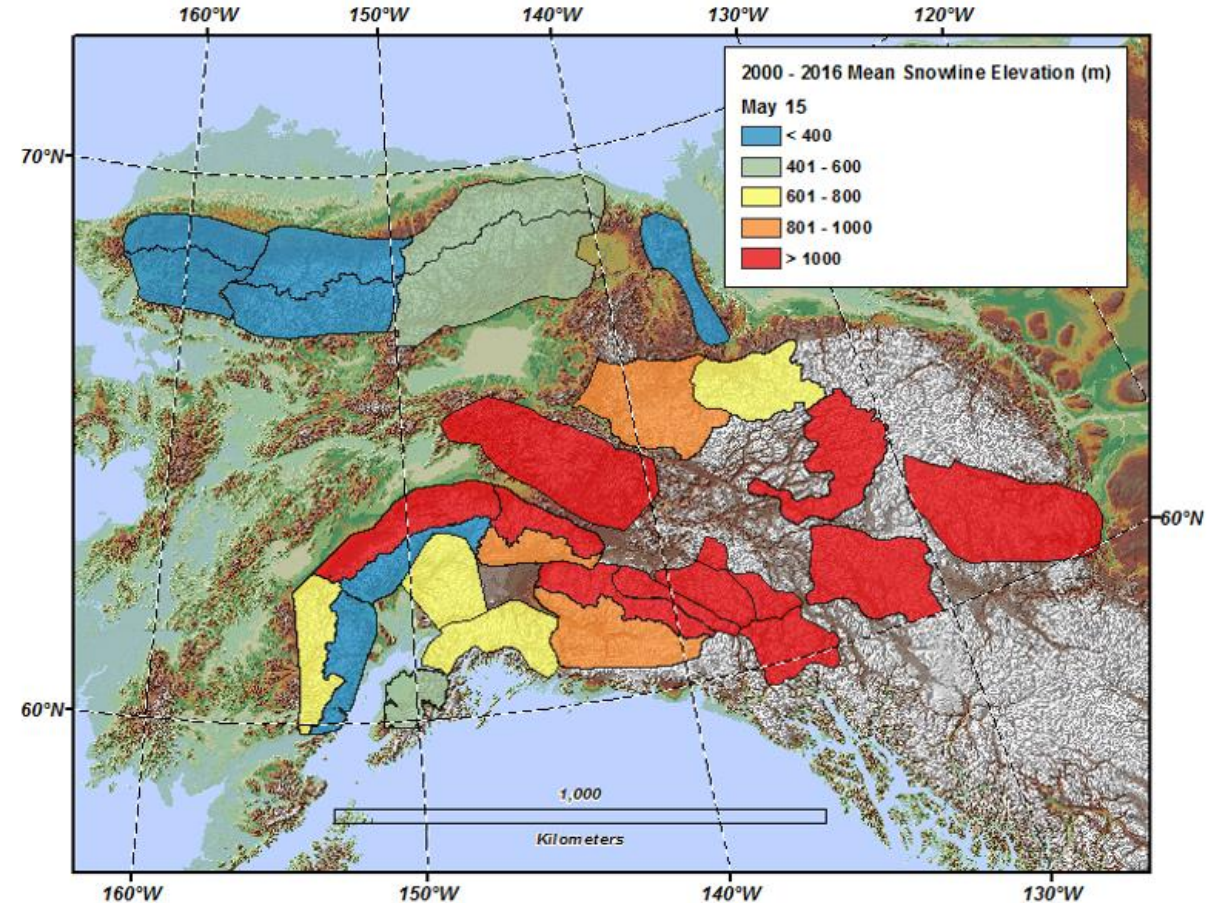


Article

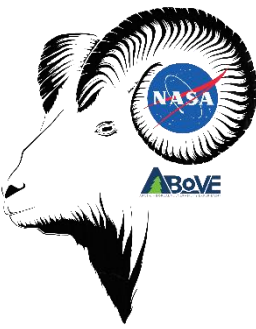
Remote Sensing of 2000–2016 Alpine Spring Snowline Elevation in Dall Sheep Mountain Ranges of Alaska and Western Canada

David Verbyla ^{1,*} , Troy Hegel ², Anne W. Nolin ³, Madelon van de Kerk ⁴, Thomas A. Kurkowski ⁵ and Laura R. Prugh ⁴ 

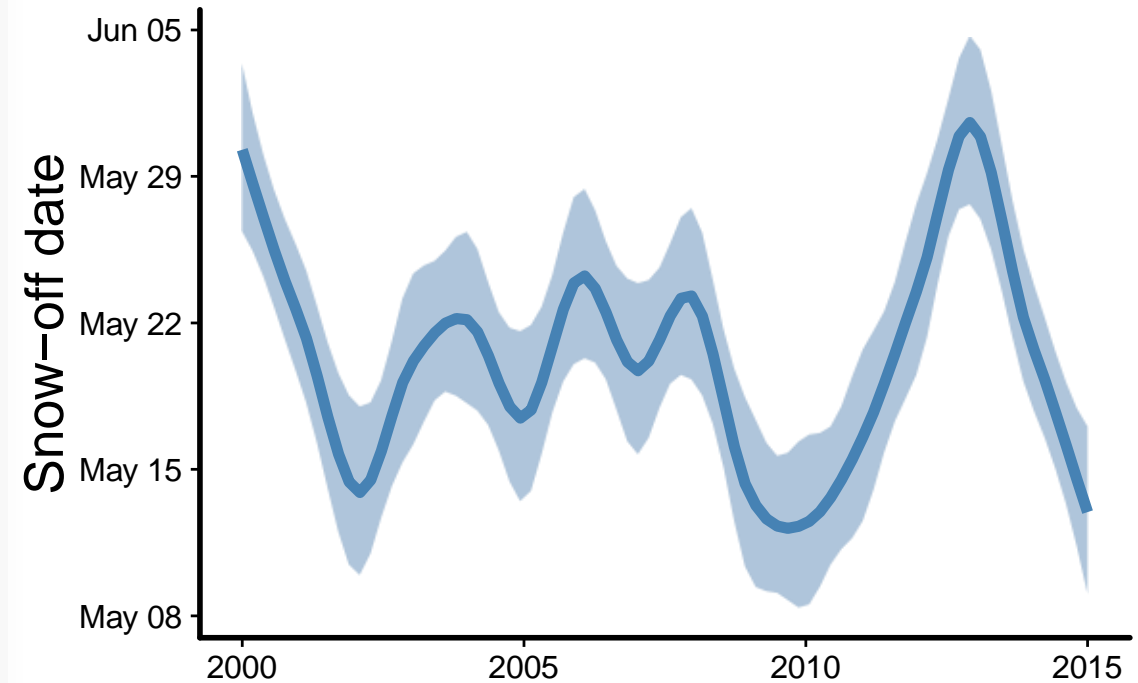
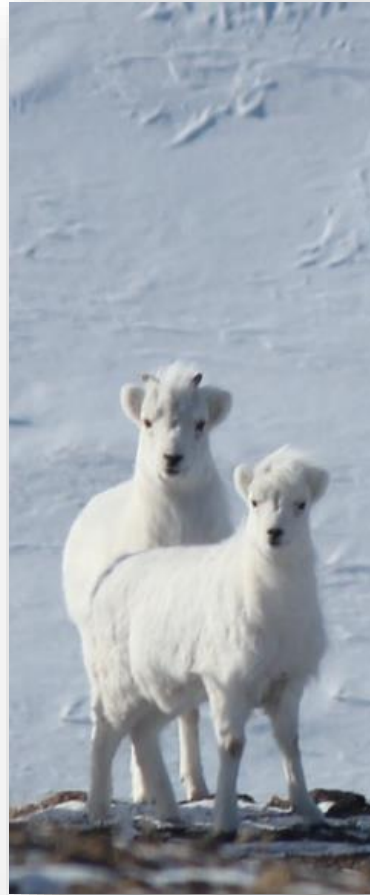
- Regression technique using daily MODSCAG snow fraction product to estimate last day of spring snow & snowline elevation for each 500-m pixel within 28 mountain areas, 2000-2016
- Validated the approach with 53 Landsat based snowlines from May 5-May30
- High spatiotemporal variability



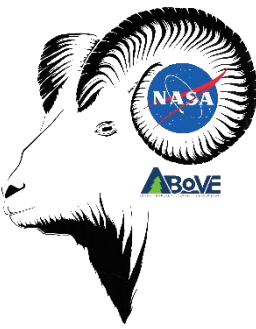
How does spring snow cover affect lamb survival?



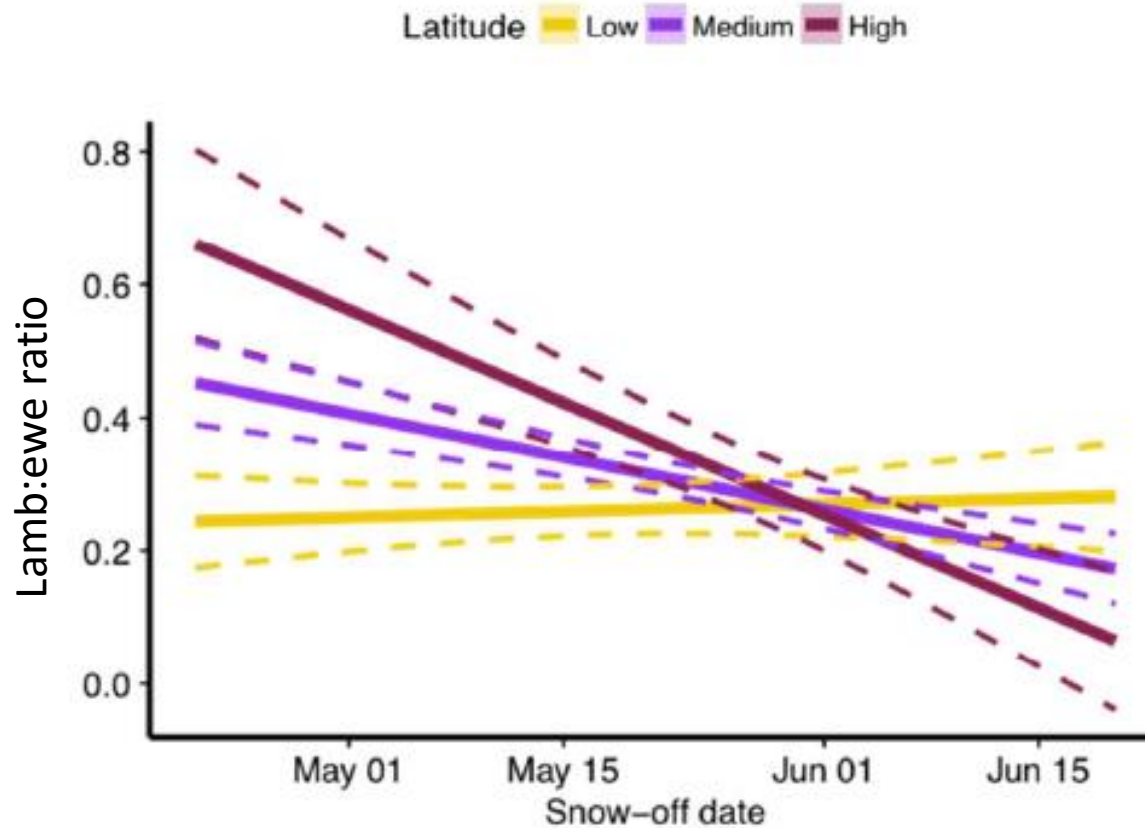
- Compiled sheep counts from 1,570 surveys from 2000-2015
- Used GLMs to examine effect of 3 spring snow cover variables on lamb:ewe ratios:
 - Snowline, duration, snow-off date
- Snow-off date had strongest effect
- No trend, but increasingly variable?



Late spring = lower lamb survival

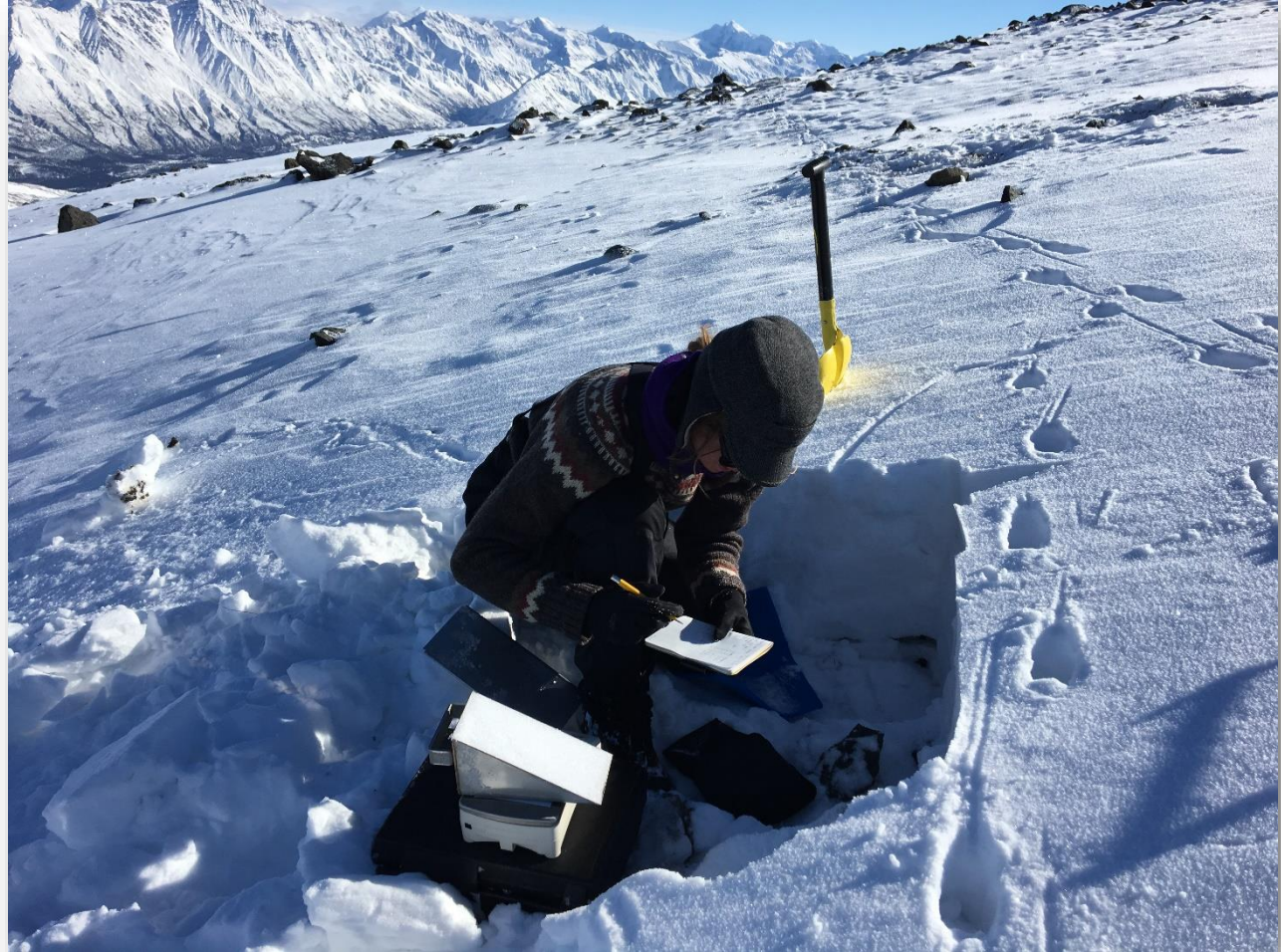
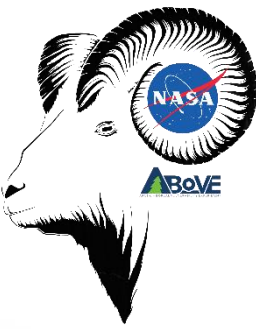


Strongest effects of snow cover at high latitudes





Snow depth and density: Wrangell Mountains





Magnaprobe

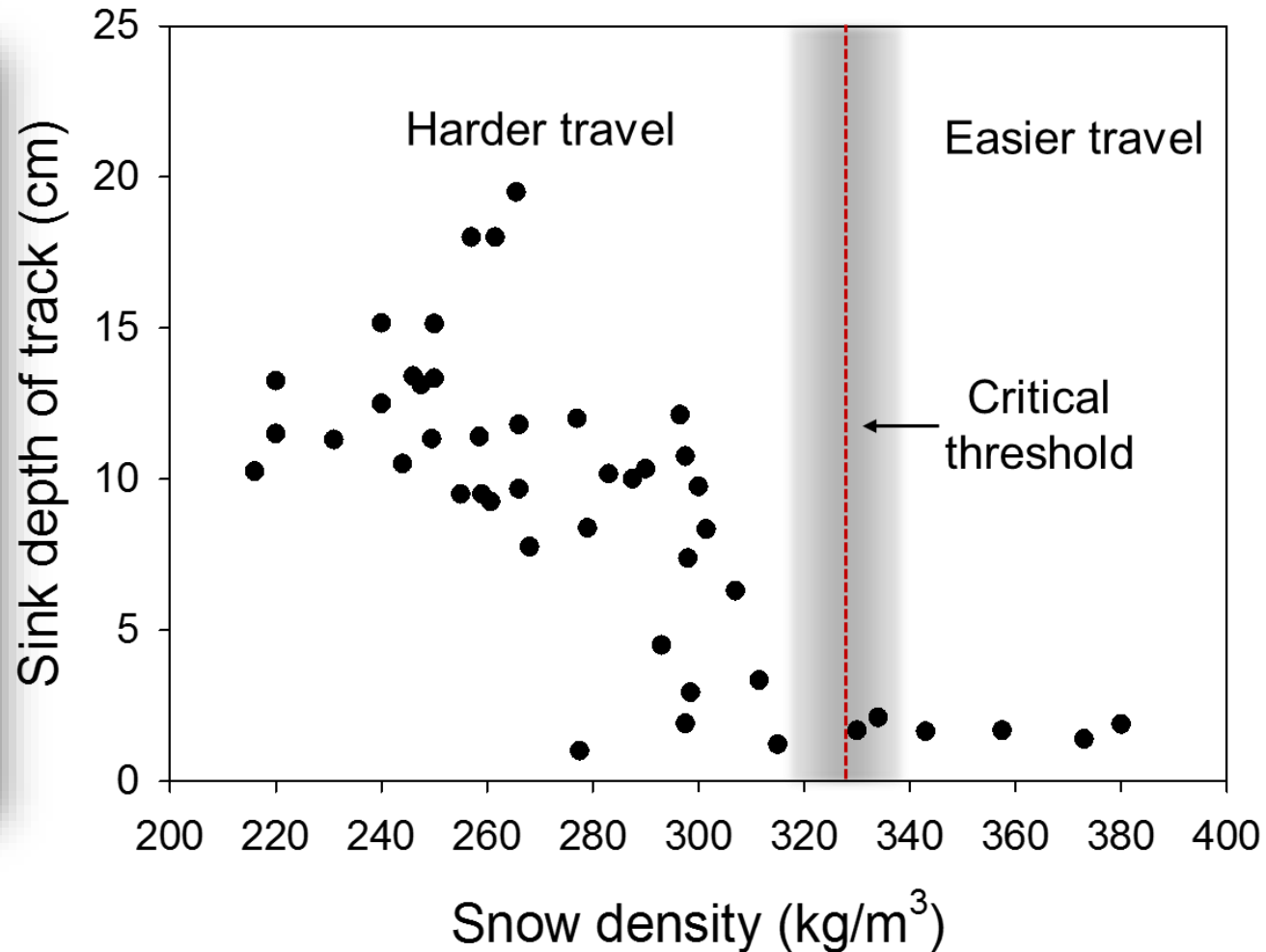
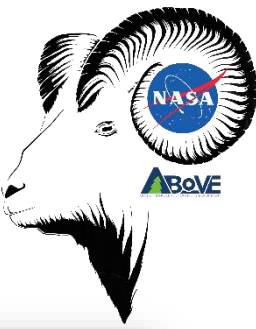


Game cameras



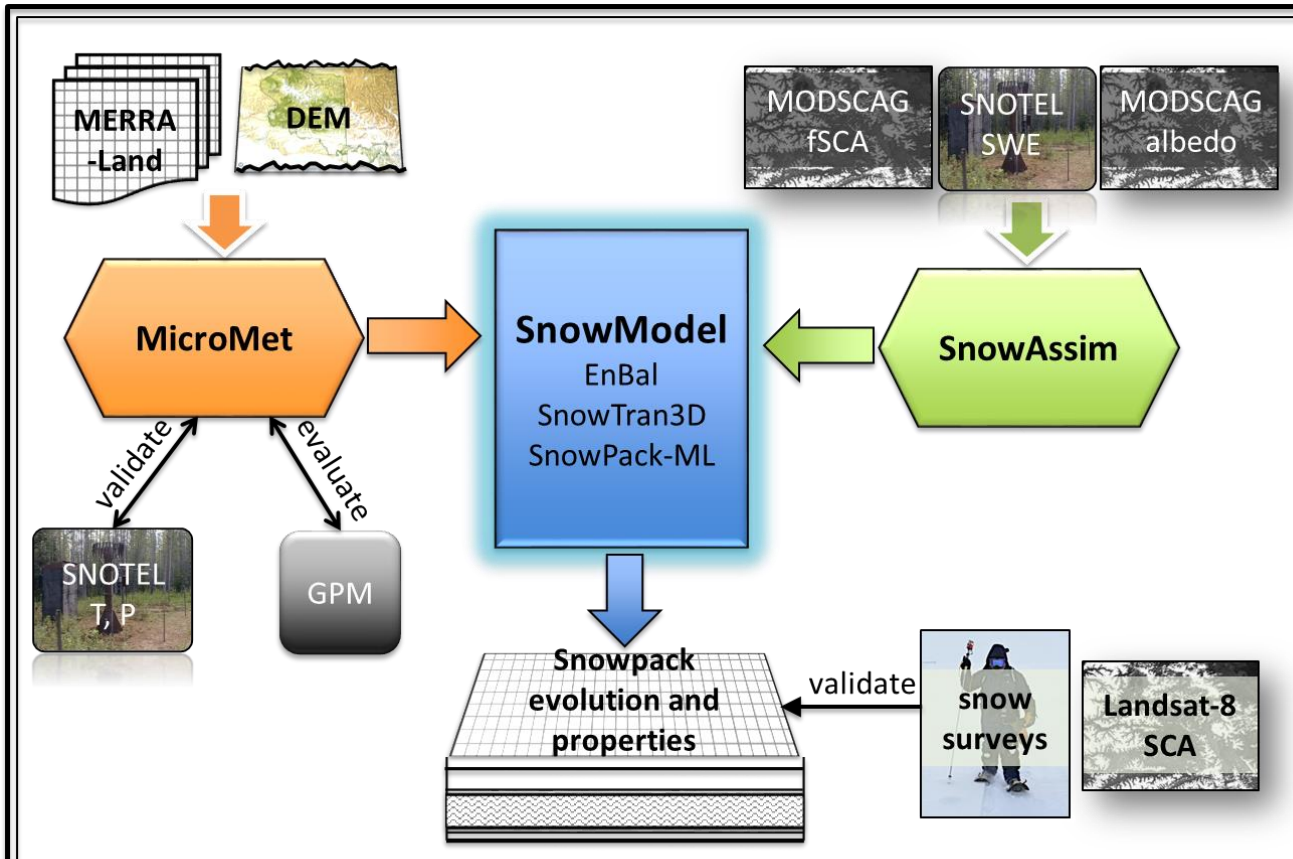
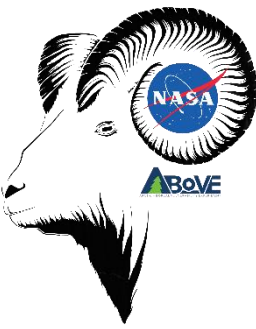
Snow pits

Critical snow density threshold: 329 kg/m^3

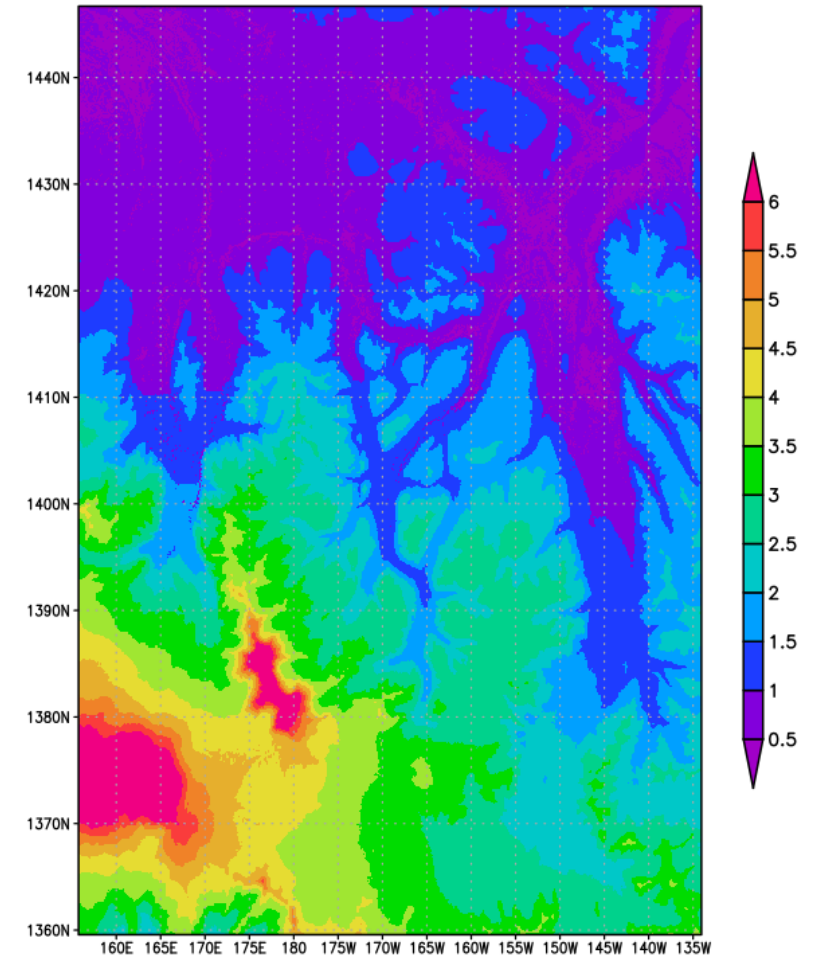


- Track sink depth unrelated to snow depth, depended on density

Snow depth and density: Modeling



Jacksina Snow Depth (m) 1st April 2001



Cosgrove in prep

Representation of SnowModel (Liston & Elder 2006), its related models MicroMet and SnowAssim, and the use of ancillary ground-based, modeled, and remotely sensed data for model input, assimilation, and validation.



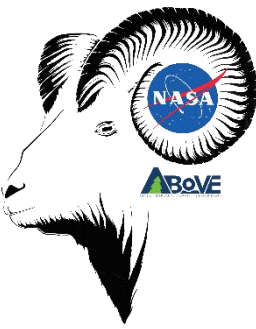
Navigating Snowscapes



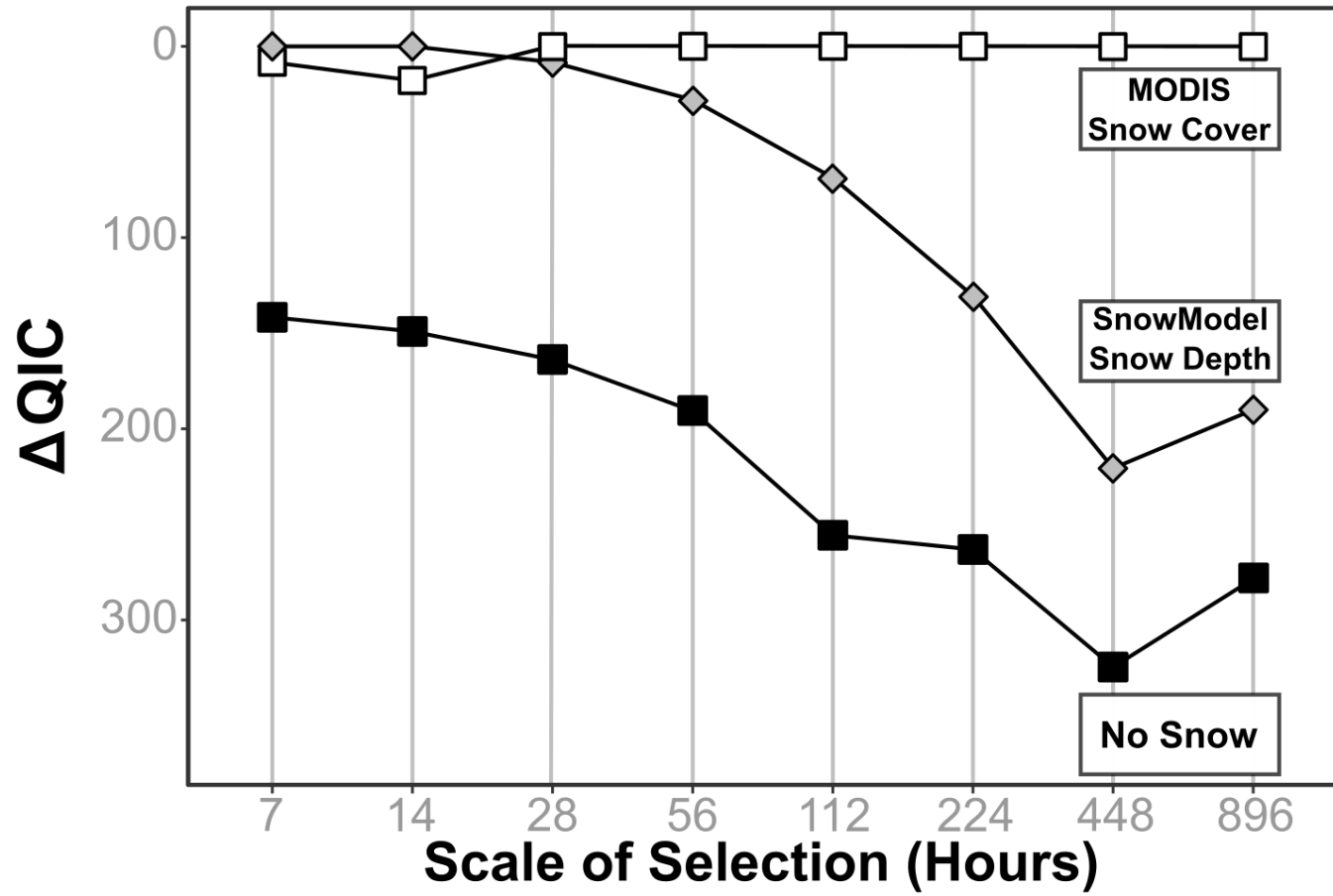
- 20,544 locations from 30 GPS-collared sheep in Lake Clark National Park, 2005-2008
- Compared MODSCAG snow fraction product to SnowModel depth & density at multiple scales



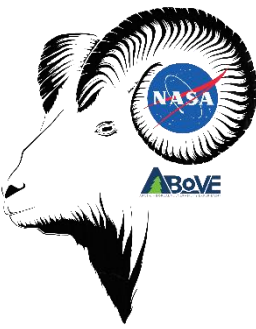
Navigating Snowscapes



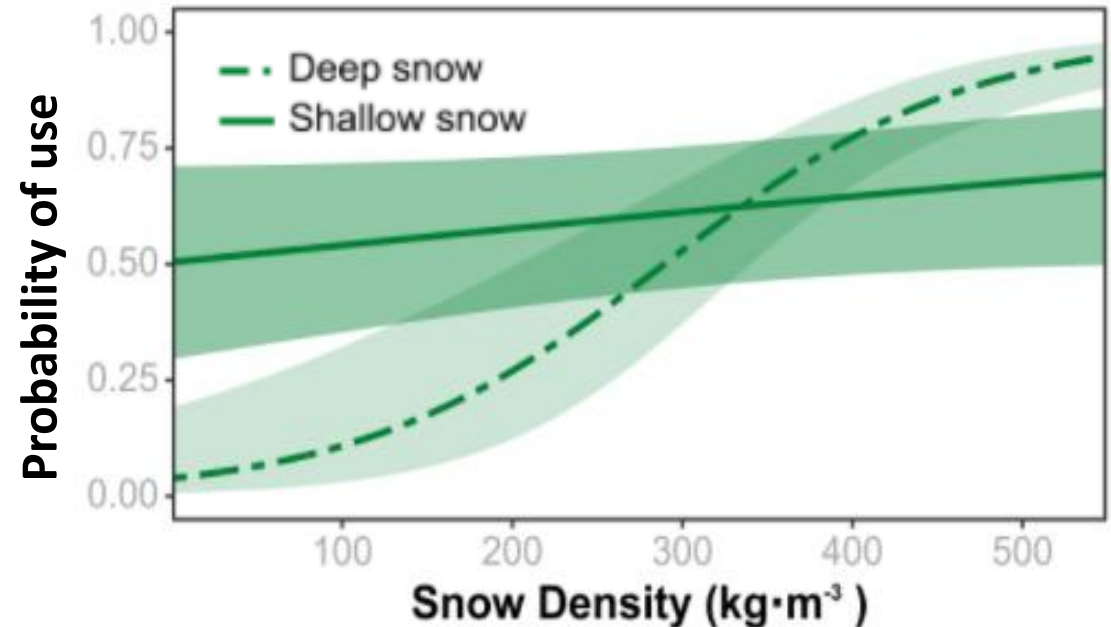
- Including snow improved ability to predict sheep movements at all scales
- Modeled depth & density outperformed MODIS snow cover at fine scale, but MODIS was best at coarse scale
- Sheep generally preferred shallow snow (< ~50 cm) and low % cover



Navigating Snowscapes



- When snow was deep, sheep preferred areas of dense snow
- Sheep may prefer shallow, fluffy snow when foraging and denser snow when traveling



Summary

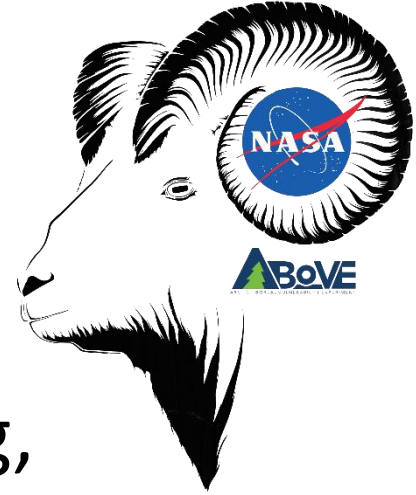


- Multiple snowscape properties have strong effects on multiple aspects of wildlife ecology
- One size doesn't fit all: best snow products depend on question and scale



Snowscape Ecology

- Integrated study of snow properties and ecological processes is needed for global change forecasting
- More collaboration between remote sensing, modeling, and wildlife research communities is needed



Contact: Laura Prugh, lprugh@uw.edu

Thank You!

- NASA ABoVE
- Dall sheep team
- Natalie Boelman & AotM
- Ellis family
- Fortymile Air