THE UNIVERSITY OF BRITISH COLUMBIA

NSERC CRSNG

Changing snow pack dynamics are altering grizzly bear behavior in spring

Annual General Meeting – 3

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Preceding Work

Ethan Berman and co-authors work on snowpack dynamics in the Yellowhead

- Set the stage in terms of modeling snow conditions
- Demonstrated that snow conditions affected individual habitat selection in spring

Daily estimates of Landsat fractional snow cover driven by MODIS and dynamic time-warping

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ARTICLE INFO

ABSTRACT

Understanding seasonal snow cover dynamics is critical for management of hydrological regimes, habitat availability for wildlife species, forest fire risk assessment and recreational demands. Although data products provided at 500 m spatial resolution by the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor provide important and readily available information on snow cover, capturing snow dynamics at finer spatial resolutions remains problematic due to the lack of high temporal and spatial resolution data, which limits the number of available observations each year. In this paper we present a new approach to create a daily time-series of 30 m snow observations (called SNOWARP), derived from daily MODIS Normalised Difference Snow Index (NDSI) snow cover data to capture the temporal dynamics of snow cover and Dynamic Time Warping (DTW) to re under historical Landsat Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETM+), and Operational Land Imager (OLI) observations to account for inter-annual variability. The SNOWARP product was produced for 2000–2018 for an area of Western Alberta (approximately 30,000 km²) and was calibrated against a network of time-lapse cameras and snow pillows. Results indicate the RMSE of the SNOWARP fractional product ranges from 31.3%–68.3%, while F score of the SNOWARP binary product ranges from 87.7% - 98.6% when compared to ground truth data. Capturing fractional snow cover at a fine spatial and temporal scale is important due to the spatial heterogeneity of snow cover, particularly in mountainous regions with implications for biodiversity assessment and monitoring. SNOWARP demonstrates a novel method to increasing the temporal resolution of Landsat derived snow cover data, providing valuable insights on regional snow cover dynamics for use in a range of applications.

Development

My research goal was

- To take these powerful, novel datasets developed by the GrizzlyPAW program describing dynamic portions of grizzly bear habitat and;
- Apply it to important ecological questions regarding grizzly bear behavior

This led to a focus on grizzly bear behavior in spring in relation to dynamic snow conditions

Research Question

How do changing snowpack conditions affect grizzly bear denning phenology in spring (i.e. bear activity date)?
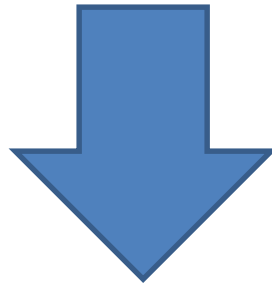
How is bear activity date likely changing through time across BMA 3?
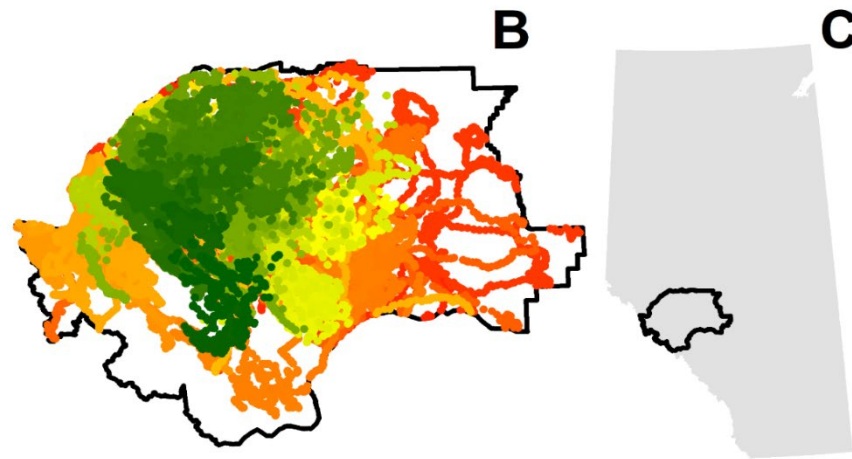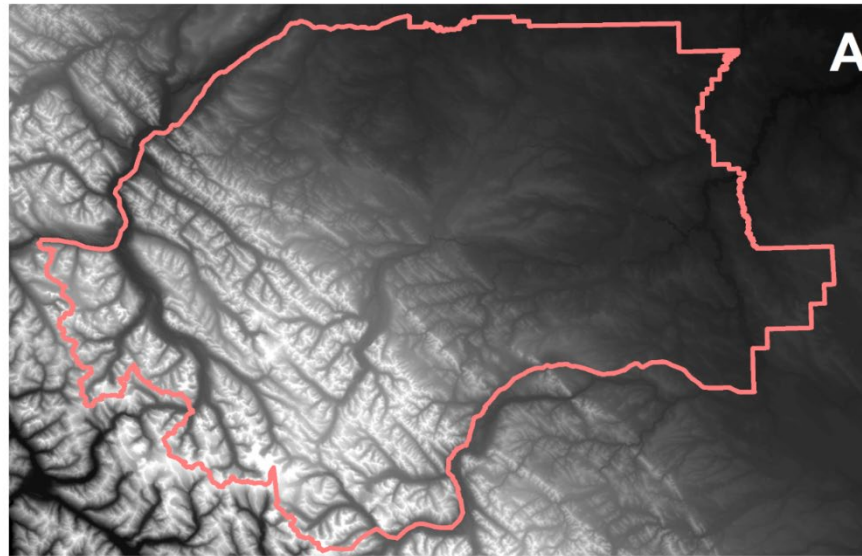
Methods

RQ – How does snow affect when individual bears become active in spring

Need to measure
- When bears become active in spring
- Spring snowmelt

Methods

Individual bear activity date

- Den emergence
  - i.e. first GPS fix of the year
- Individual bear activity date
  - When an individual leaves the proximity of the den site and begins to access their larger home range
  - Measured using an Net Squared Displacement (NSD) curve

Methods - NSD
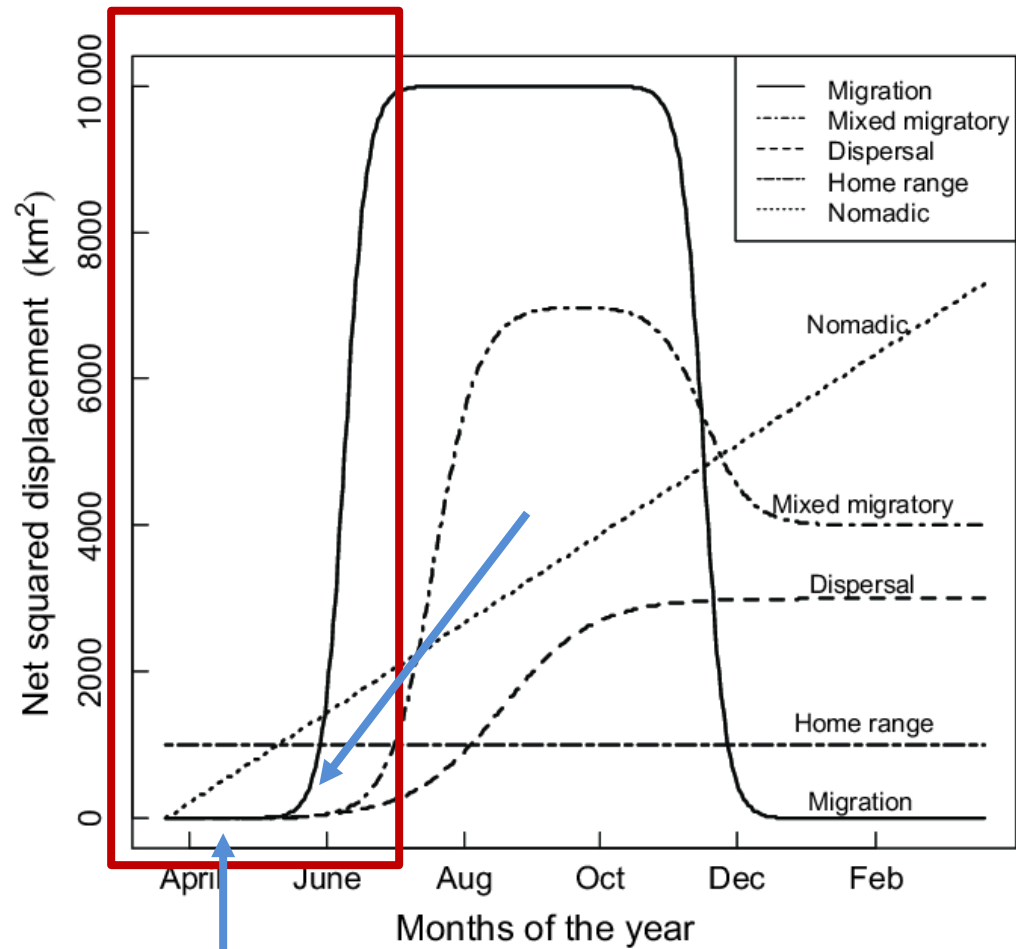
Methods – Snow conditions

Snowpack dynamics

- Began with Berman et al. estimating snowmelt date using median melt date

- Further developed to describe

  - Start date of melt

  - End date of melt

  - Melt rate

  - Melt consistency

Methods – Snow Conditions
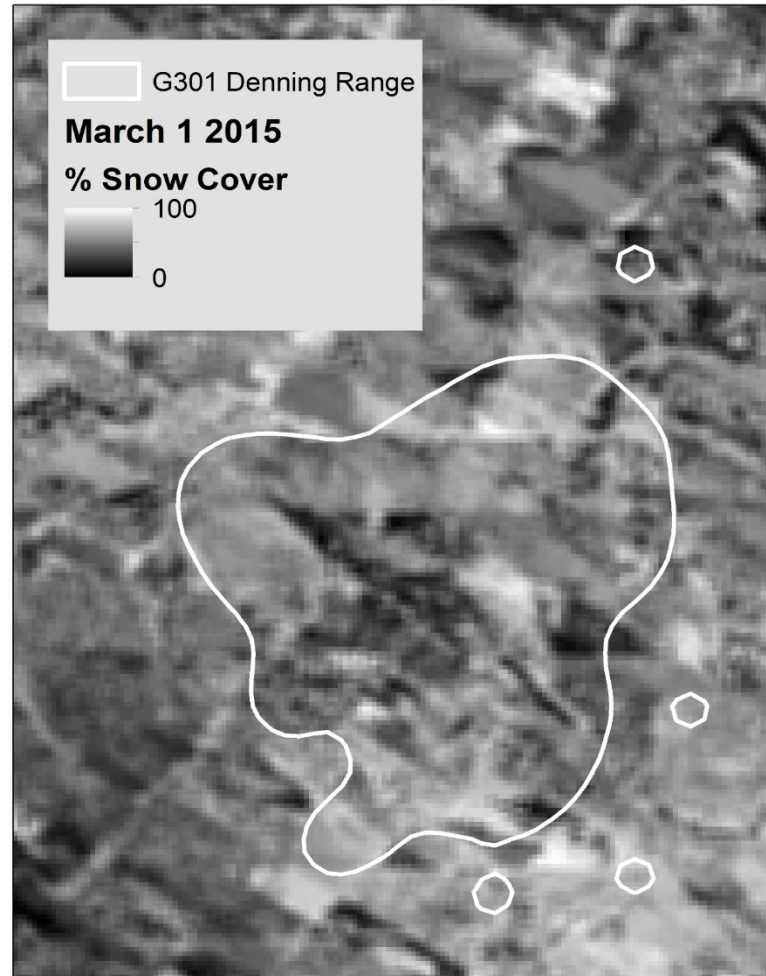
Methods – Snow Conditions
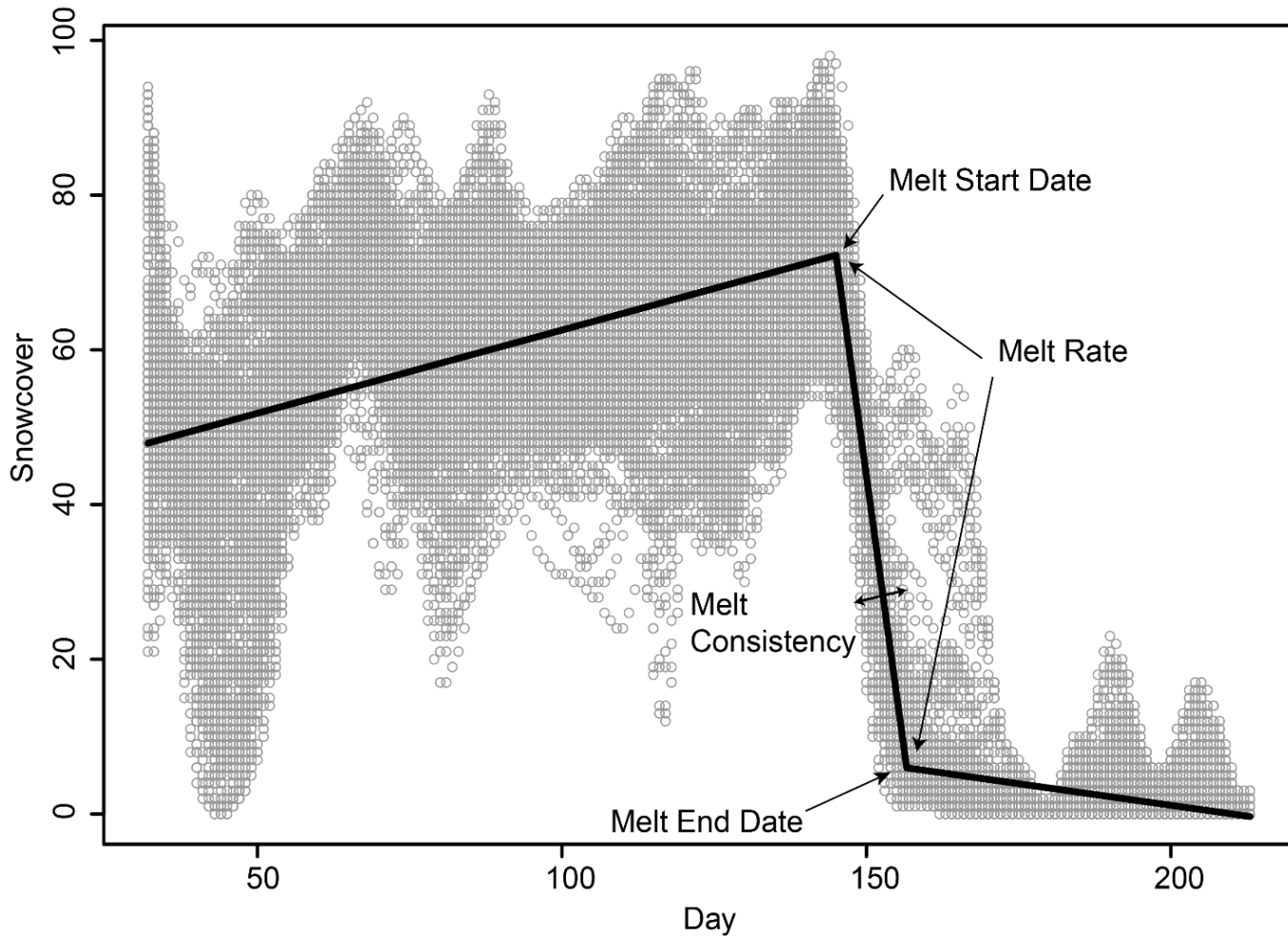
Methods

Build a simple model using 48 unique individuals

Individual bear activity date ~ melt start date + melt end date + melt rate + melt consistency

Results

Individual bear activity date highly associated with three snowpack variables

- Earlier melt end date = earlier activity date
- More rapid melt rate = earlier activity date
- Less consistent melt = earlier activity date

These three variables explained 45% of variation in individual activity date

Results

We then applied the activity date – snowmelt model across BMA 3 to assess potential changes through time

Results

2000
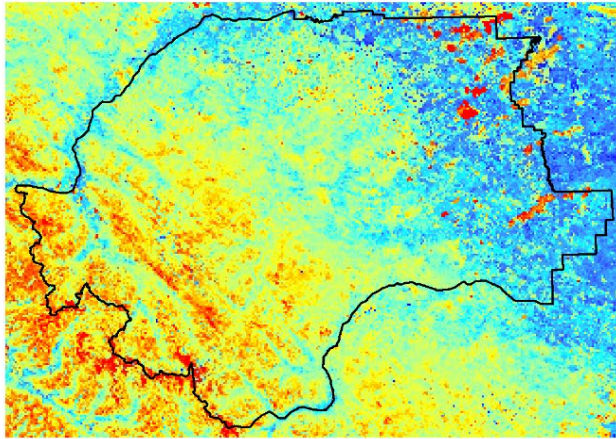
2016
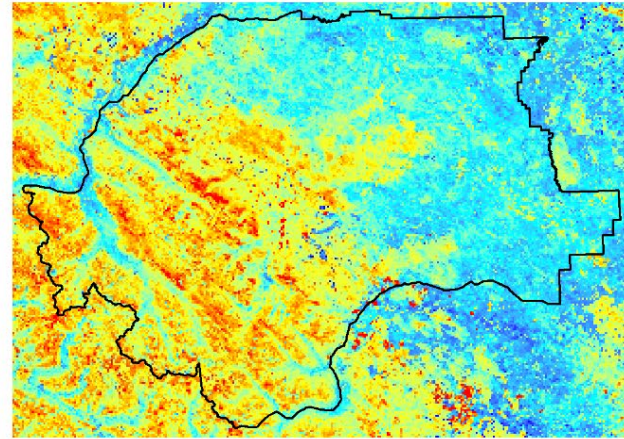
Activity Date (Day of Year)

78   145

Results

Theil-Sen's Slopes
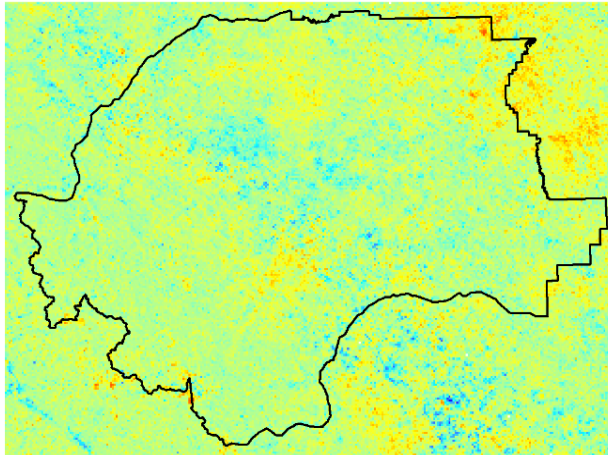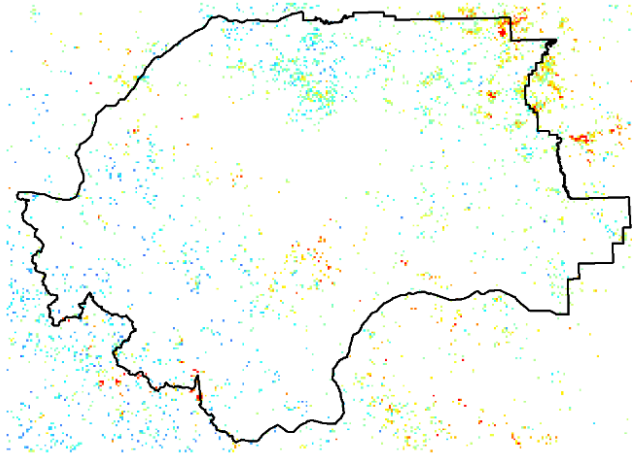
Mann-Kendall p-Values

Slope Magnitude

-1.83   1.81

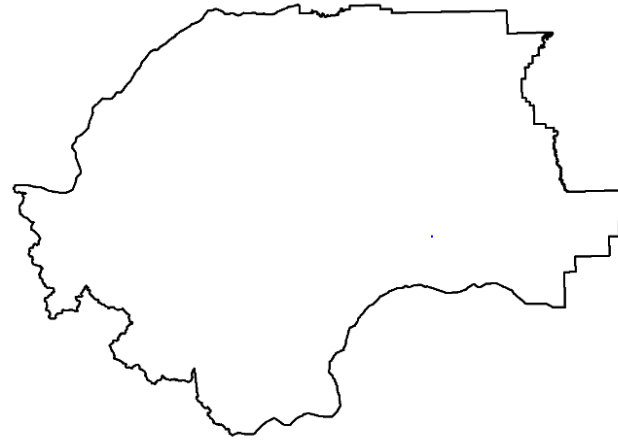p-Value of Slope

<0.001   >0.999
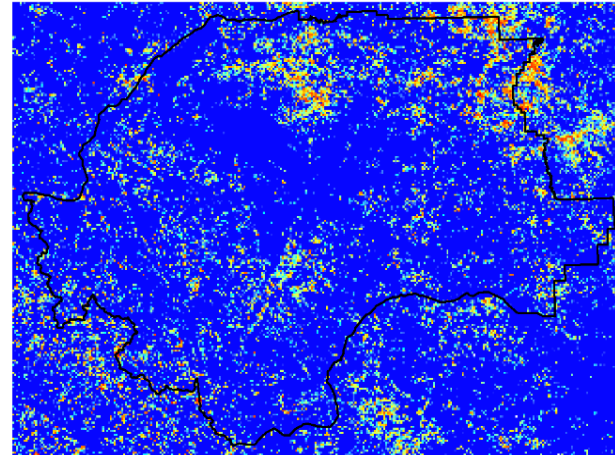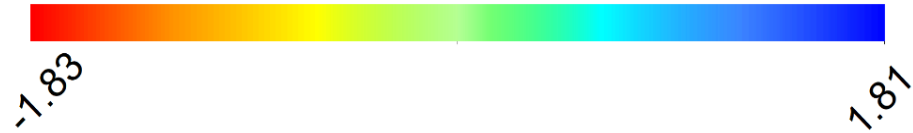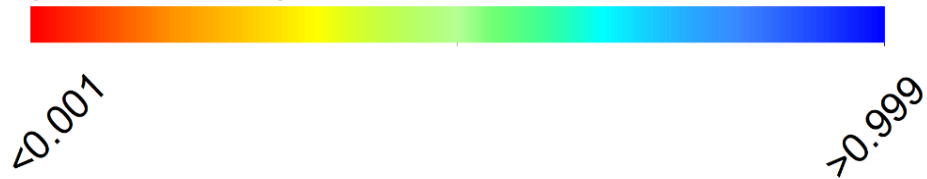
Results

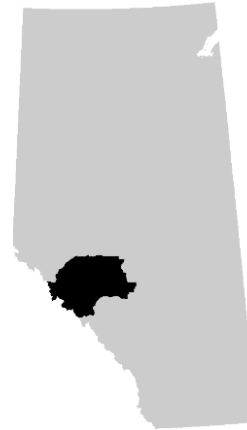**Significant Negative Slopes**   **Significant Positive Slopes**

Bear Activity Date Change

Greater   Lesser

Key Takeaways

Individual spring activity dates in grizzly bear are largely dictated by snow melt characteristics.

Melt end date, melt rate, and melt consistency all influenced when individuals began to access their larger annual home ranges.

Earlier and more rapid melt resulted in earlier activity dates.

Key Takeaways

Predicted bear activity dates across the Yellowhead region indicated that bear activity is likely unchanged or becoming earlier due to snow

Depending on how bear food phenology is changing (Cam!!) this could result in increased food scarcity at a time when available forage is already scarce

Finally, an increase in food scarcity could lead to increased human – grizzly bear conflict in areas with human populations and advancing snow melt.

Thank You for Attending