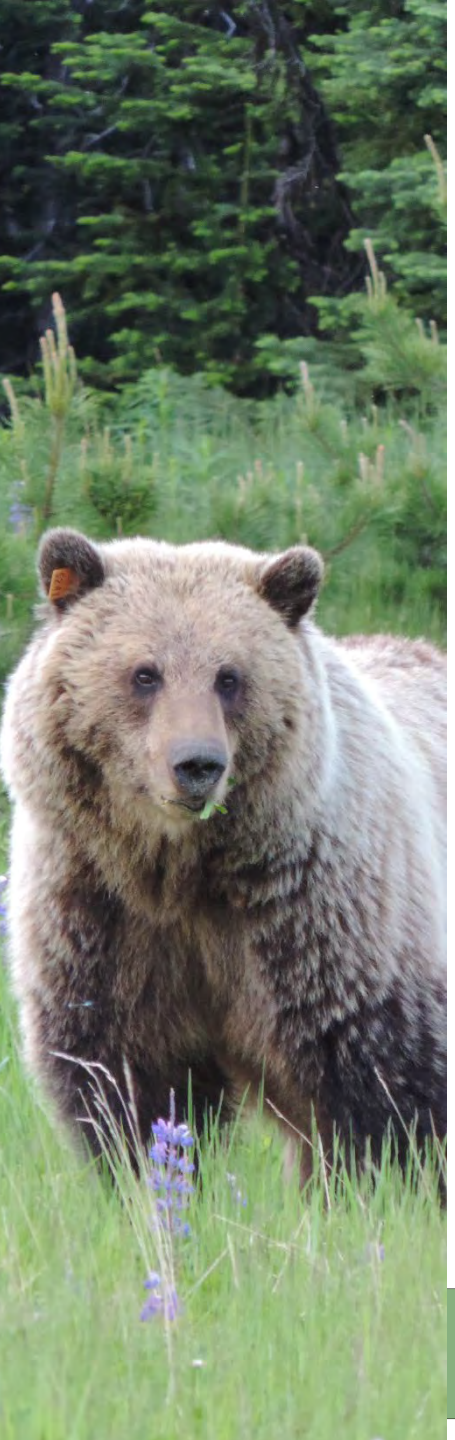


Grizzly-PAW: Grizzly Population Assessment in yelloWhead: Integrated Approaches Toward Conserving Grizzly Bears On A Human-Dominated Landscape Of Western Alberta.

Show Case of Research Outcomes

Nicholas Coops

October 18th 2019

Thank You for Attending

- Many thanks to all attendees for travelling long distances and taking time from their busy schedules
- Special thanks to industrial sponsors for attending, both this morning and this afternoon
- FRI Research
- TransCanada for hosting us in Calgary
- University faculty, graduate students and postdocs – some of whom now have jobs and taken time off to attend

Context for the Proposal

Conservation of Grizzly Bears in Western Alberta

- Grizzly bears are considered a threatened species in Alberta from 2010
- From a management perspective there is uncertainty about current population levels and how anthropogenic landscape change and human activities have affected grizzly bears in Alberta in the past and into the future.

- Within Yellowhead Bear Management Area, the first grizzly bear population unit inventory was in 2004 with the population estimated (based on DNA sampling) was 36 bears

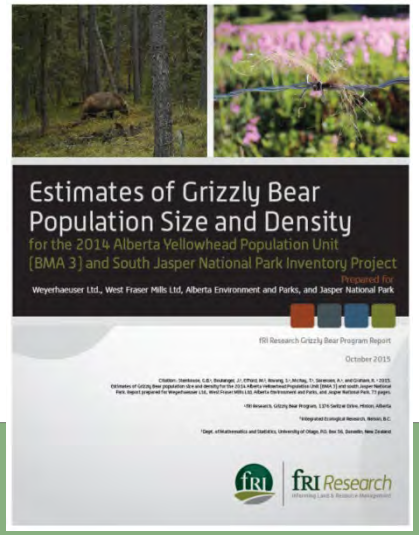
- A decadal survey was completed by FRI Research (Stenhouse) in 2014, which spurred this proposal.

- The 2014 inventory estimated 71 using DNA in Yellowhead BMA indicating a 7% annual population rate increase

- This is very encouraging given

  the significant resource extraction

  and human activity in the area



a place of mind

THE UNIVERSITY OF BRITISH COLUMBIA

University of Victoria

UNIVERSITY OF SASKATCHEWAN

Teck

ConocoPhillips Canada

TransCanada

Shell

SEVEN GENERATIONS ENERGY LTD

REPSOL

West Fraser

WESTMORELAND COAL COMPANY

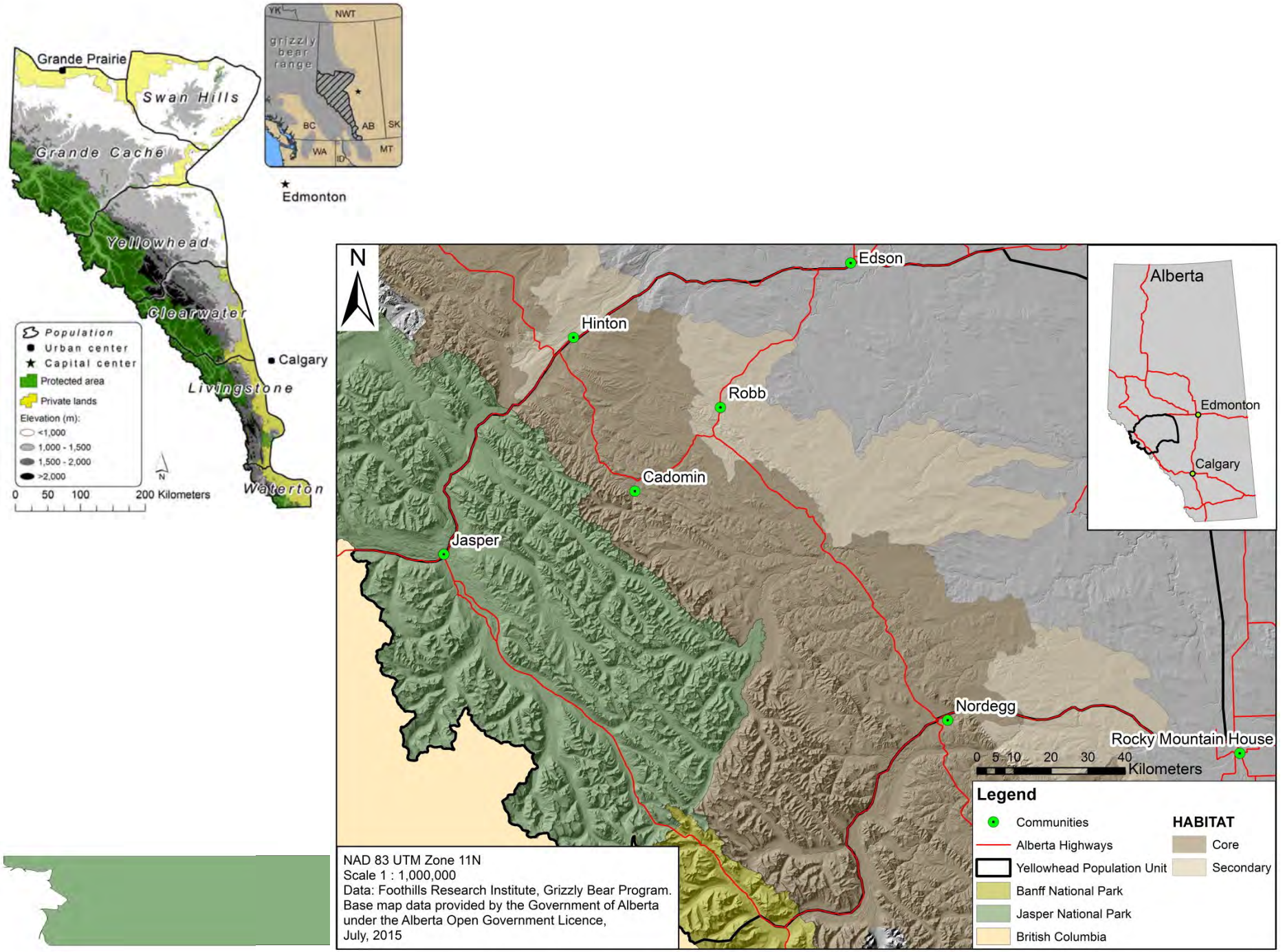
Forest Resource Improvement Association of Alberta

Alberta Newsprint Company

Weyerhaeuser

fRI Research

Informing Land & Resource Management

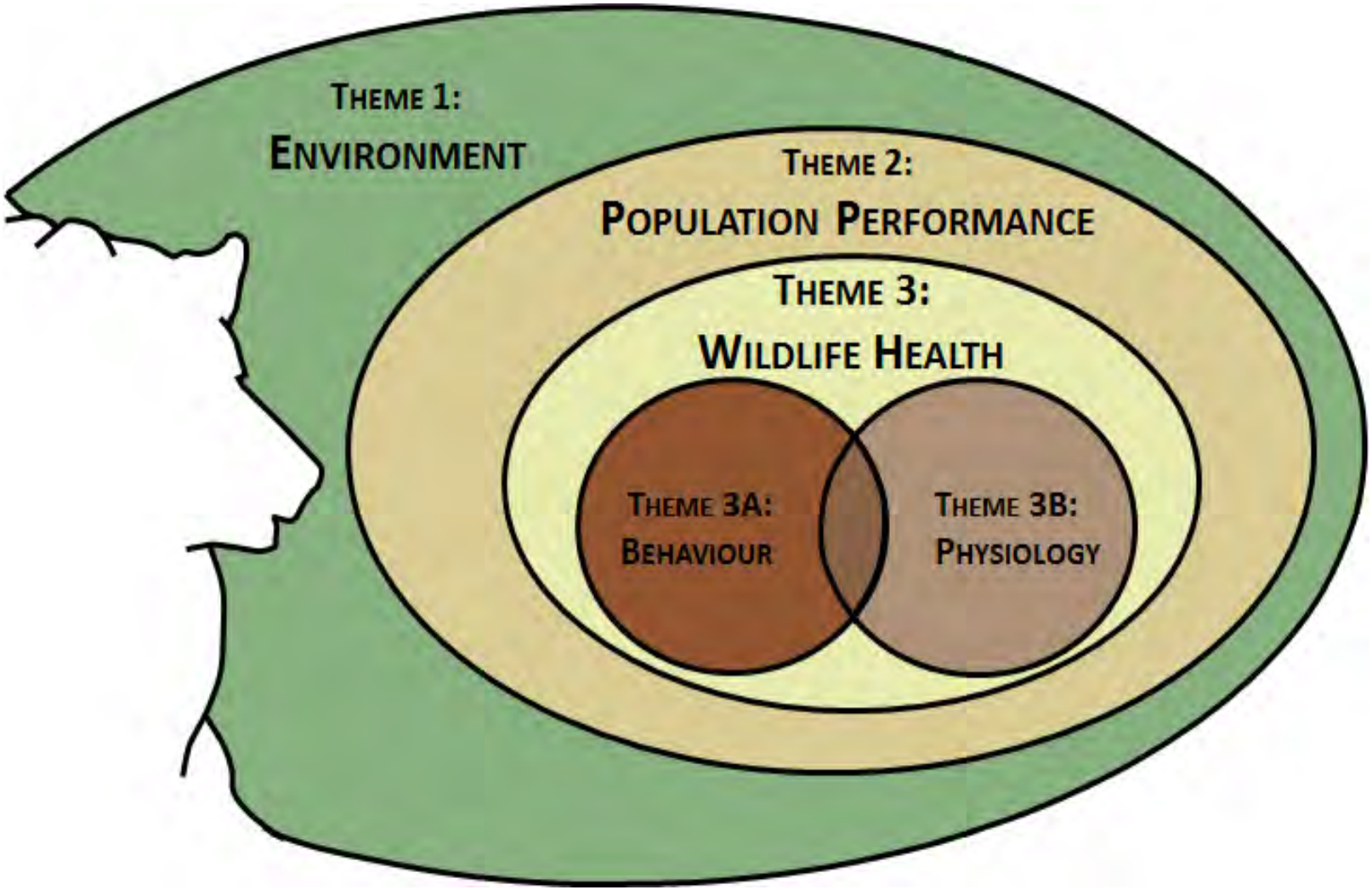

Grande Prairie
Swan Hills
Grande Cache
Yellowhead
Clearwater
Livingstone
Waterton
Calgary
Edmonton
YK
NWT
grizzly bear range
BC
AB
SK
WA
ID
MT
Population
Urban center
Capital center
Protected area
Private lands
Elevation (m):
<1,000
1,000 - 1,500
1,500 - 2,000
>2,000
N
0 50 100 200 Kilometers
N
Edson
Hinton
Robb
Cadomin
Jasper
Nordegg
Rocky Mountain House
0 5 10 20 30 40
Kilometers
Alberta
Edmonton
Calgary
Legend
Communities
Alberta Highways
Yellowhead Population Unit
Banff National Park
Jasper National Park
British Columbia
HABITAT
Core
Secondary
NAD 83 UTM Zone 11N
Scale 1 : 1,000,000
Data: Foothills Research Institute, Grizzly Bear Program.
Base map data provided by the Government of Alberta
under the Alberta Open Government Licence,
July, 2015

Industry Needs

8 key questions asked by Industry which this proposal aims to address

- NSERC Collaborative and Development Project (CRD)
  - 4 year project (3 years of funding)
  - Approved for funding in July 2016
  - End in June 2020

- As most projects are coming to an end an opportunity to see research outcomes and share internally within the project and with wider community

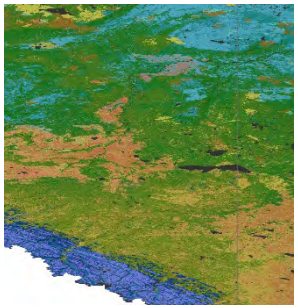


Three thematic areas of research and scales:

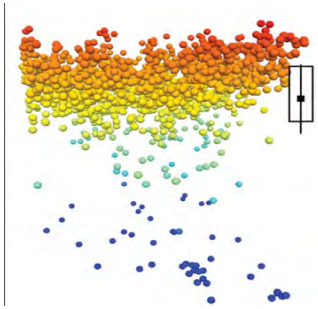
(1) the environment that sets the broader landscape and environmental context of the Yellowhead bear management unit;
(2) demographic responses relating to population status, size and change; and
(3) wildlife health which involves individual-animal responses relating to their (a) behaviour and (b) physiology

Today

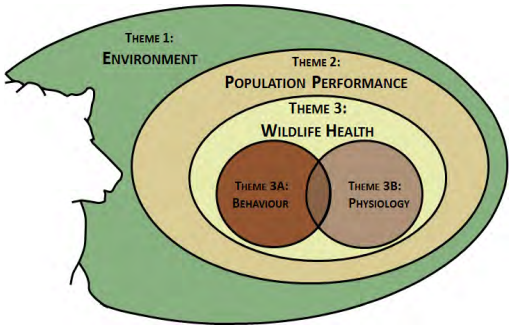
- *In the Afternoon:*
- Open to other interested researchers / industries
- Summary talks by the lead faculty members
- Posters on each project for further discussion
- Chance to discuss future research opportunities / ideas



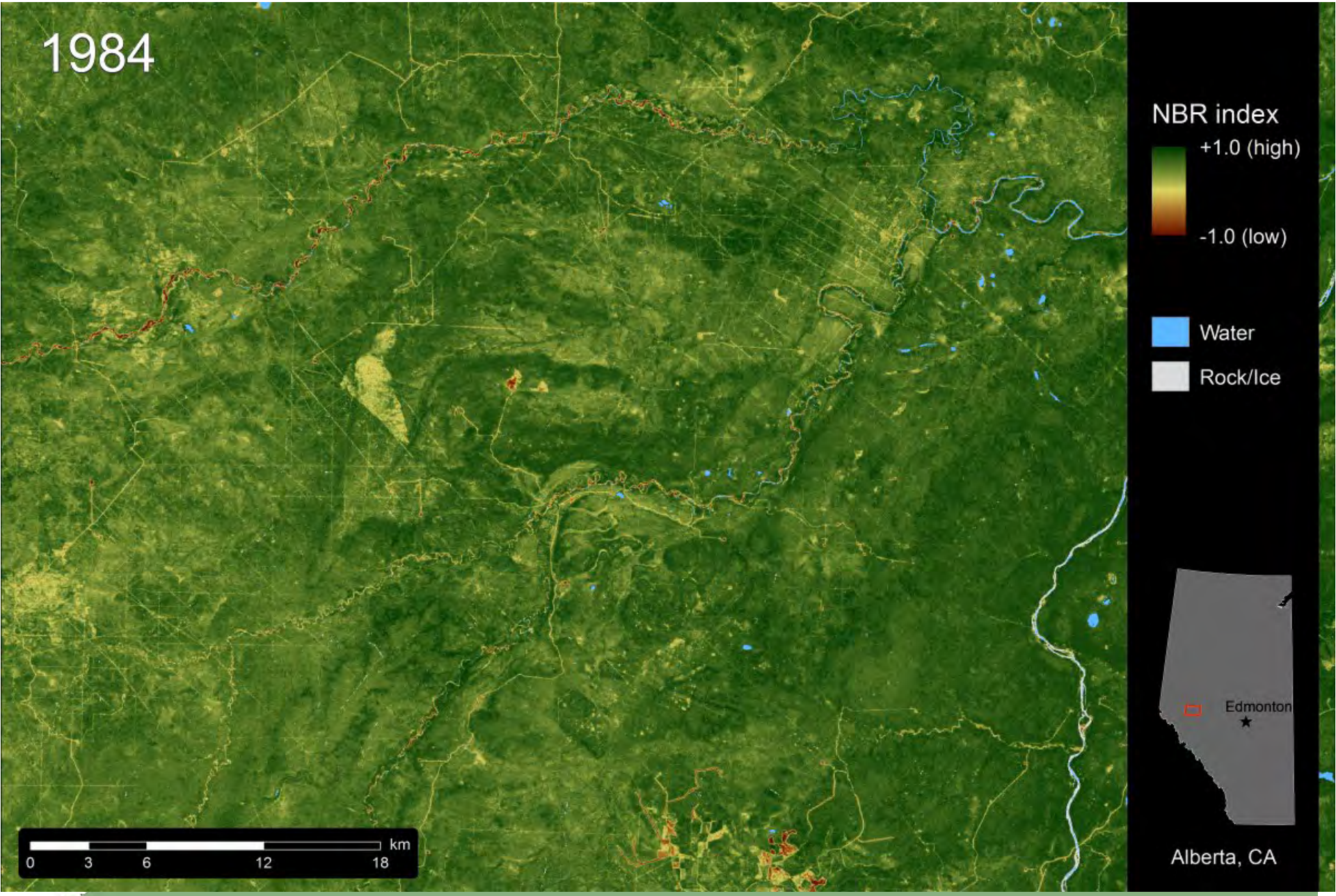
10°C
TESTCAMTA
18 MAR 2017 01:13 pm



What is the Current Environment in the Yellowhead and how is it changing for Grizzly Bears ?

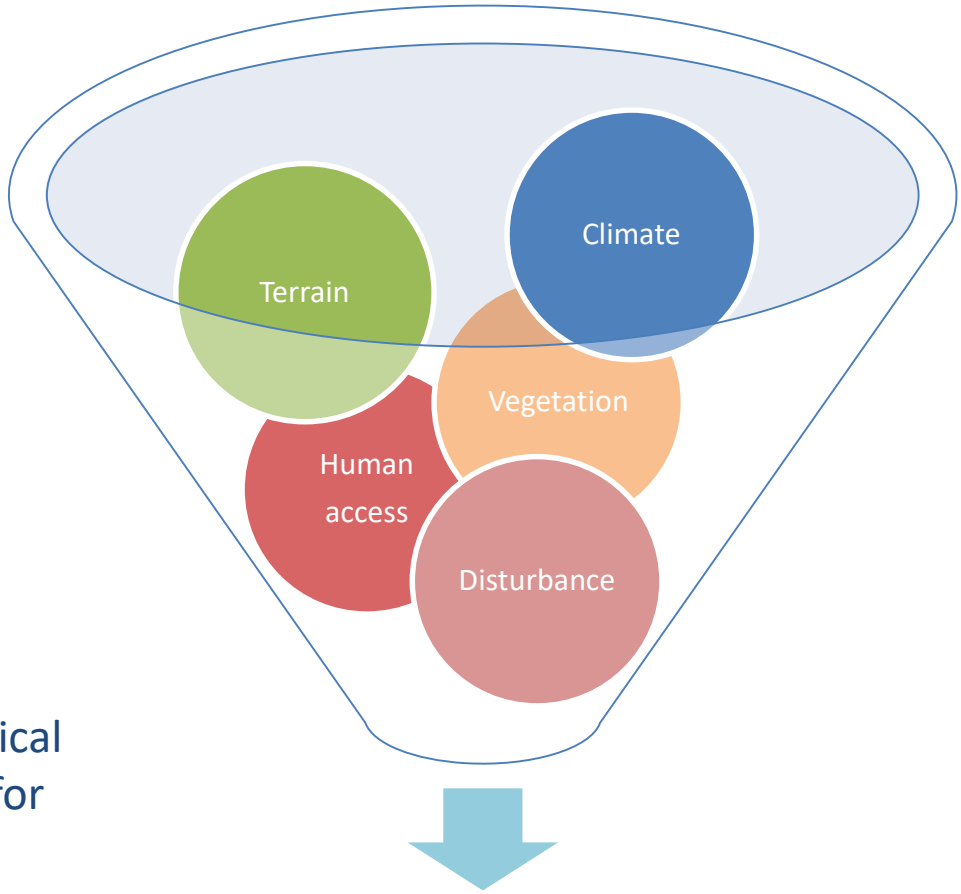


Can we describe patterns of forest harvesting, oil and gas exploration, mining as well as urban development ?

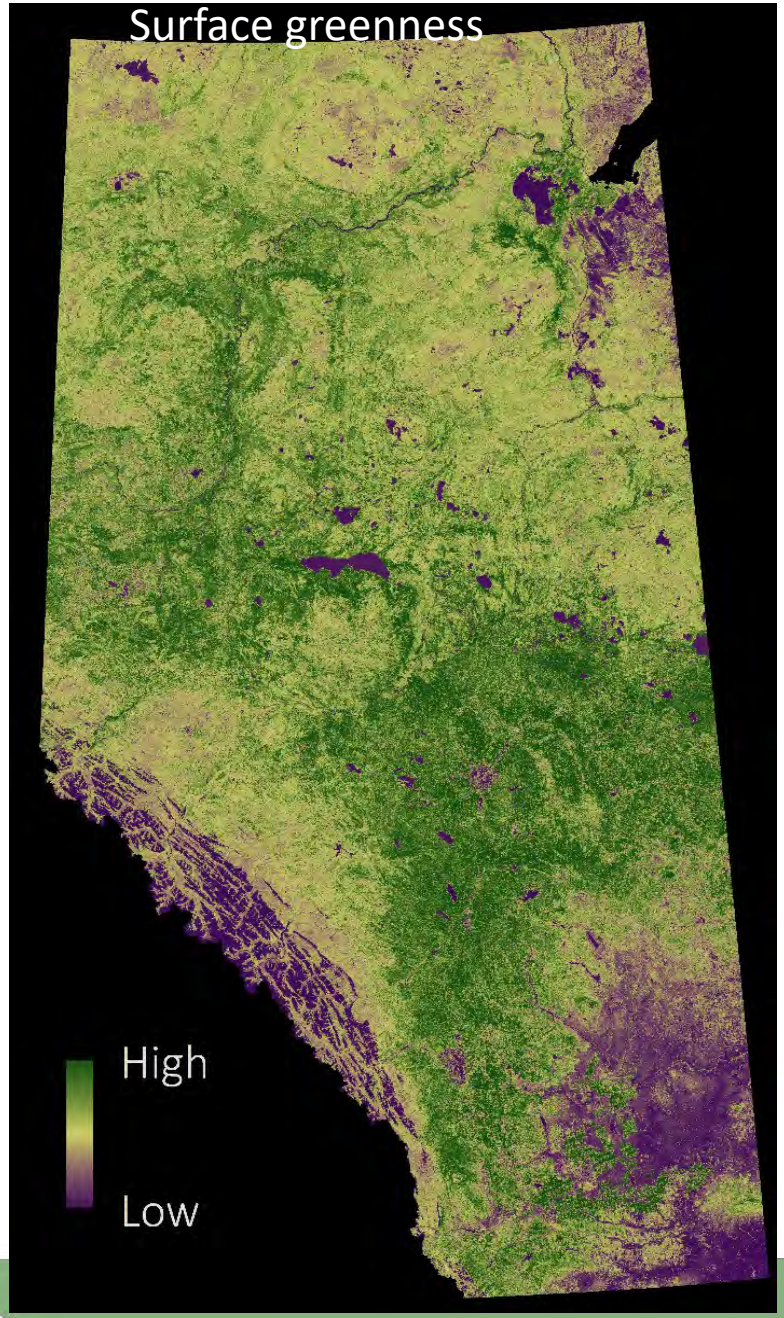

1984
NBR index
+1.0 (high)
-1.0 (low)
Water
Rock/Ice
Edmonton
Alberta, CA
km
0
3
6
12
18

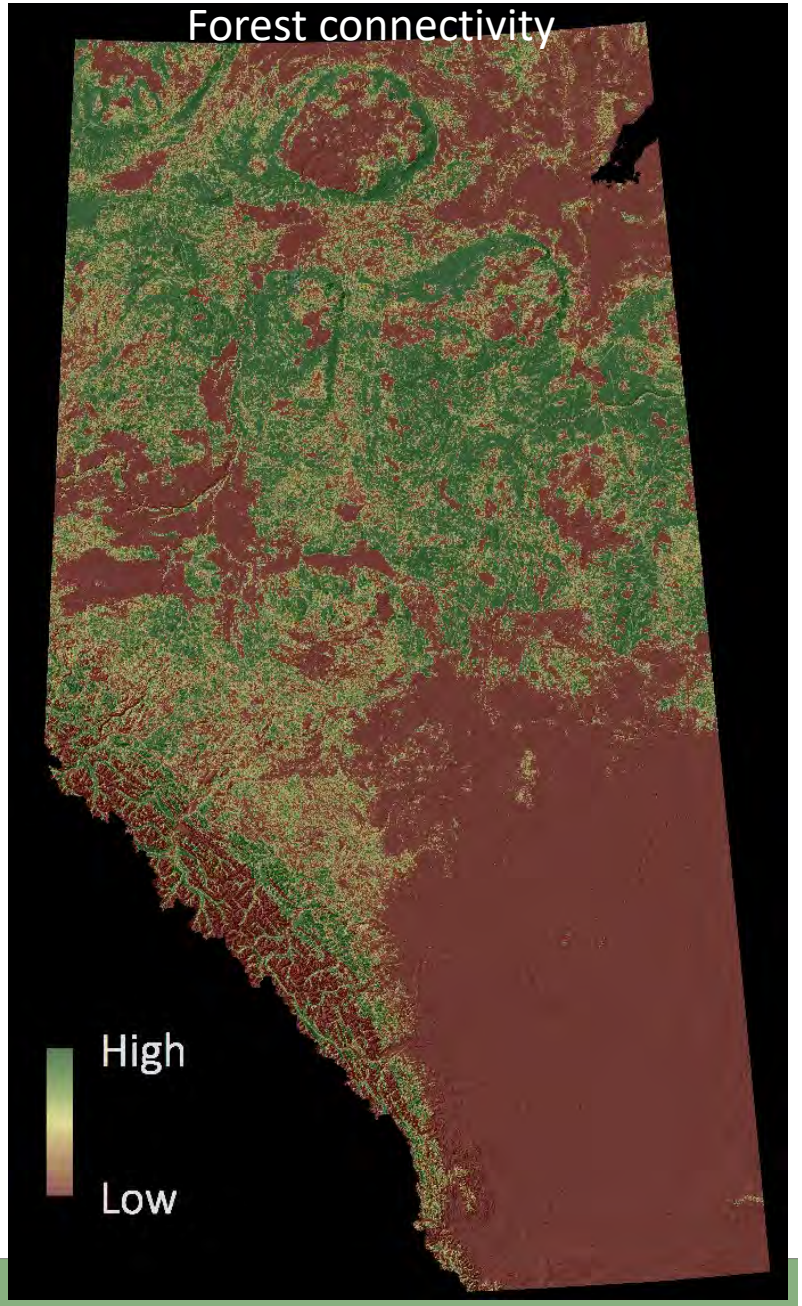
ECO-ANTHROMES

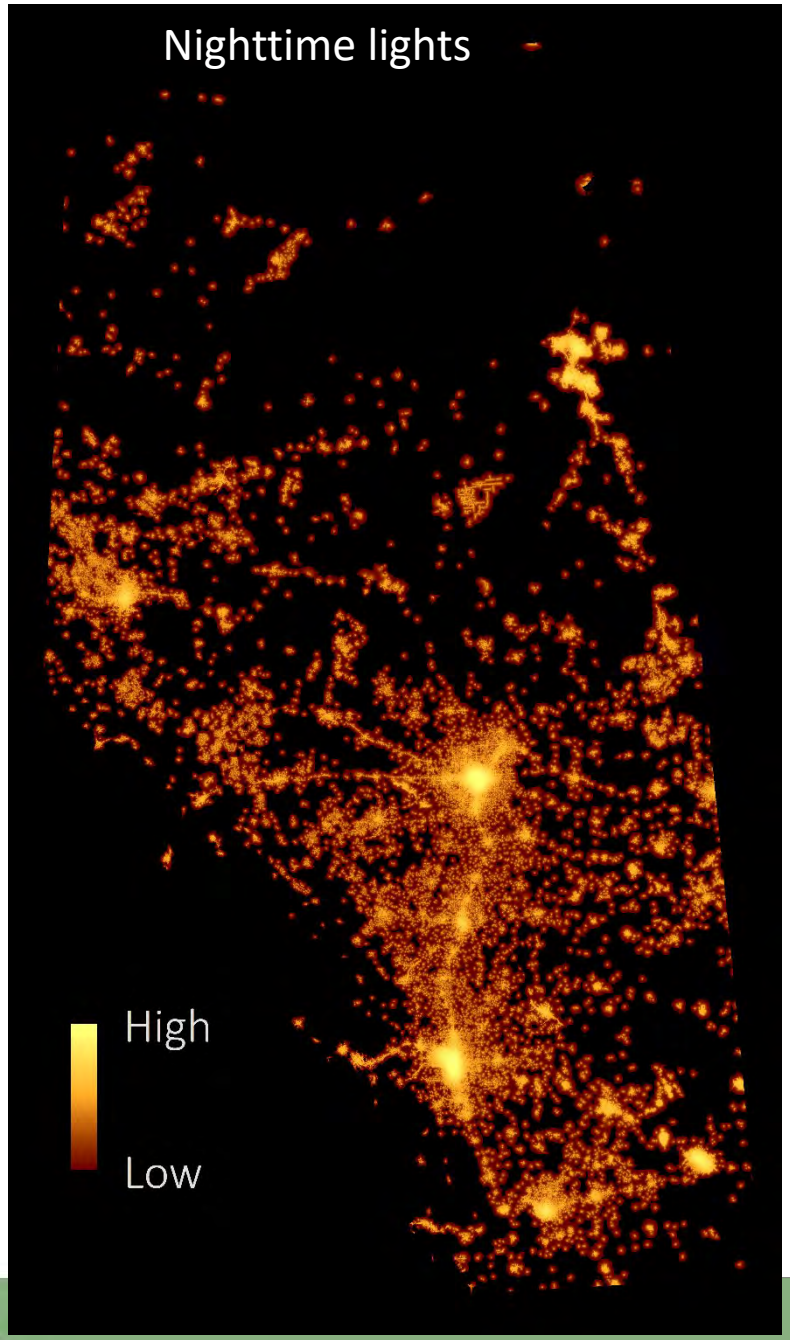
A wall-to-wall, disturbance-informed ecological regionalization (30 m) for Alberta, Canada for the period 2006 – 2015

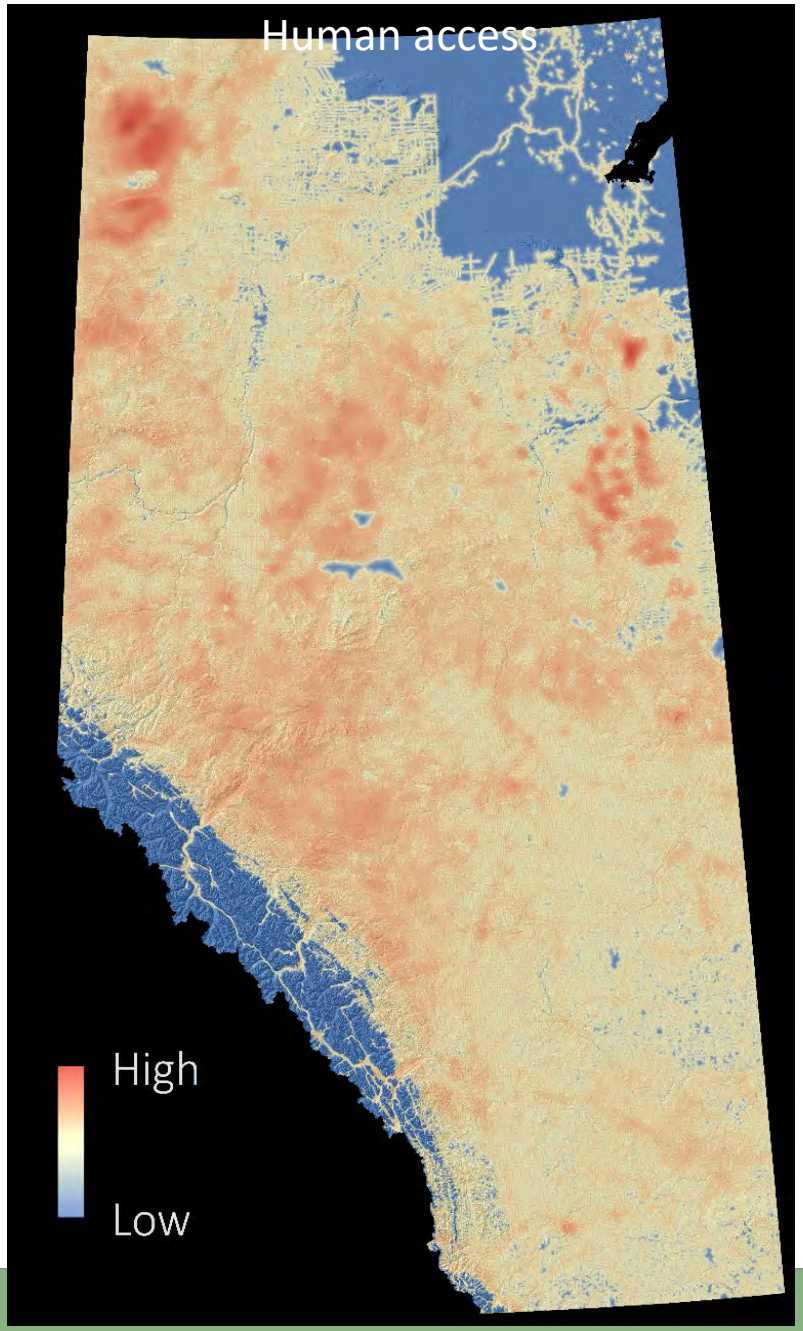


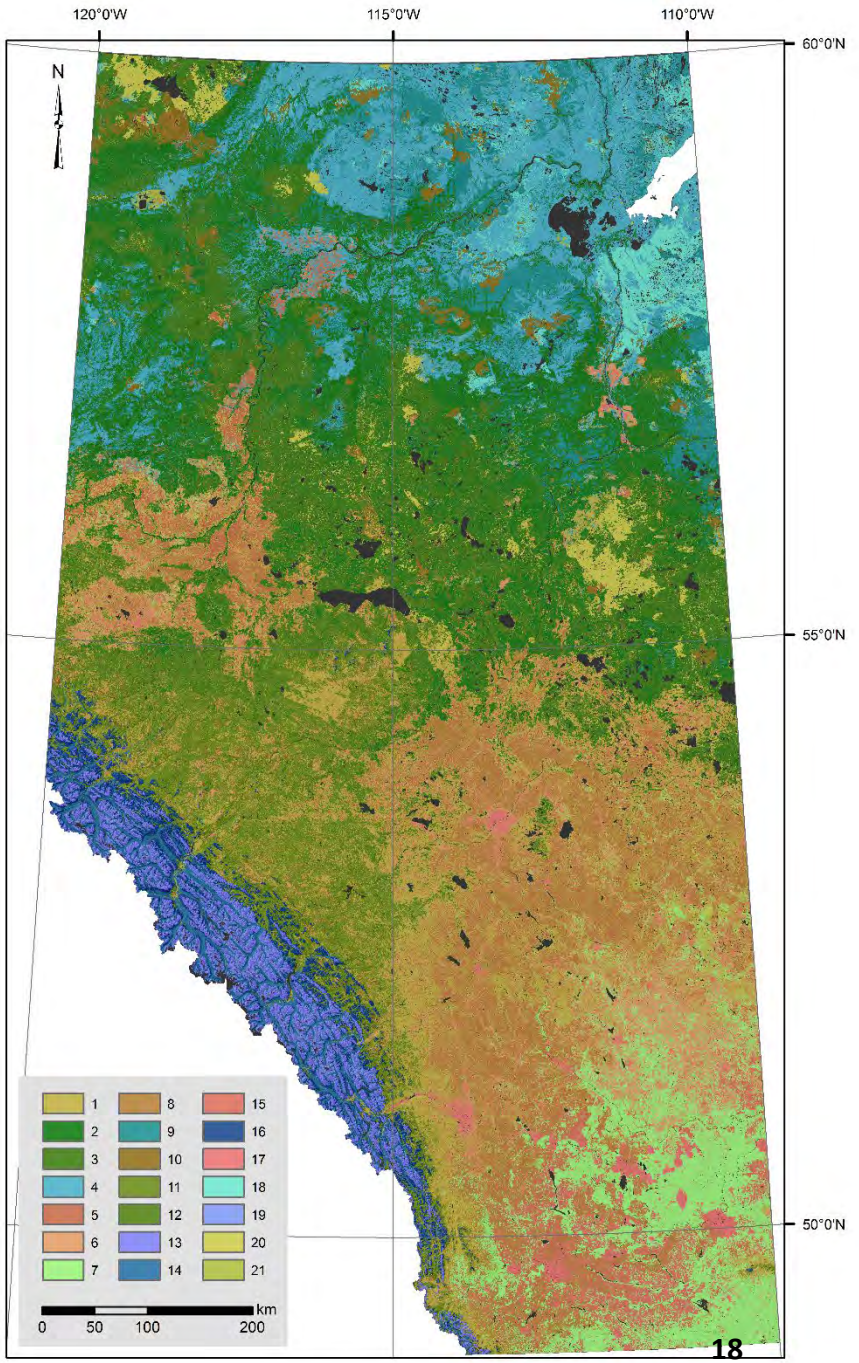
Two-step clustering algorithm

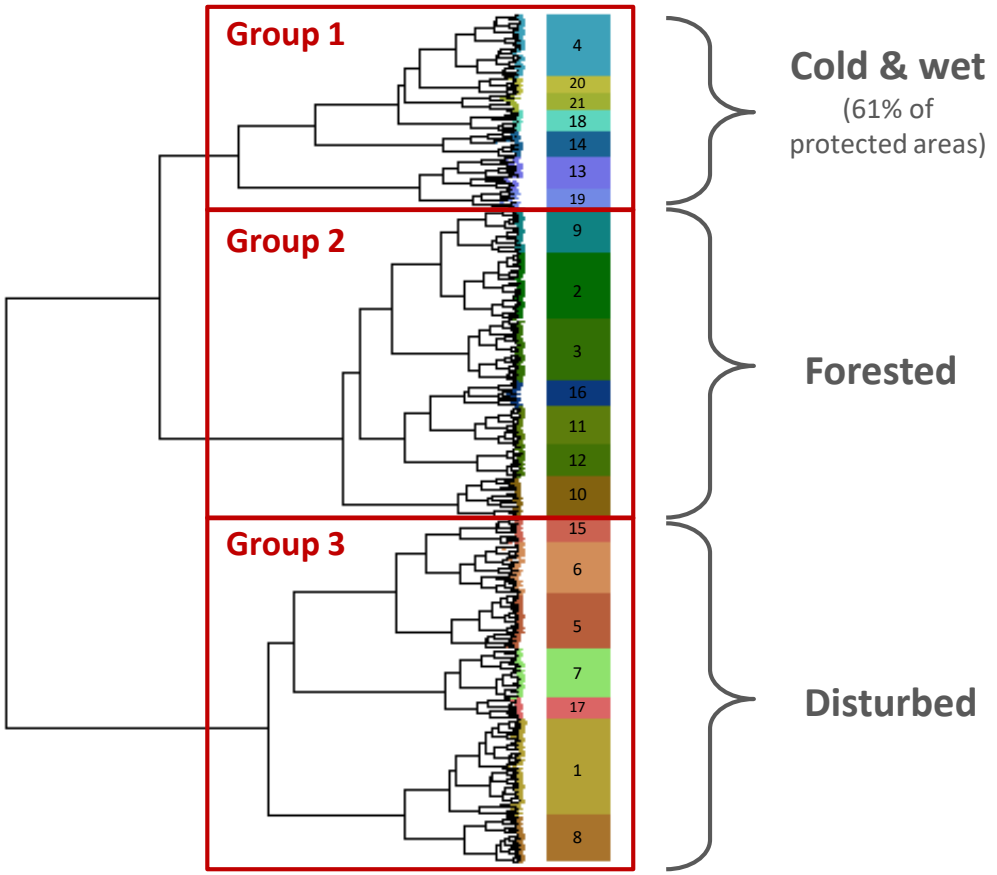

Surface greenness
High
Low

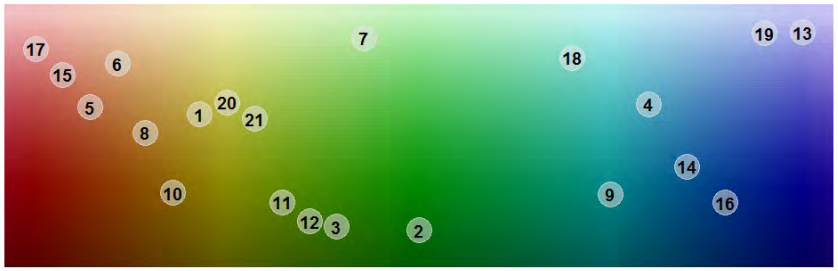

Forest connectivity
High
Low


Nighttime lights
High
Low

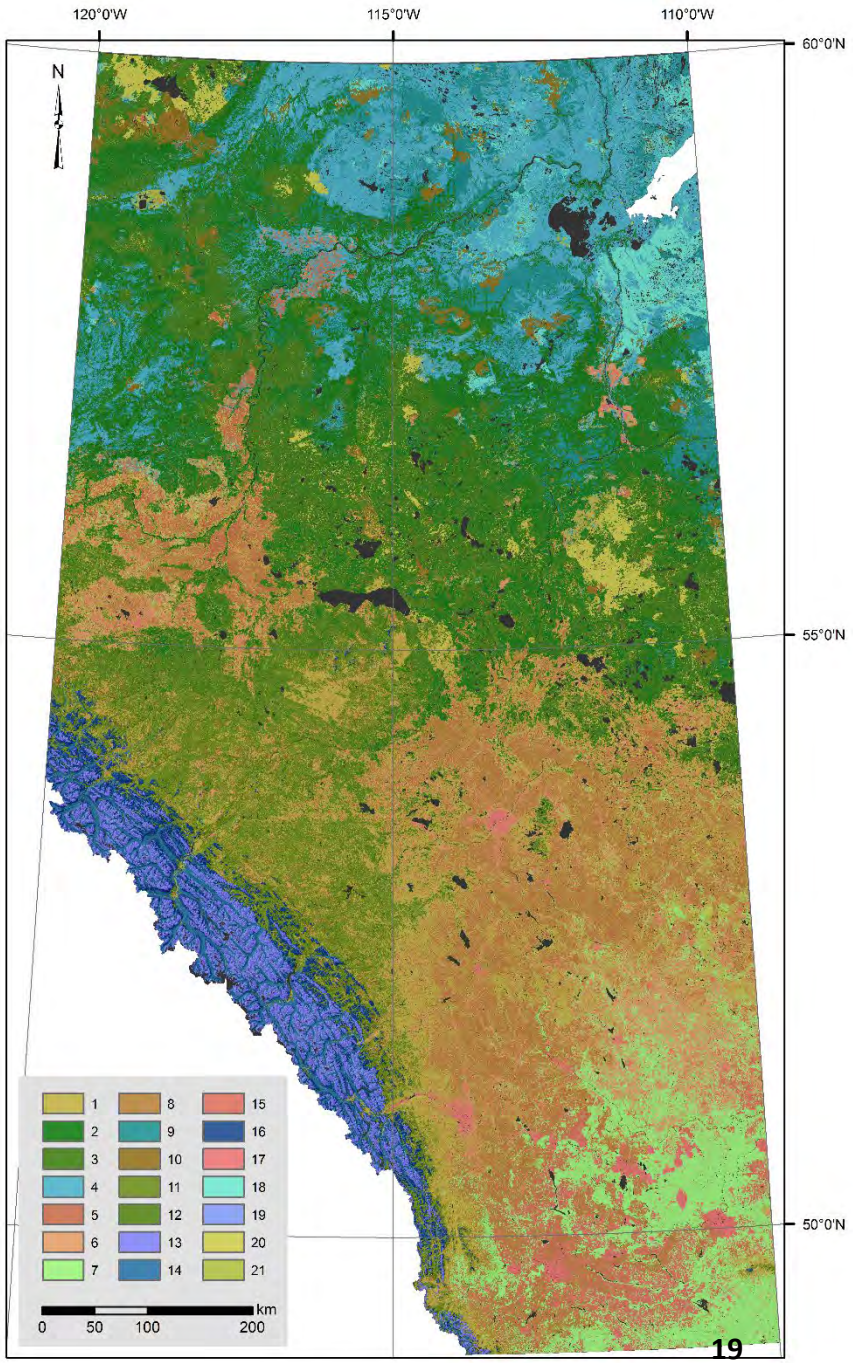

Human access
High
Low

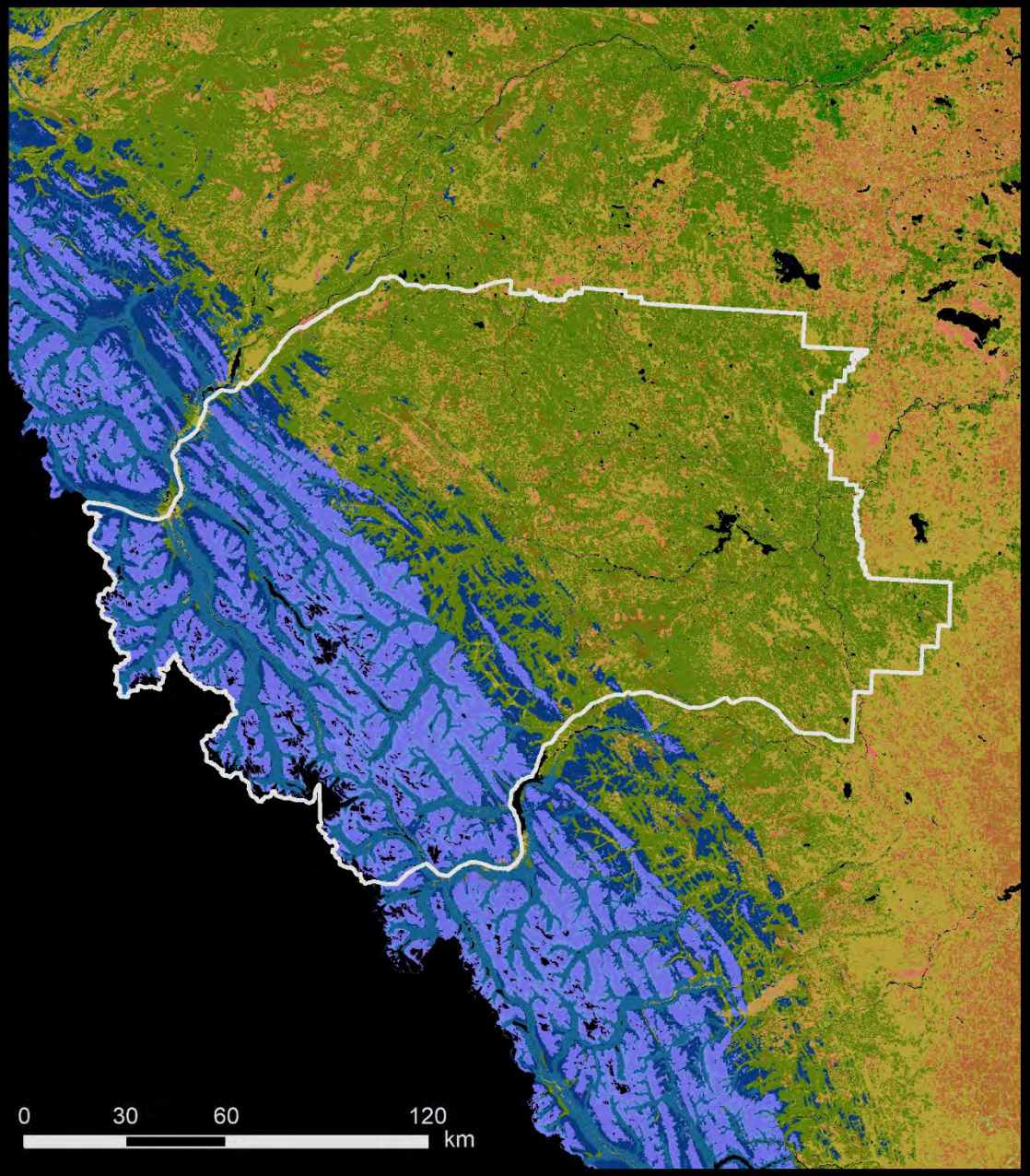

120°0'W
115°0'W
110°0'W
60°0'N
55°0'N
50°0'N
N
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
km
0
50
100
200

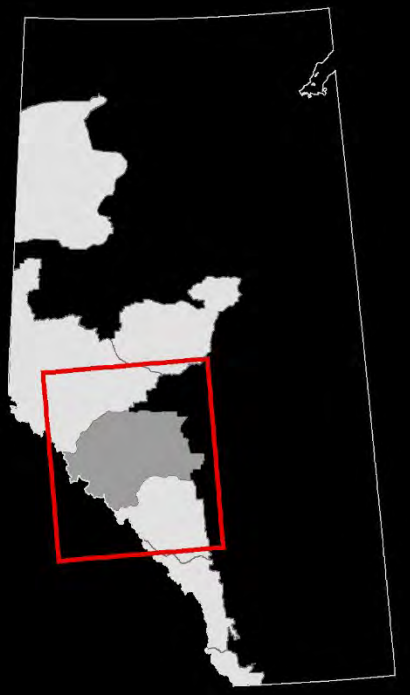




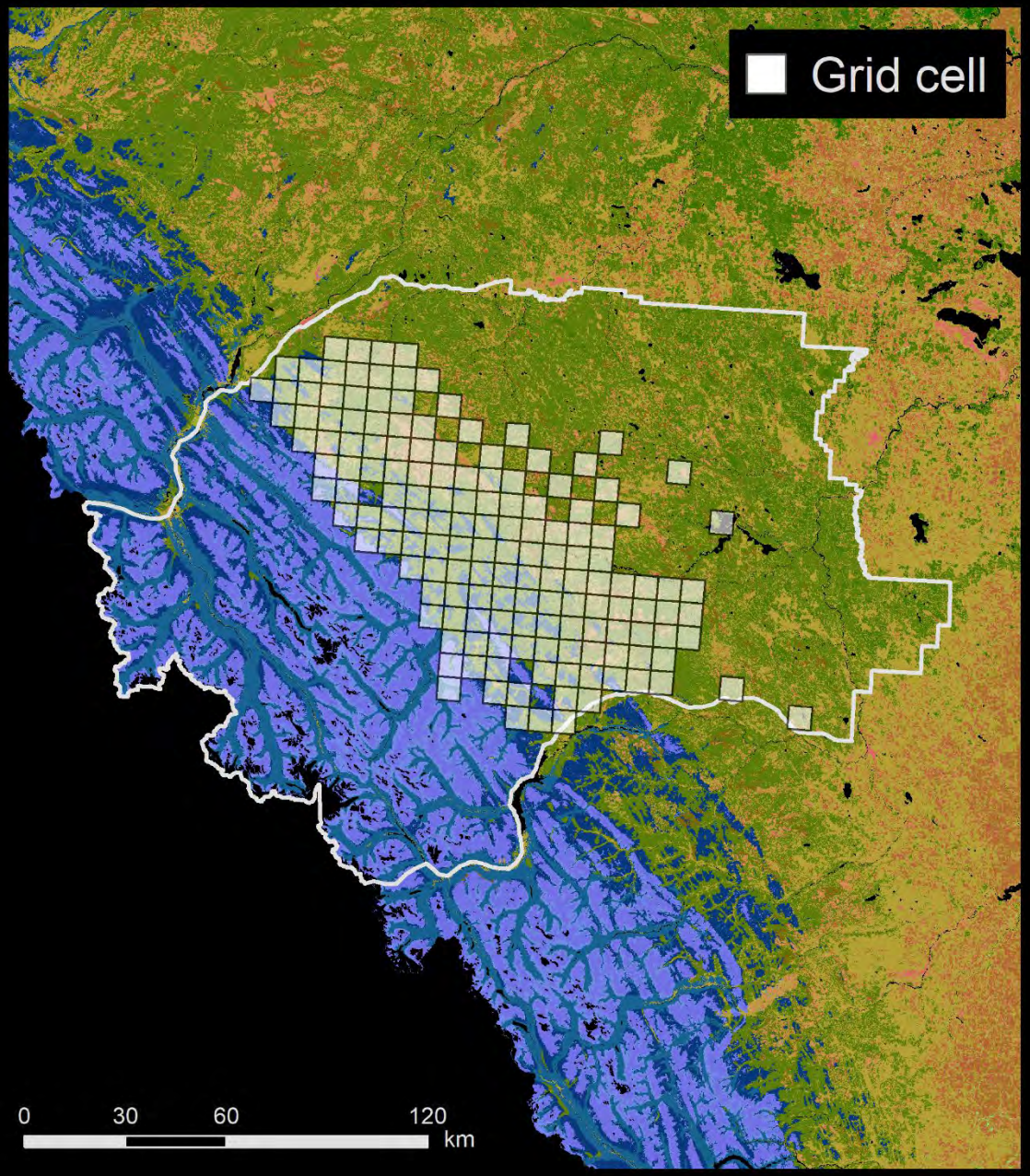
More forested

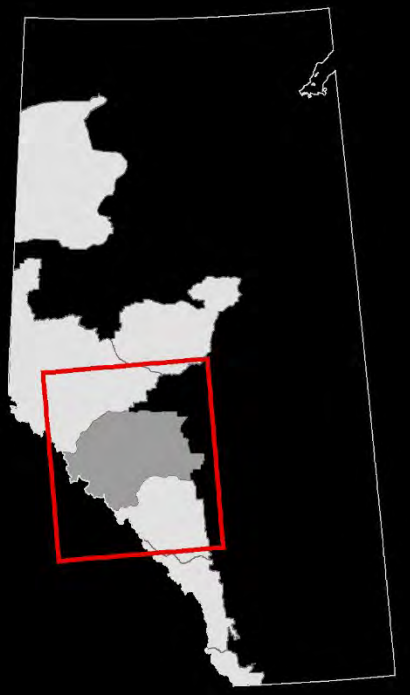


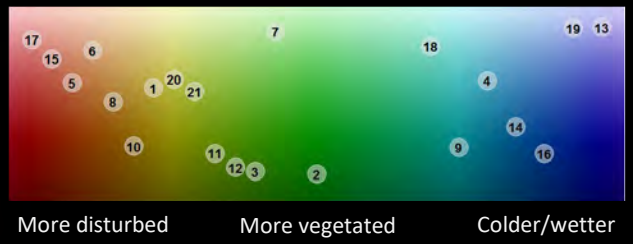

0
30
60
120
km



17
15
6
5
8
10
1
20
21
7
11
12
3
2
18
4
9
14
16
19
13
More forested
More disturbed
More vegetated
Colder/wetter


Grid cell
0
30
60
120
km




17
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6
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12
3
2
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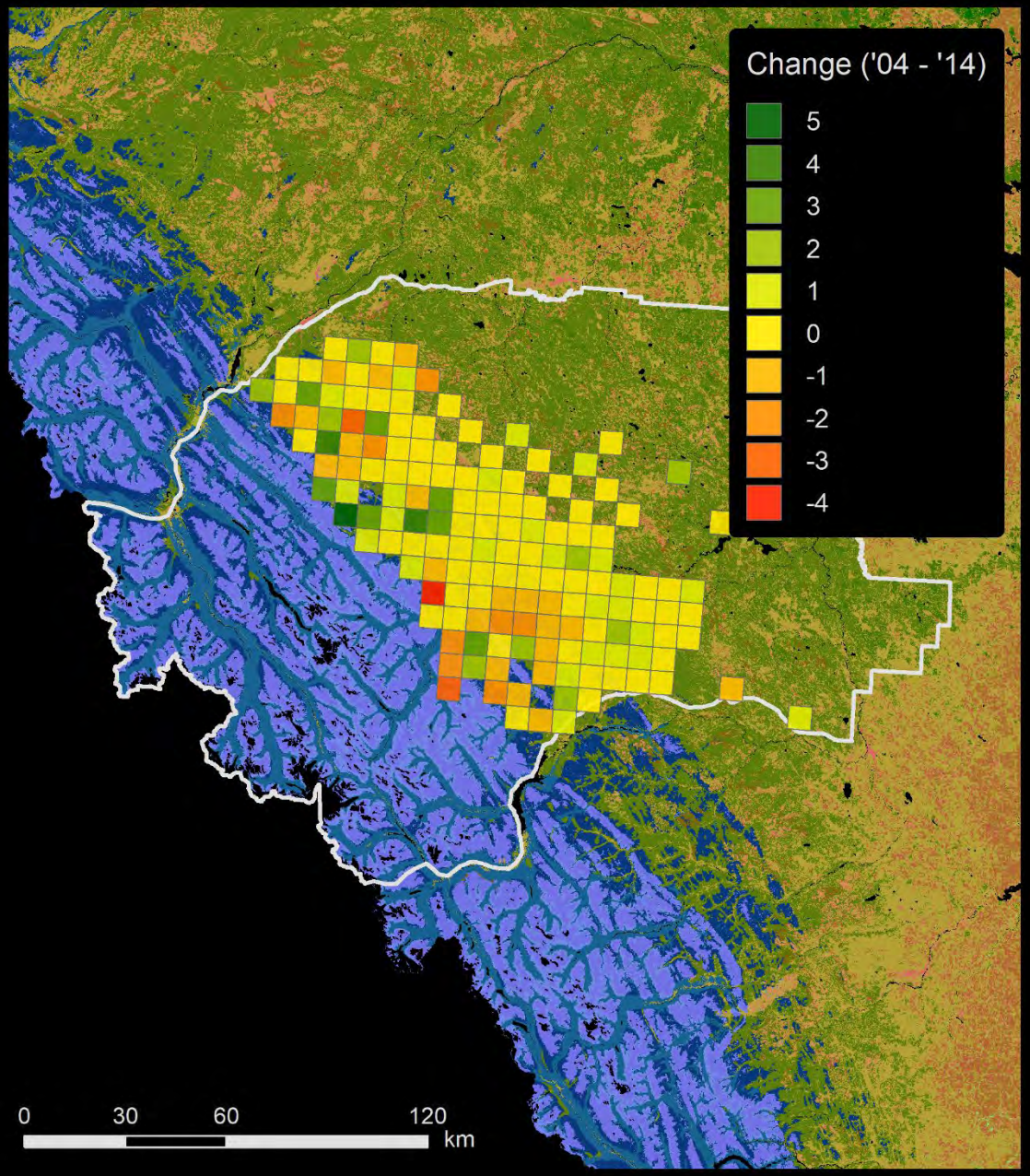
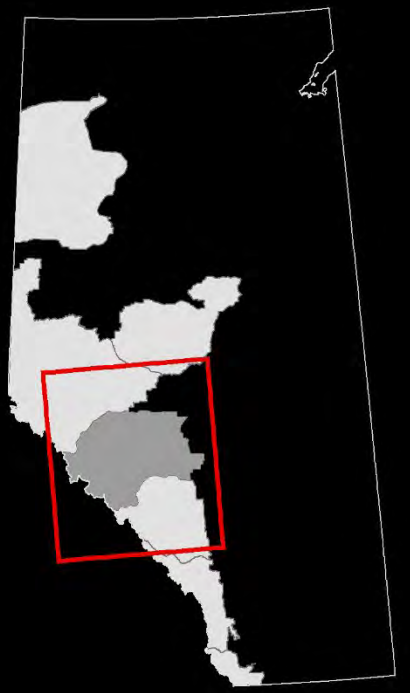
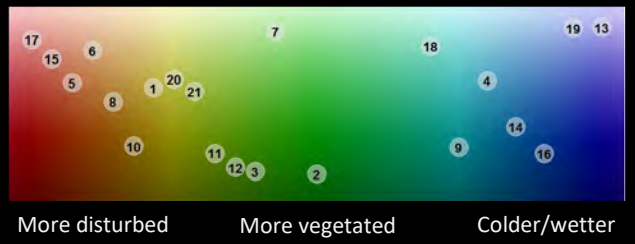
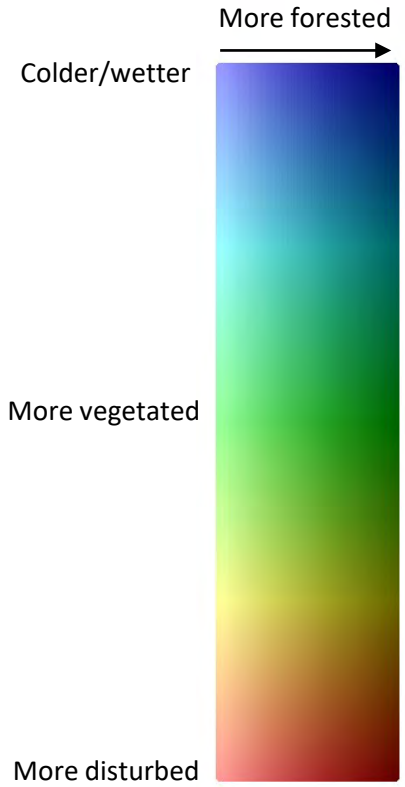
19
13
4
14
9
16
More disturbed
More vegetated
Colder/wetter
More forested

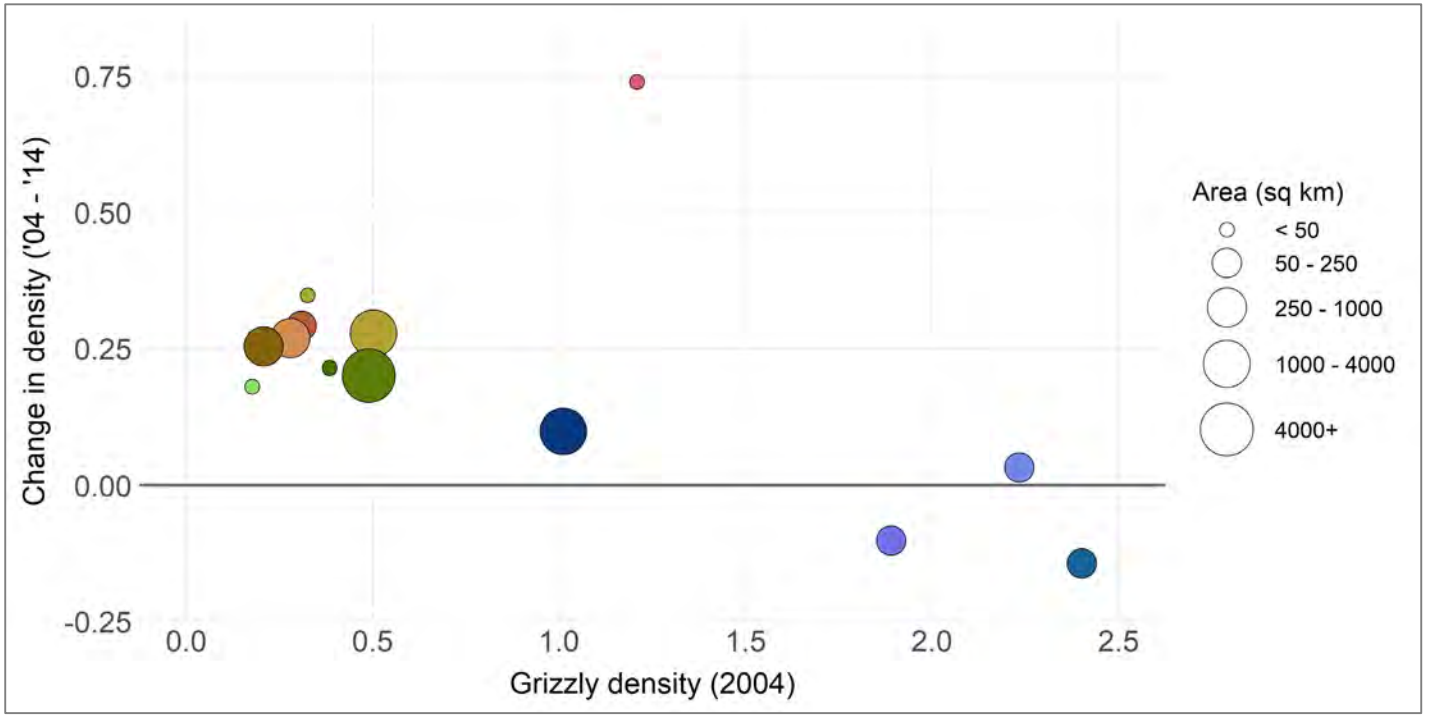

Change ('04 - '14)
5
4
3
2
1
0
-1
-2
-3
-4
0
30
60
120
km




17
15
6
5
8
10
1
20
21
7
11
12
3
2
18
19
13
4
14
9
16
More disturbed
More vegetated
Colder/wetter
More forested

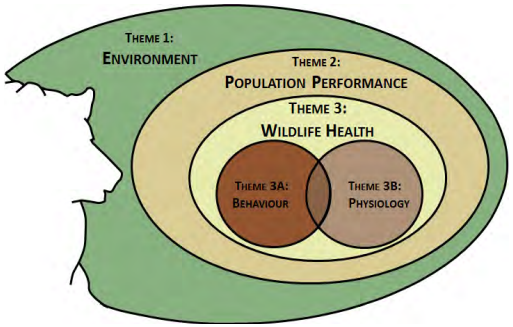
Change in grizzly density by EcoAnthromes





- Density increased more in **disturbed** regions
- Density is higher but declining in **colder/wetter** regions
- Grizzlies may be moving into lower elevation, human-disturbed areas from high-density regions

What about the Snow Cover and how it is changing ?



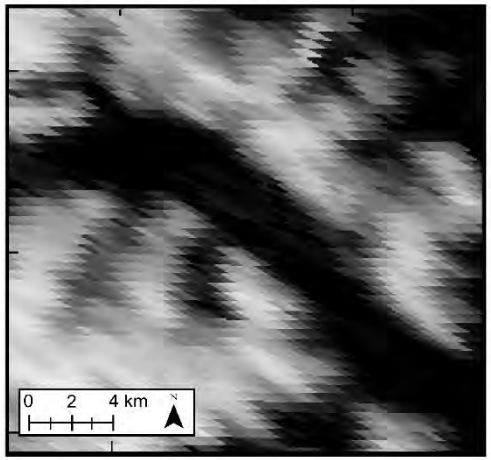
Are we seeing changes in snow accumulation and melt and is it impacting bear behaviour ?

SNOWARP: Daily 30-m Fractional Snow Covered Area (fSCA)

Dynamic Time Warping

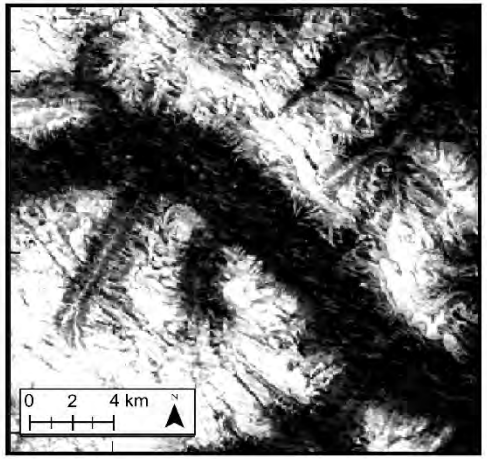
MODIS generated rule-sets used to re-arrange historical Landsat record

Daily MODIS NDSI snow cover (**500 m**)



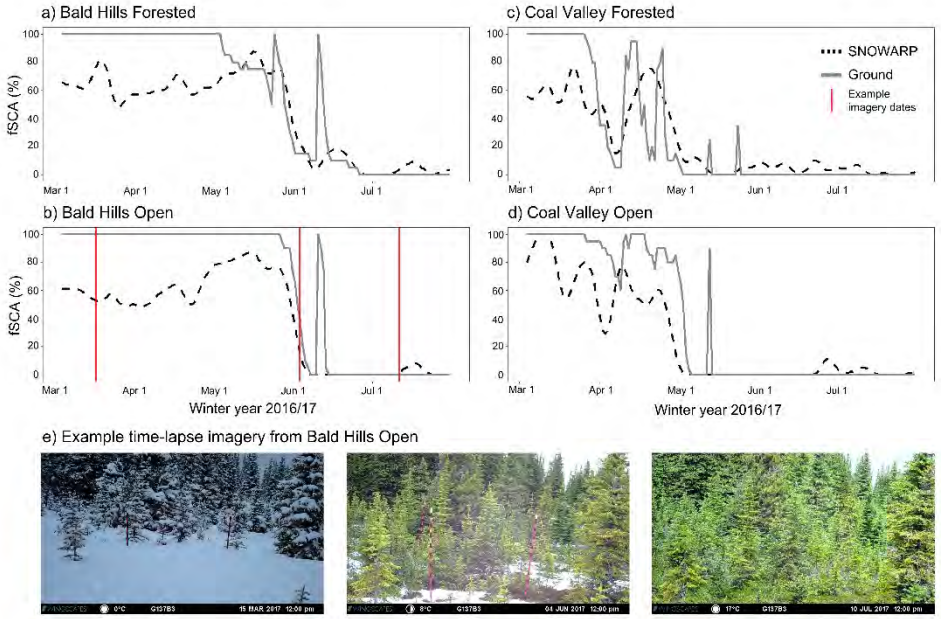
MOD10A1 - 102.9 Observations/year

Daily Landsat fractional snow cover (**30 m**)

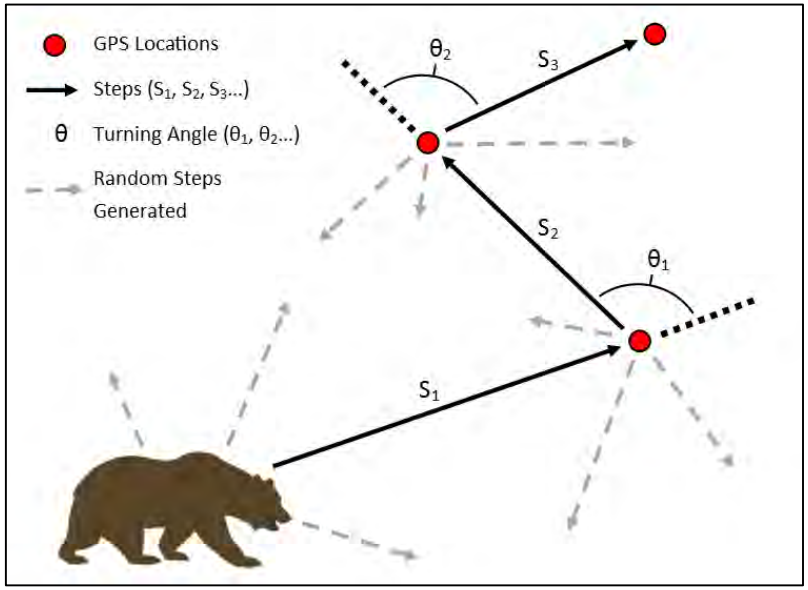


TMSCAG - 136.2 Observations/year

Ground-Based Testing



Modelling Approach

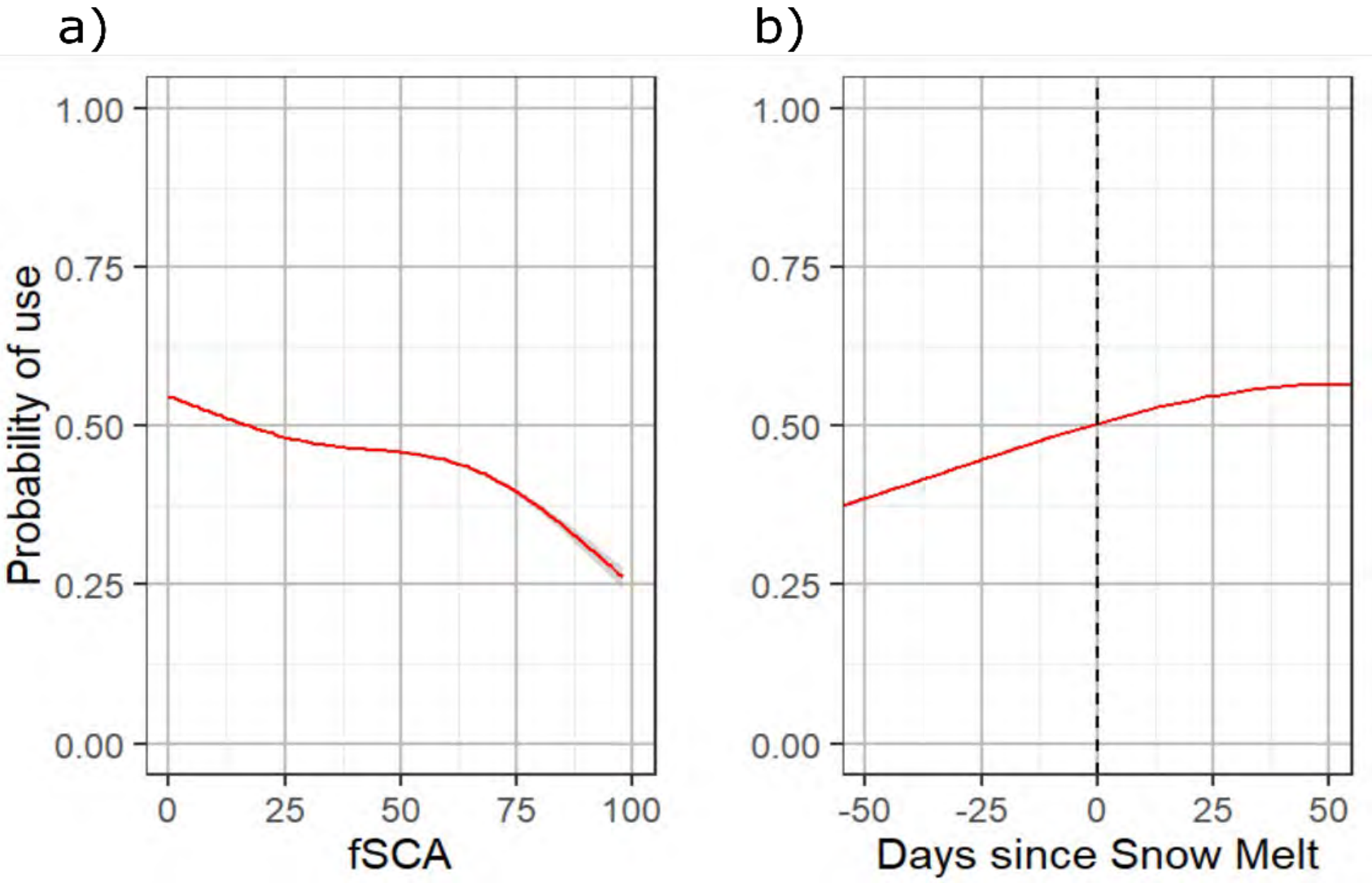


- Used vs. Available steps
- Core Environmental Variables
  - Step length, time of day, elevation, distance to road, terrain wetness, distance to forest edge, landcover, solar insulation
- Snow Variables
  - Fractional snow covered area, binary snow covered area, days since snow melt

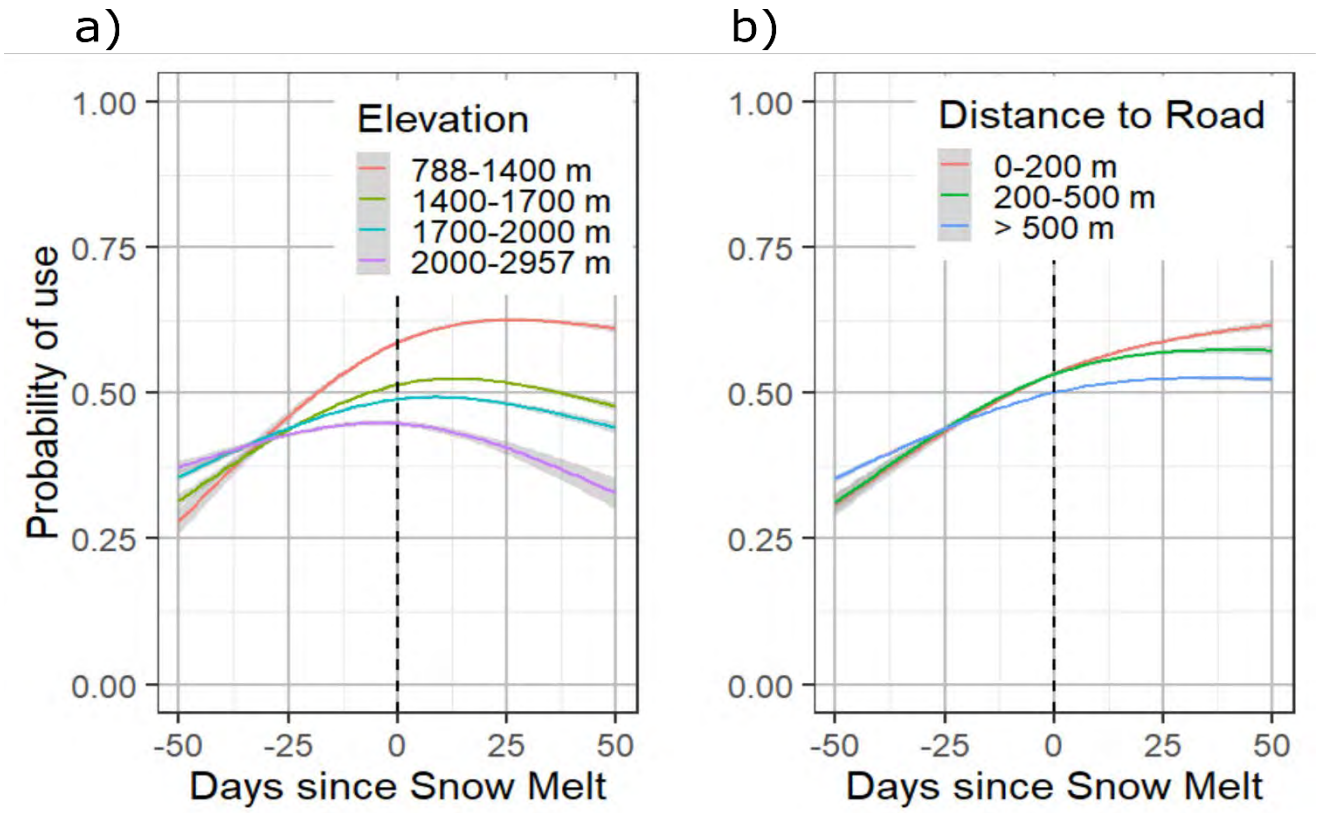
Model Comparison

Model	AIC Tally	Average AIC Weight
Core	11	0.1460
Days since snow melt (DSM)	9	0.1508
Binary snow covered area (bSCA)	5	0.1357
Fractional snow covered area (fSCA)	37	0.5675

How does snow influence grizzly bear use of the landscape?



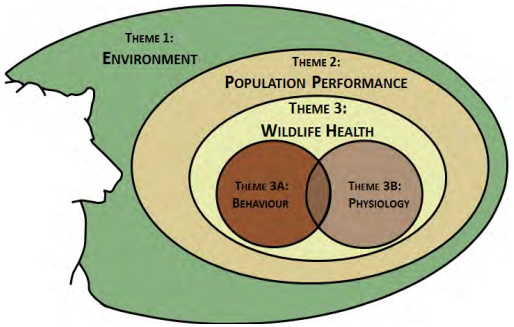
More likely to use snow free areas and areas where snow melted sooner



More likely to use lower elevation locations, especially when snow free/earlier melt

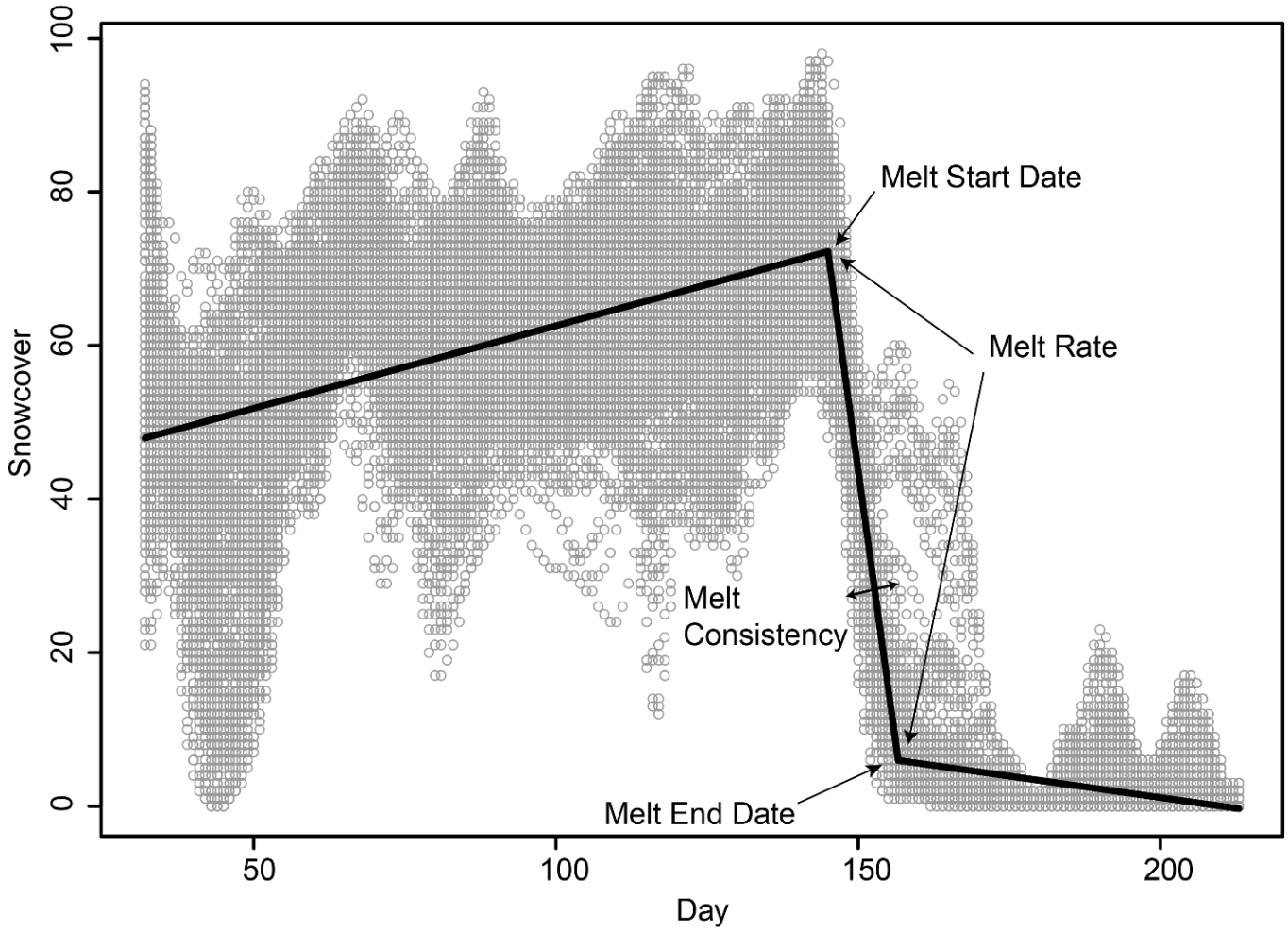
More likely to use locations closer to roads, especially after snow melt

What about the Snow Cover and how it is changing ?



Are we seeing changes in den emergence with changing snow conditions?

Methods


Snowcover
0
20
40
60
80
100
50
100
150
200
Day
Melt Start Date
Melt Rate
Melt
Consistency
Melt End Date

Results

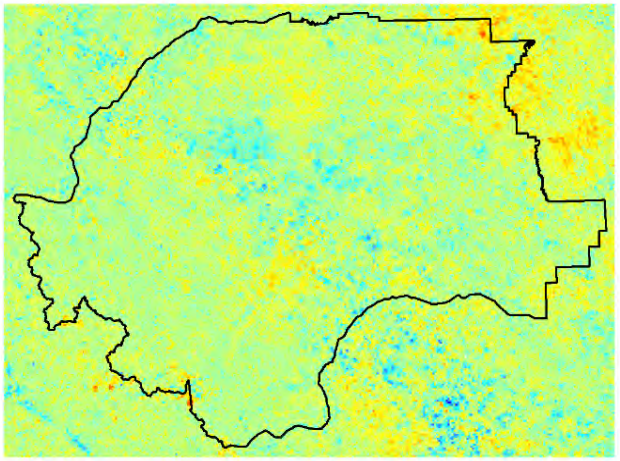
Individual bear activity date highly associated with three snowpack variables

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

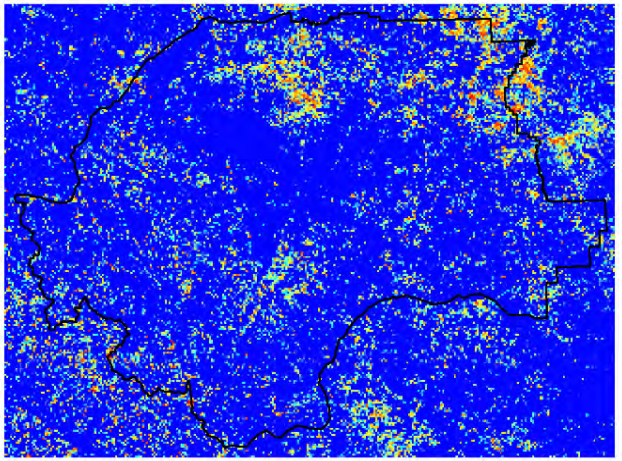
These three variables explained 45% of variation in individual activity date

Results

Theil-Sen's Slopes



Mann-Kendall p-Values



Slope Magnitude

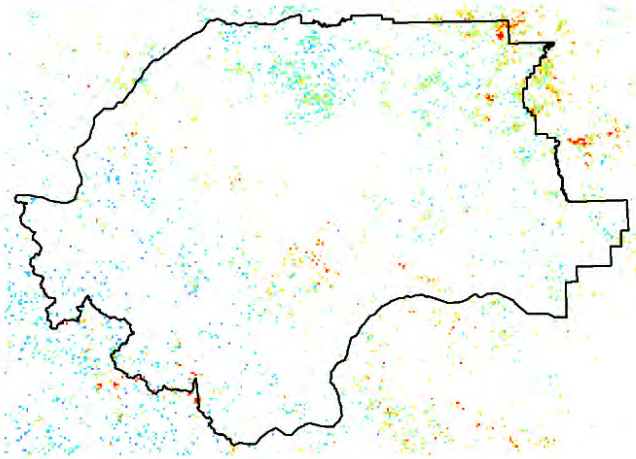
-1.83 1.81

p-Value of Slope

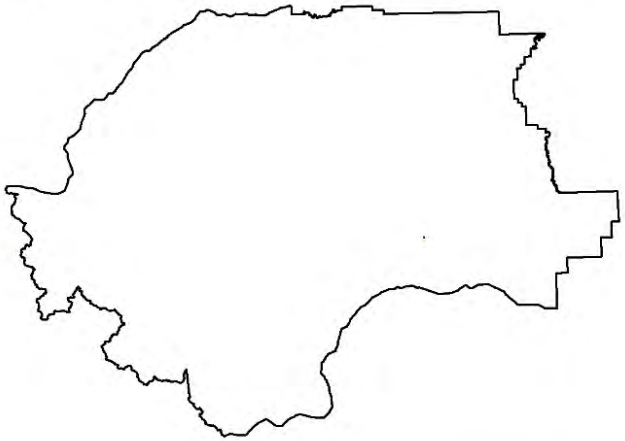
<0.001 >0.999

Results

Significant Negative Slopes



Significant Positive Slopes

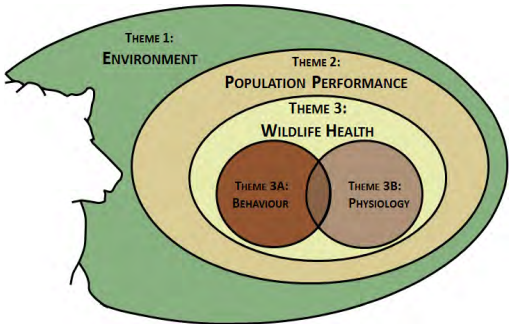


Bear Activity Date Change

Greater

Lesser

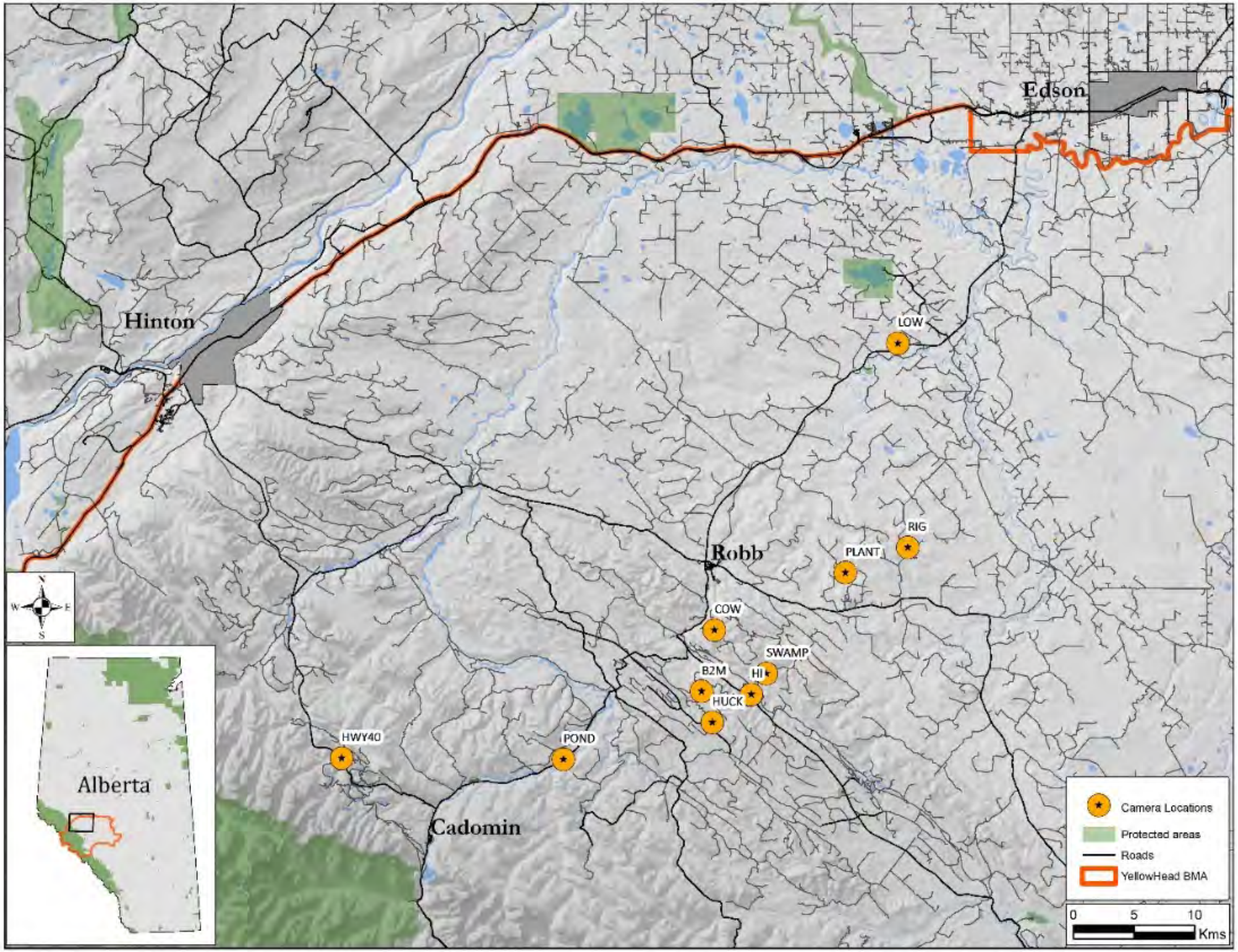
What about the food availability and how it is changing ?

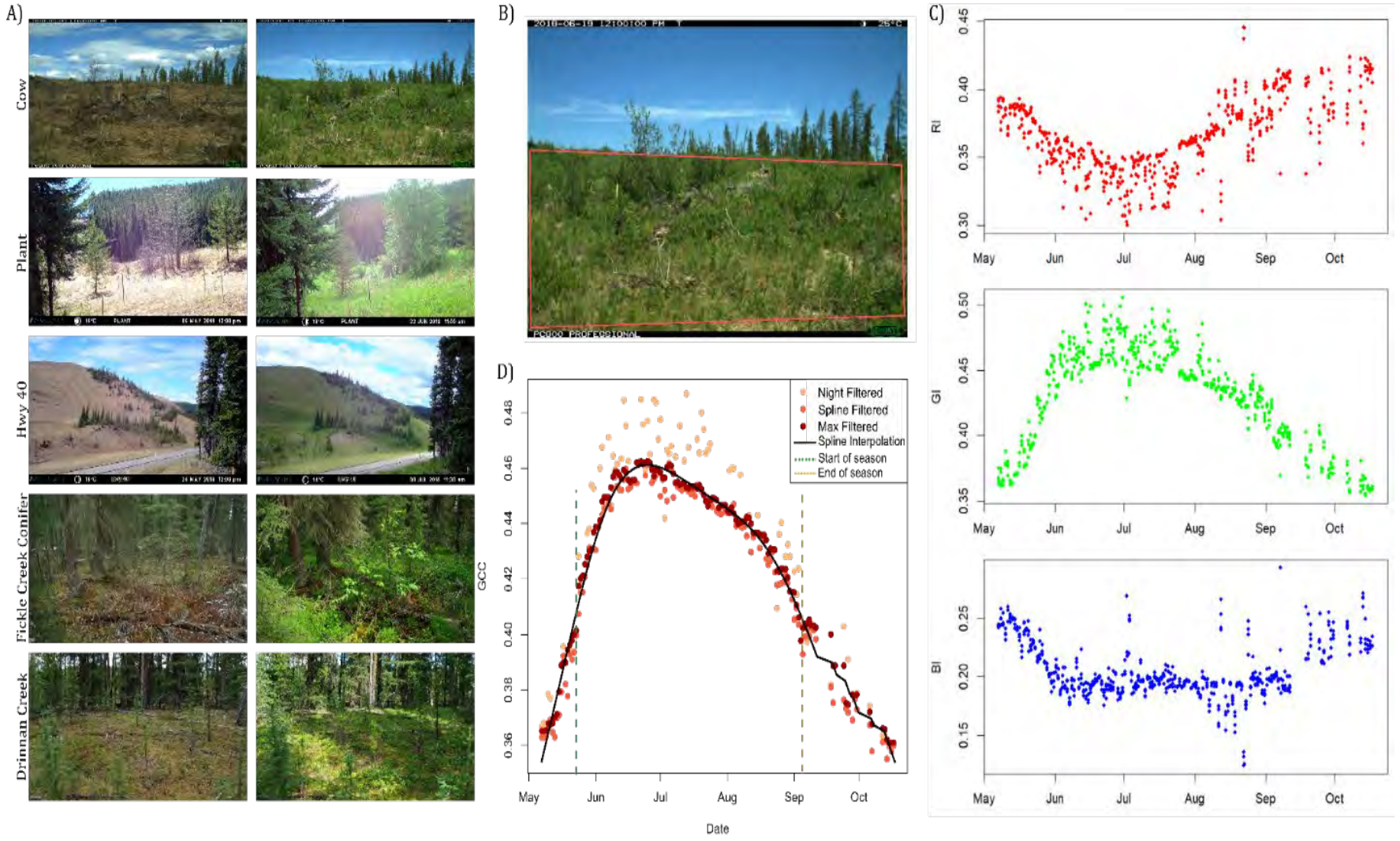


Are bears changing their behaviour with seasonal variations in understory food availability ?

Three Distinct Foraging Seasons

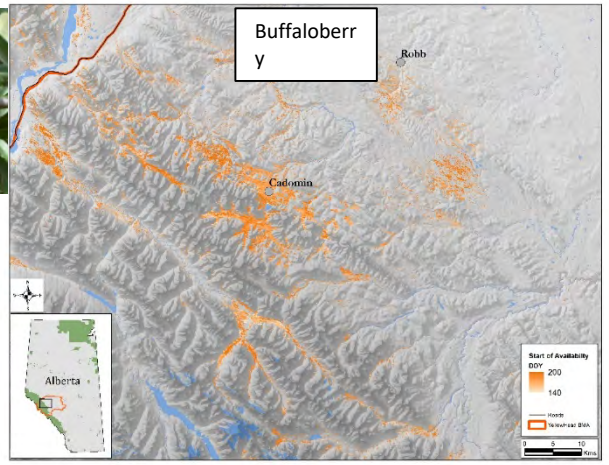
- Hypophagia (spring): Den emergence to mid June
- Early Hyperphagia (summer): Mid June to mid July
- Late Hyperphagia (fall): Late July to denning

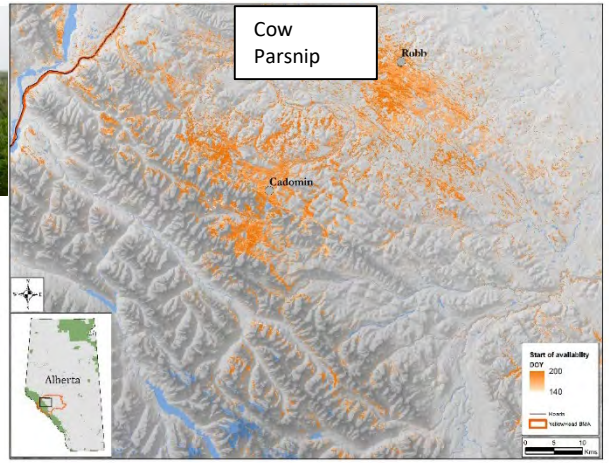

Edson
Hinton
Robb
Cadomin
Alberta
LOW
RIG
PLANT
COW
SWAMP
B2M
HI
HUCK
HWY40
POND
Camera Locations
Protected areas
Roads
YellowHead BMA
0
5
10
Kms

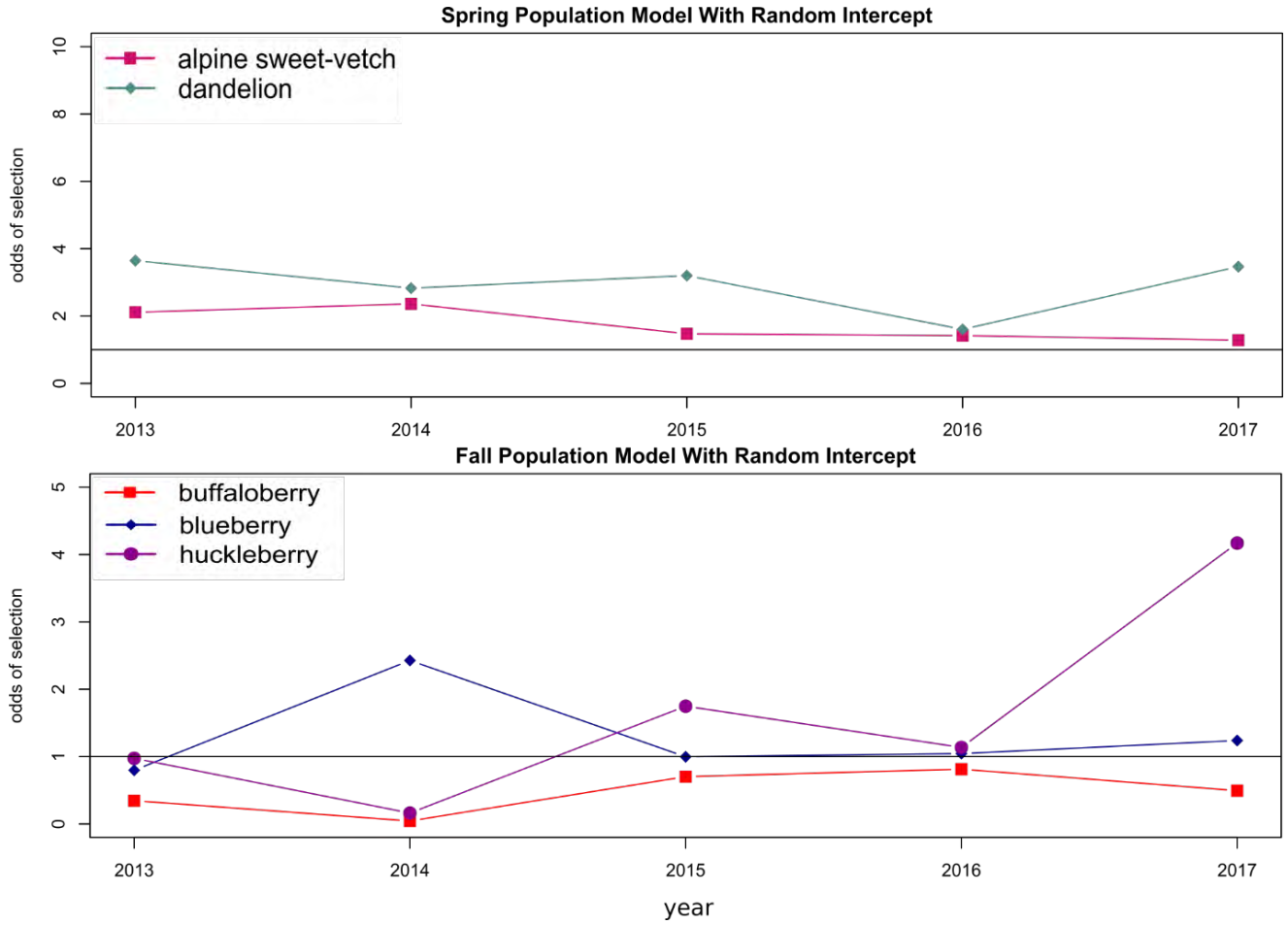

A)
Cow
Plant
Hwy 40
Fickle Creek Conifer
Drinnan Creek
B)
C)
RI
GI
BI
May
Jun
Jul
Aug
Sep
Oct
D)
Night Filtered
Spline Filtered
Max Filtered
Spline Interpolation
Start of season
End of season
GCC
Date

Availability layers

- Extracted availability windows using ground cameras and DRIVE data.
- Only include pixels with a probability of occurrence 80 percent or higher.
- Show day of year in which each species becomes available.

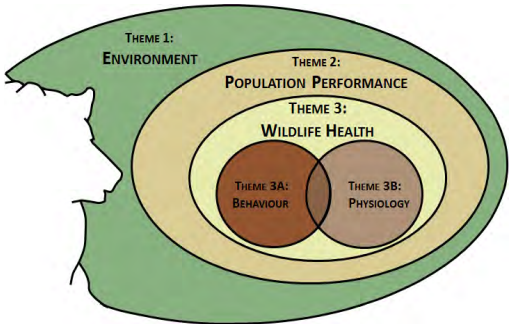




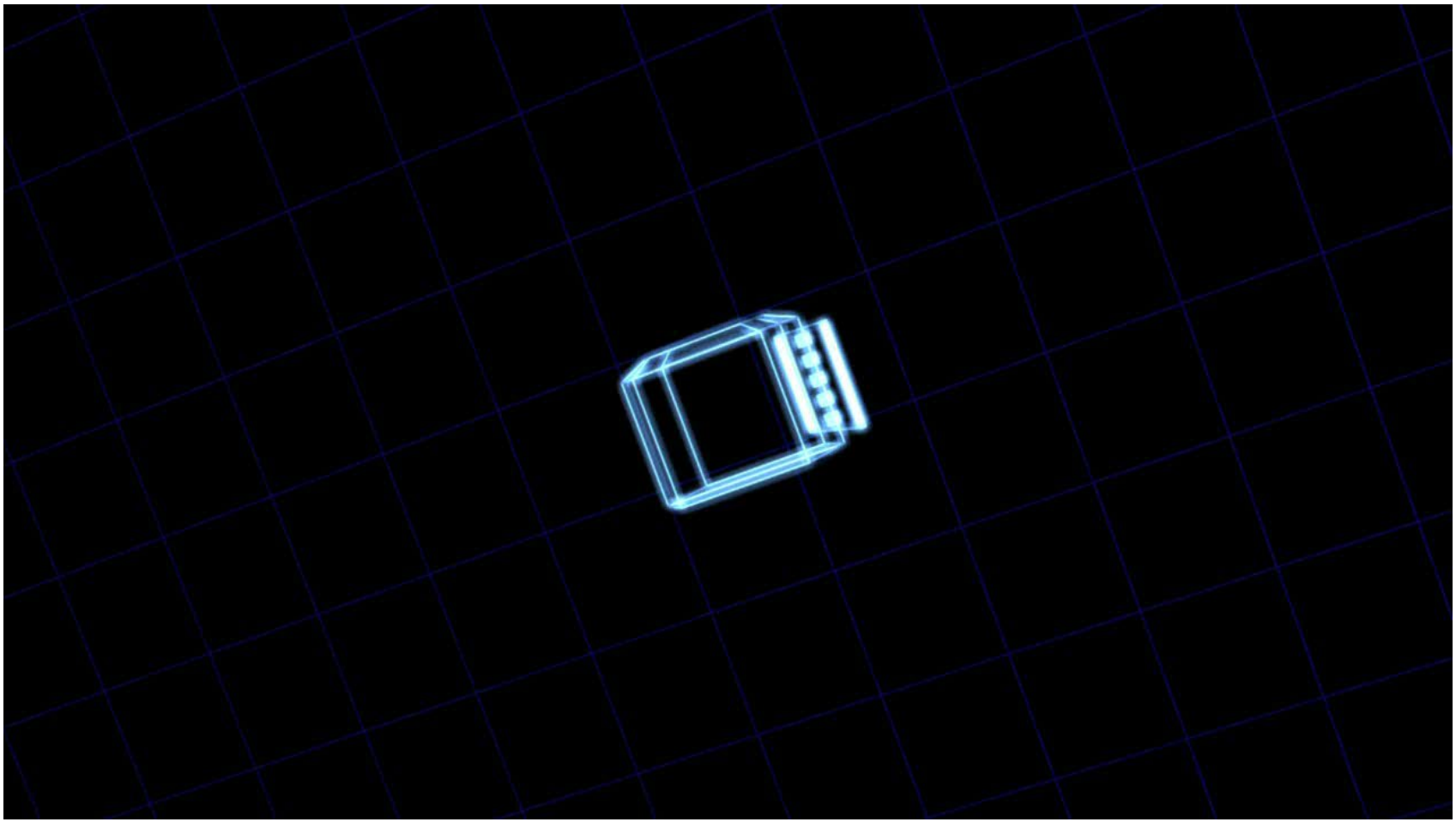


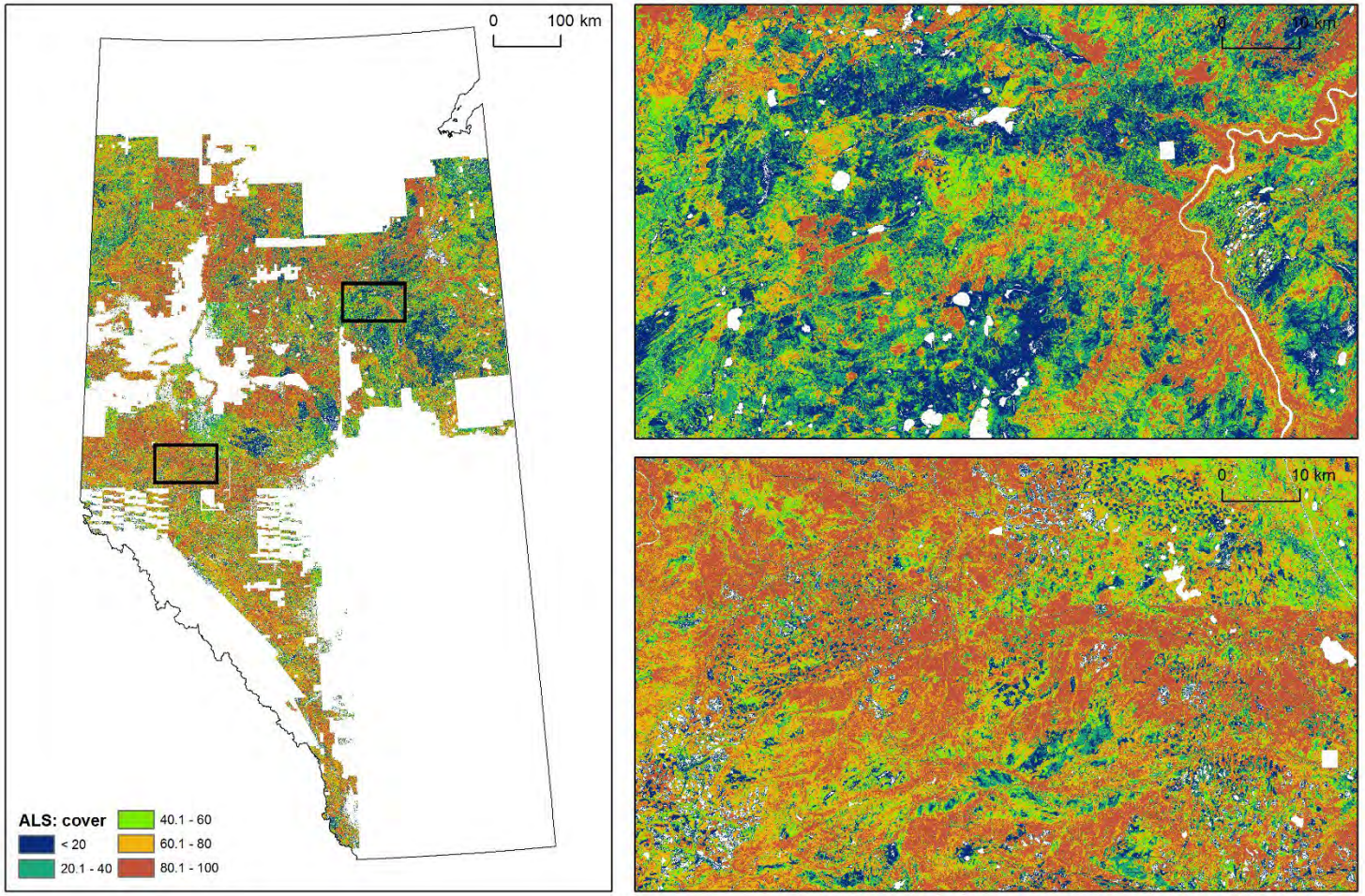
- Core model: Distance to roads + Terrain wetness index + distance to edge + land cover + elevation + insolation
- Food covariates
  - Was a bear within 100m of a individual food species at a time when it was “available”.
- Food models improve upon core model

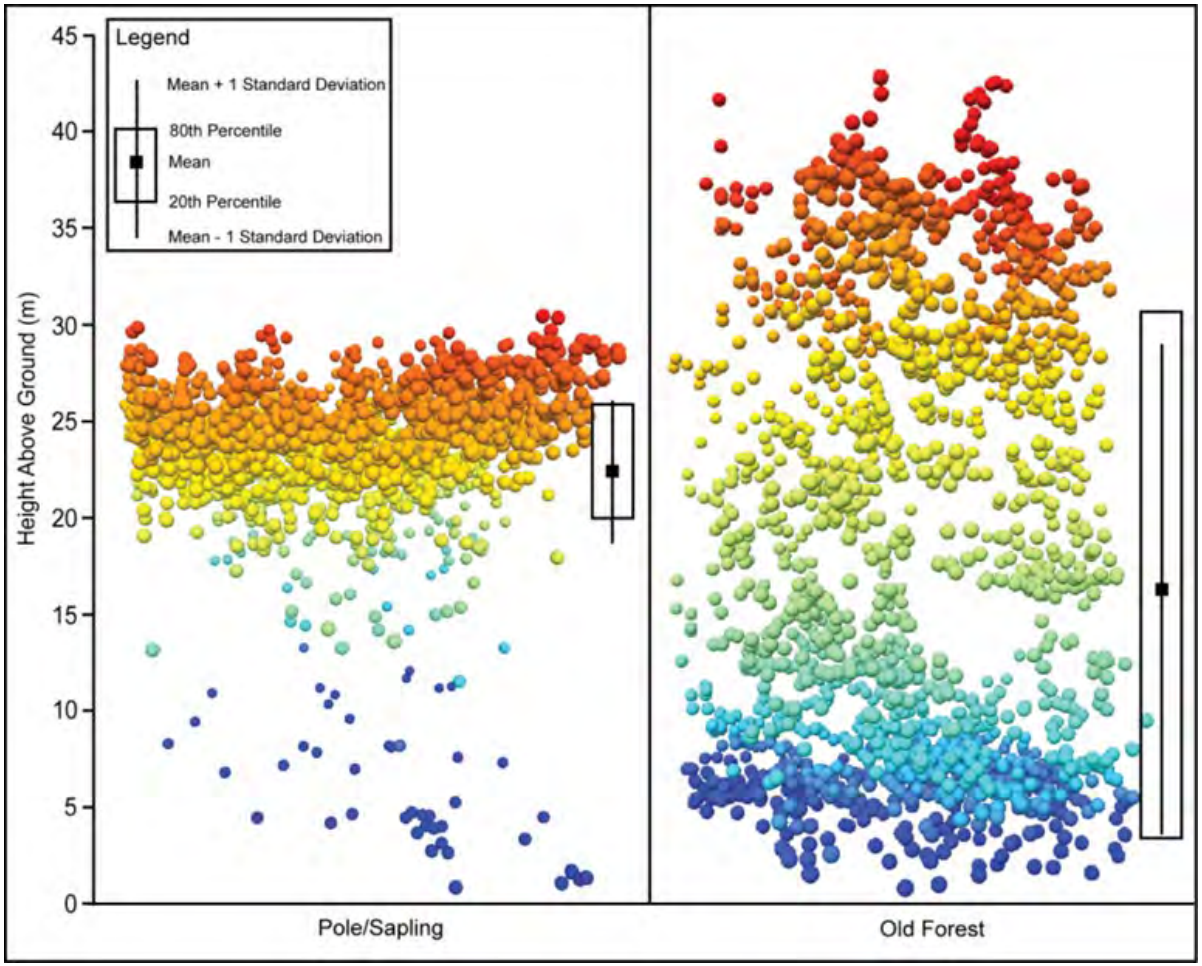
Does Changing Forest Structures Impact Bear Movement ?

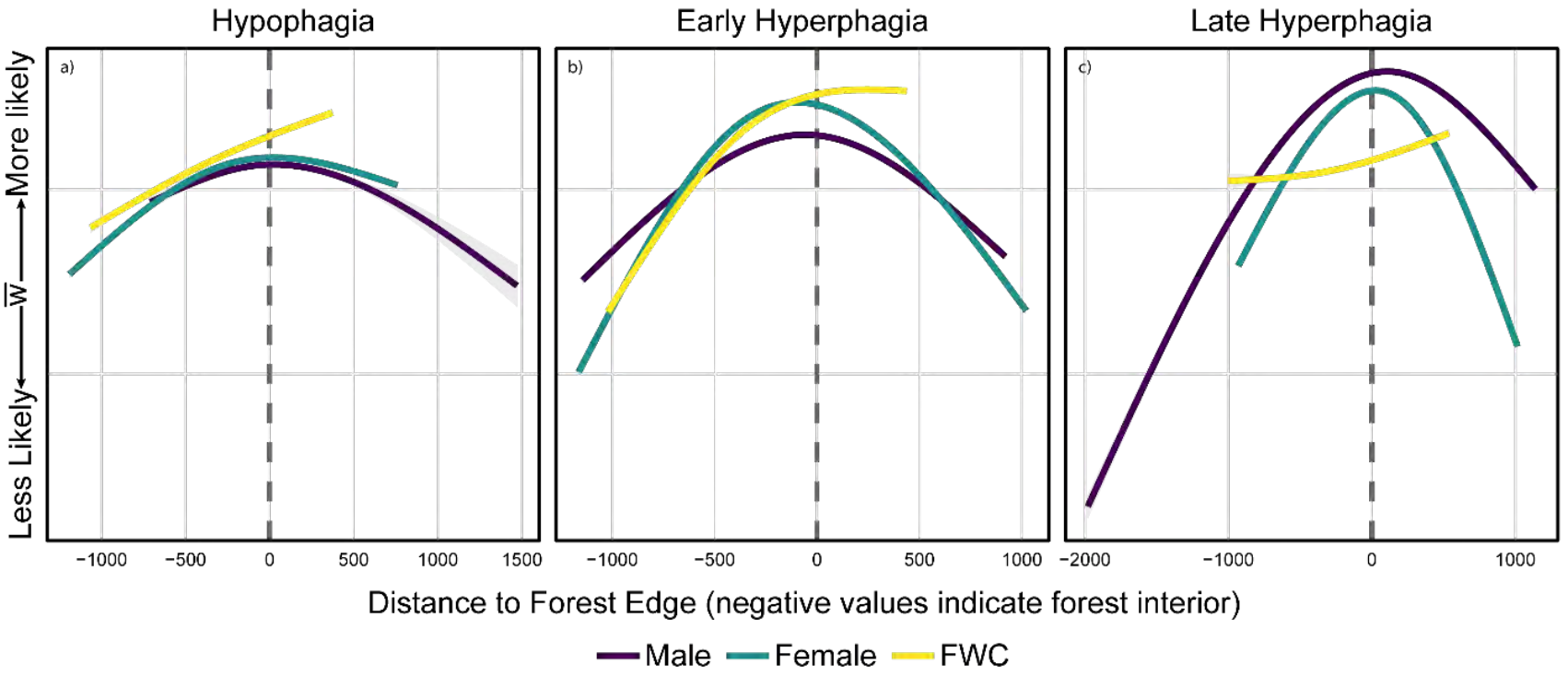


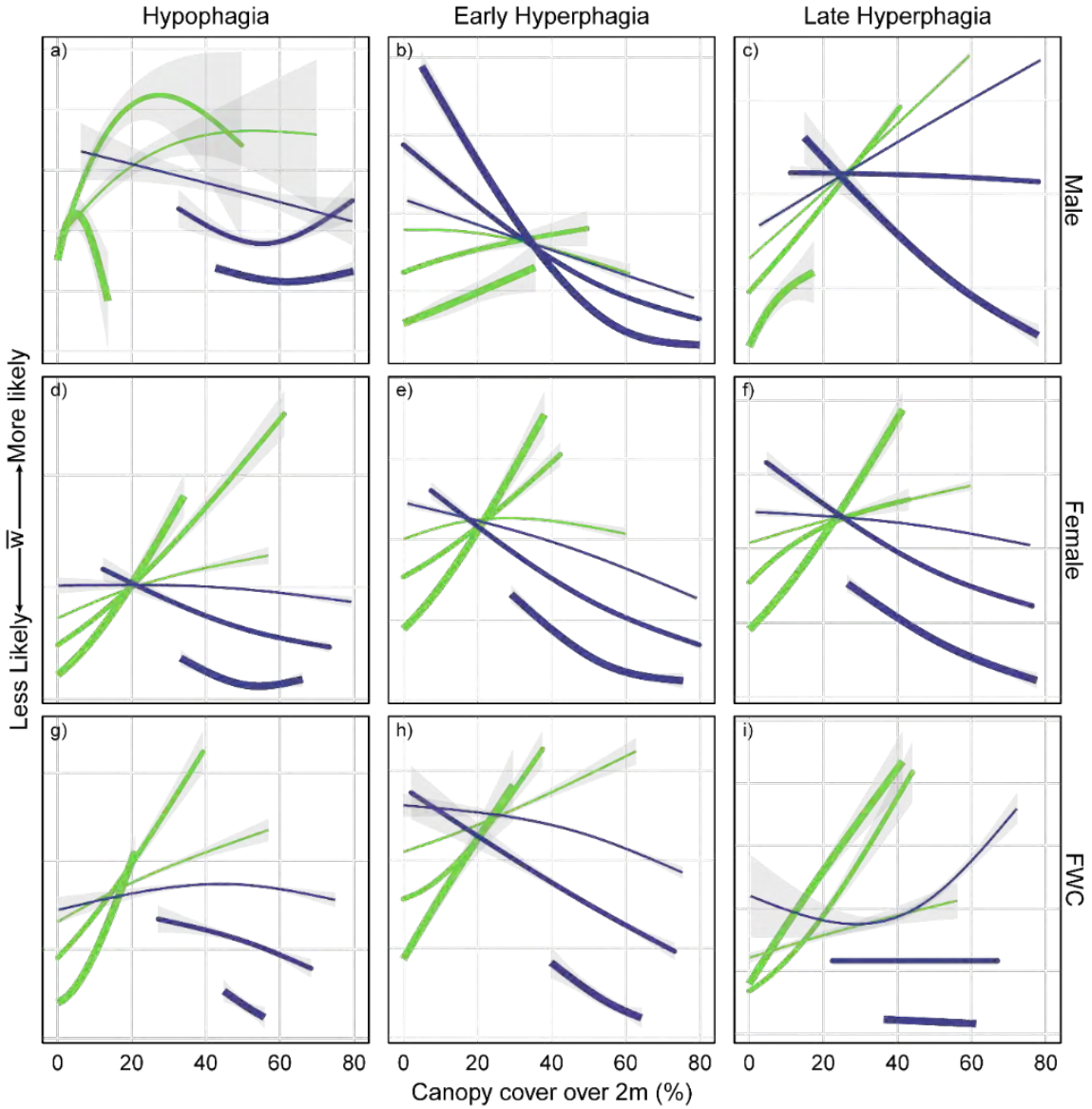
Do bears display preference for certain forest heights or canopy cover conditions?



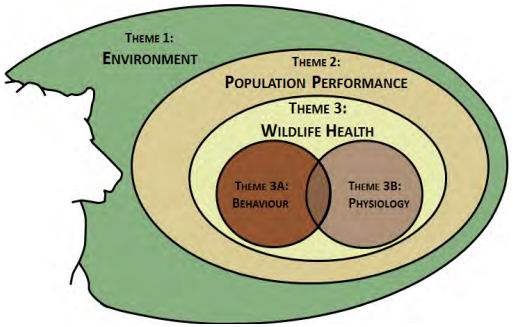

0
100 km
ALS: cover
< 20
20.1 - 40
40.1 - 60
60.1 - 80
80.1 - 100
0
10 km
0
10 km


Legend
Mean + 1 Standard Deviation
80th Percentile
Mean
20th Percentile
Mean - 1 Standard Deviation
Height Above Ground (m)
45
40
35
30
25
20
15
10
5
0
Pole/Sapling
Old Forest


Hypophagia
Early Hyperphagia
Late Hyperphagia
a)
b)
c)
Less Likely ← $\overline{w}$ → More likely
−1000
−500
0
500
1000
1500
−1000
−500
0
500
1000
−2000
−1000
0
1000
Distance to Forest Edge (negative values indicate forest interior)
Male
Female
FWC


Hypophagia
Early Hyperphagia
Late Hyperphagia
a)
b)
c)
d)
e)
f)
g)
h)
i)
Male
Female
FWC
Less Likely ← $\bar{w}$ → More likely
0
20
40
60
80
Canopy cover over 2m (%)
Outside Forest
Inside Forest
1km − 300m from edge
300m − 1000m from edge
300m − 100m from edge
100m − 300m from edge
<100m from edge
<100m from edge

What road conditions, and use most impact bear movement and mortality ?



- A lot of studies have examined bear behaviour and roads
- We know:
  - Most mortalities human-caused near roads
  - 19/22 mortalities within 500 m of a road (Boulanger et al. 2014)
  - decreased reproductive success at high road densities (Roever et al. 2008)
  - But bears select for roads - potential attraction to roadside food

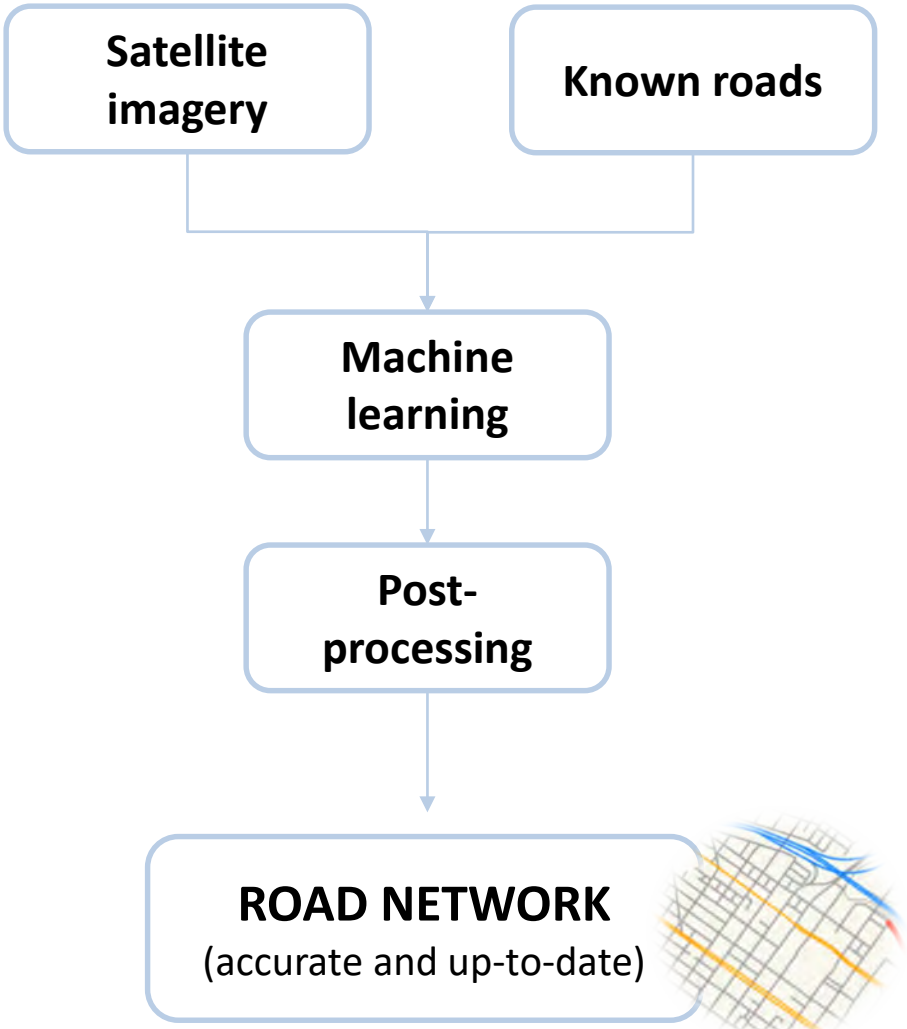
- Traffic dependent

Can we build a better model of how bears perceive roads in terms of what it sees and hears ?

ROAD NETWORK
(accurate and up-to-date)

INTENSITY OF USE
(traffic, timing, …)

TYPE OF USE
(recreation, industrial, …)


Satellite imagery
Known roads
Machine learning
Post-processing
ROAD NETWORK
(accurate and up-to-date)

Satellite imagery

Known roads

Machine learning

Post-processing

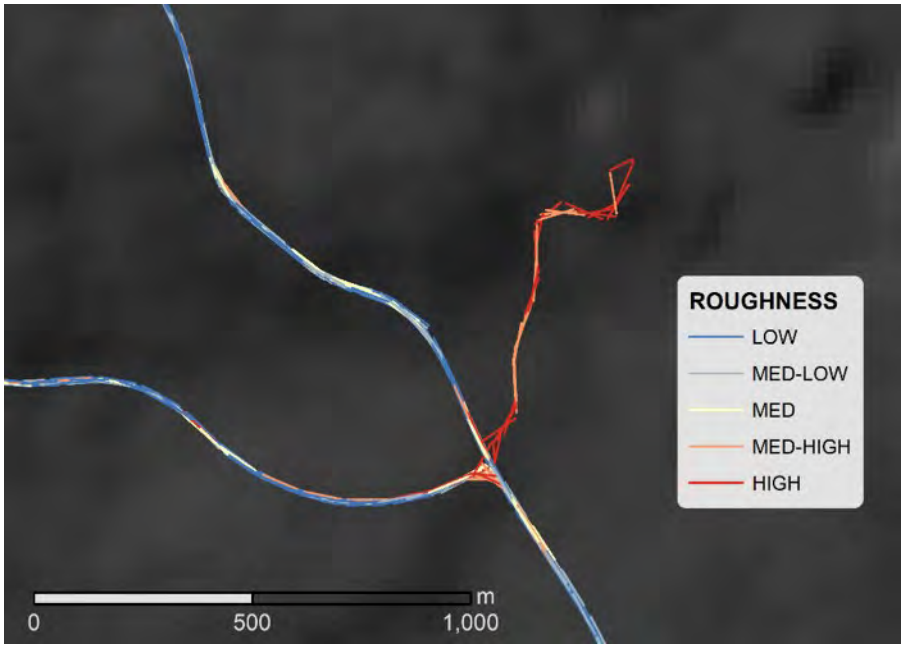
ROAD NETWORK
(accurate and up-to-date)

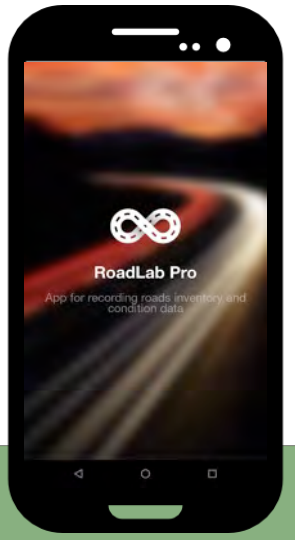
Satellite imagery

Machine learning

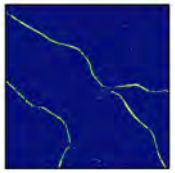
Post-processing

ROAD NETWORK
(accurate and up-to-date)

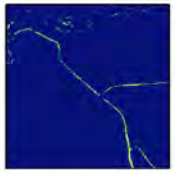




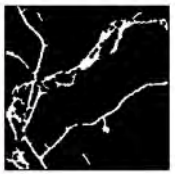
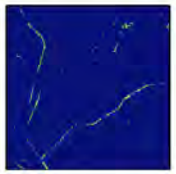
GOOD RESULTS

Training data	CNN outputs	Post-processing	
	Initial extraction		
Imagery + Ground truth		Step 1	Final extraction
			
	Probability		

GOOD RESULTS AFTER POST-PROCESSING

Training data	CNN outputs	Post-processing	
	Initial extraction		
Imagery + Ground truth		Step 1	Final extraction
			
	Probability		

OK RESULTS AFTER POST-PROCESSING

Training data	CNN outputs	Post-processing	
	Initial extraction		
Imagery + Ground truth		Step 1	Final extraction
			
			
	Probability		

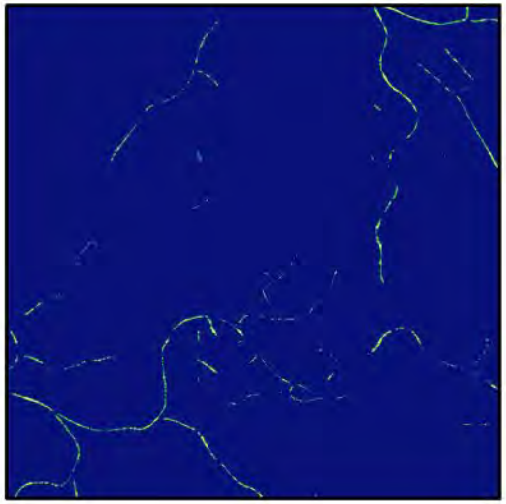
POOR RESULTS EVEN AFTER POST-PROCESSING

Training data	CNN outputs	Post-processing	
	Initial extraction		
Imagery + Ground truth		Step 1	Final extraction
	Probability		

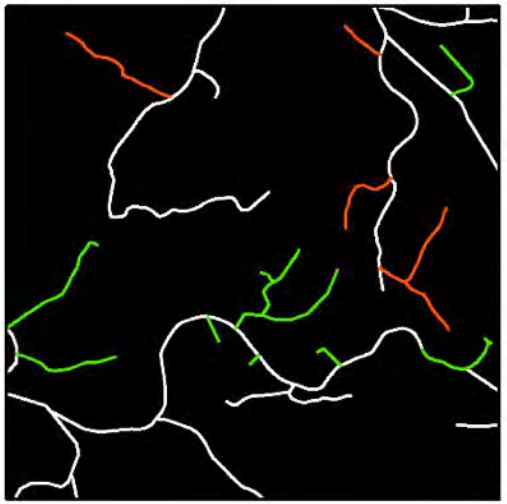
Imagery

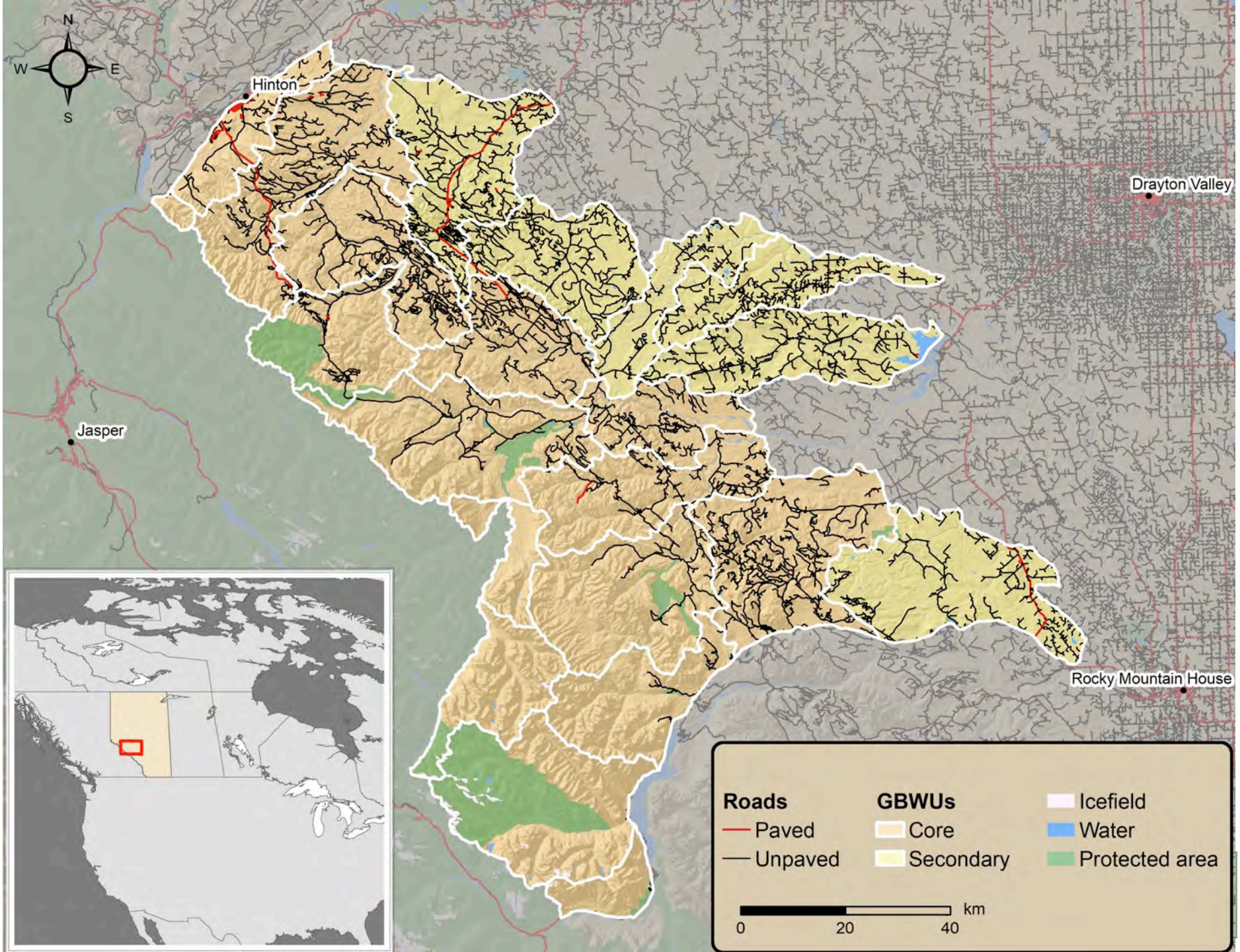
Final prediction

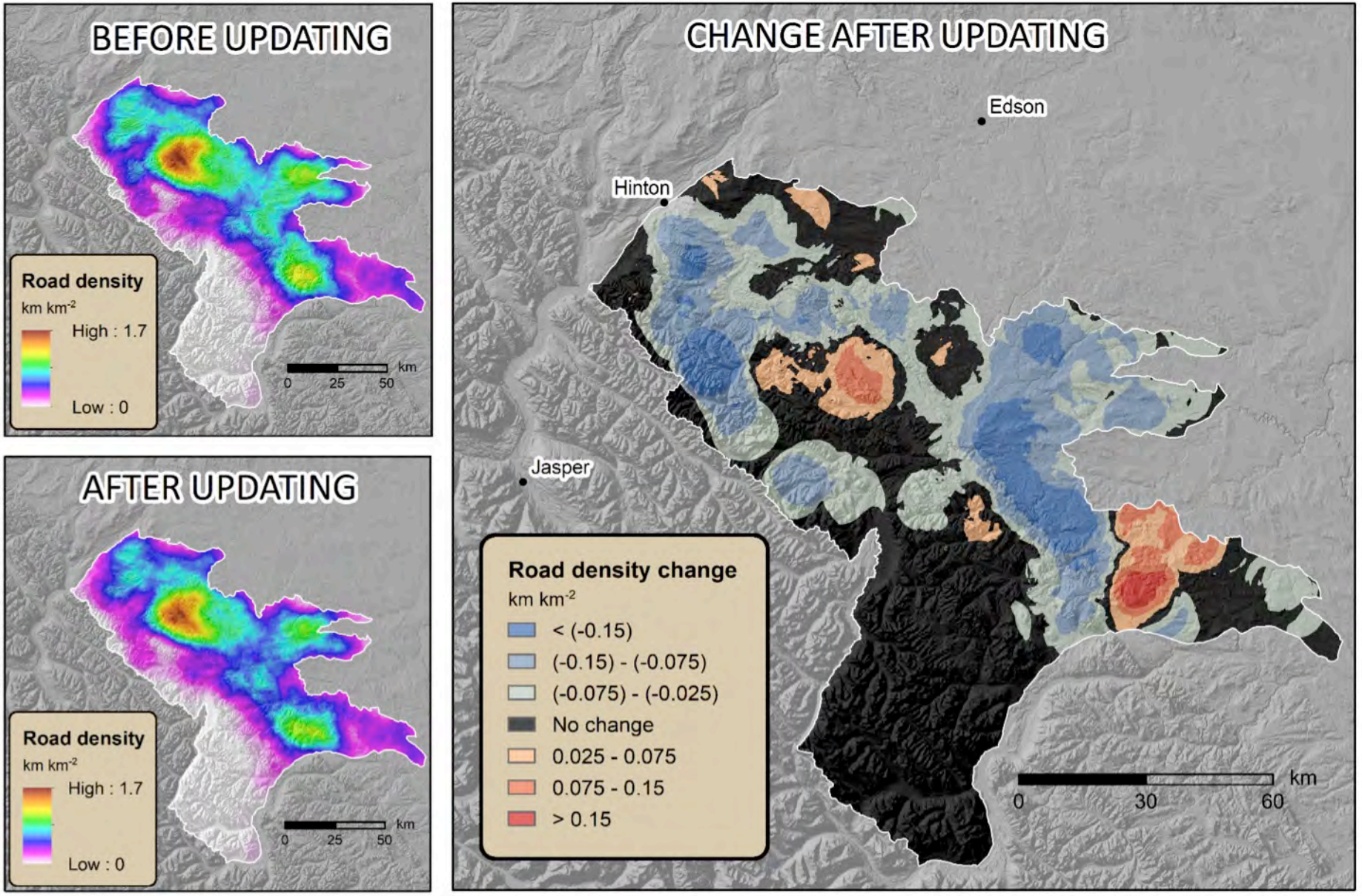
Probability

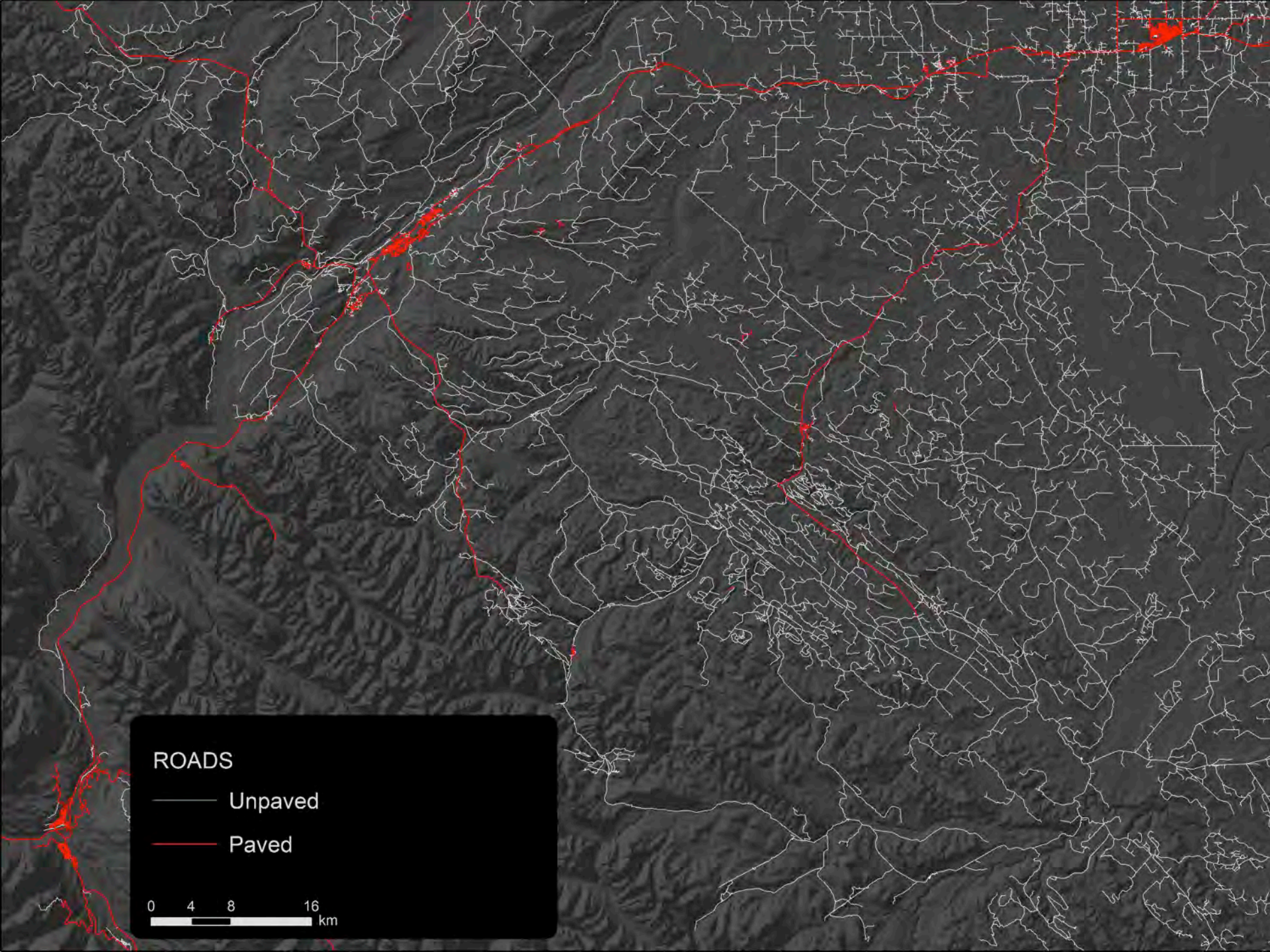


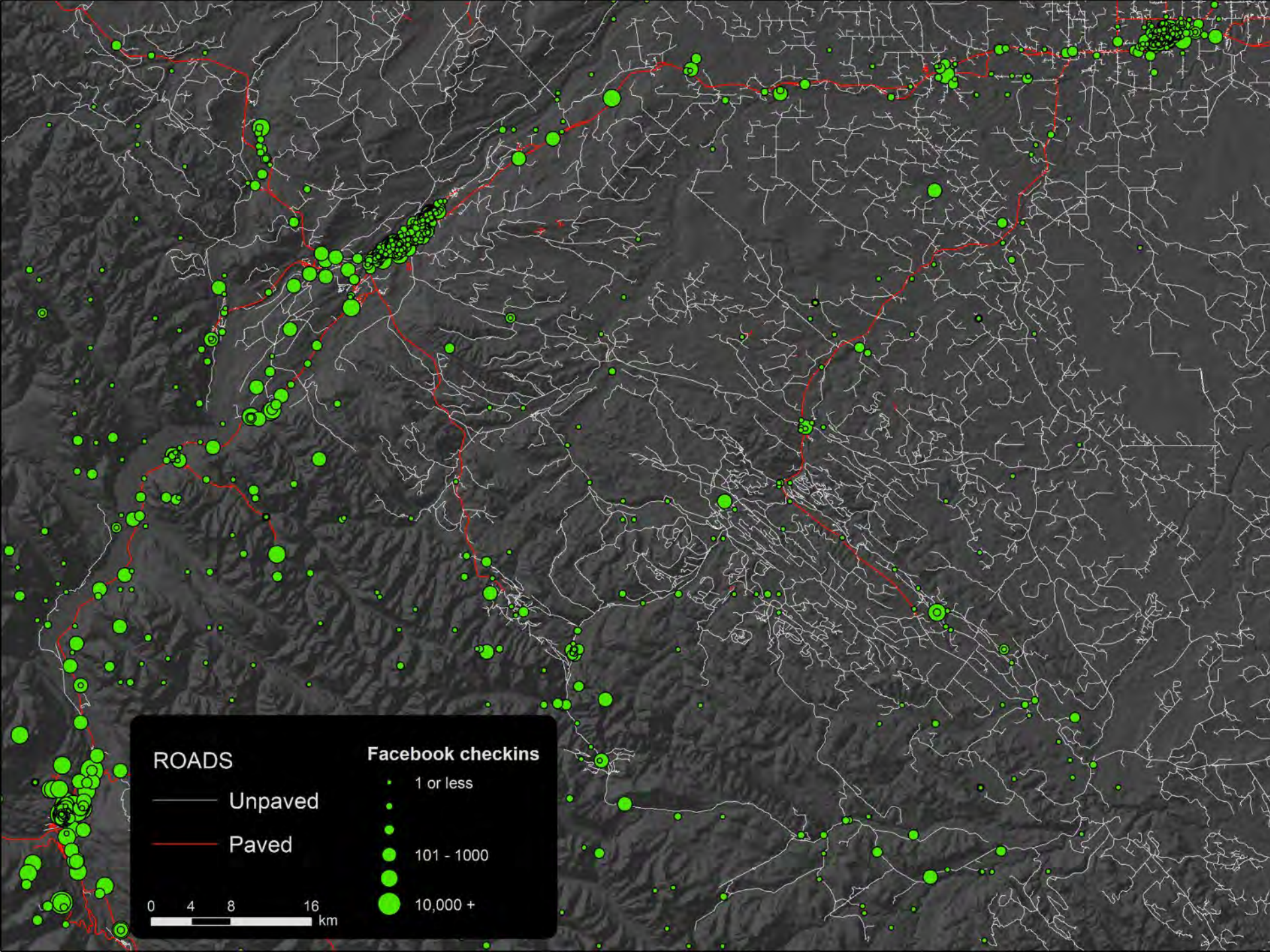
Updated network

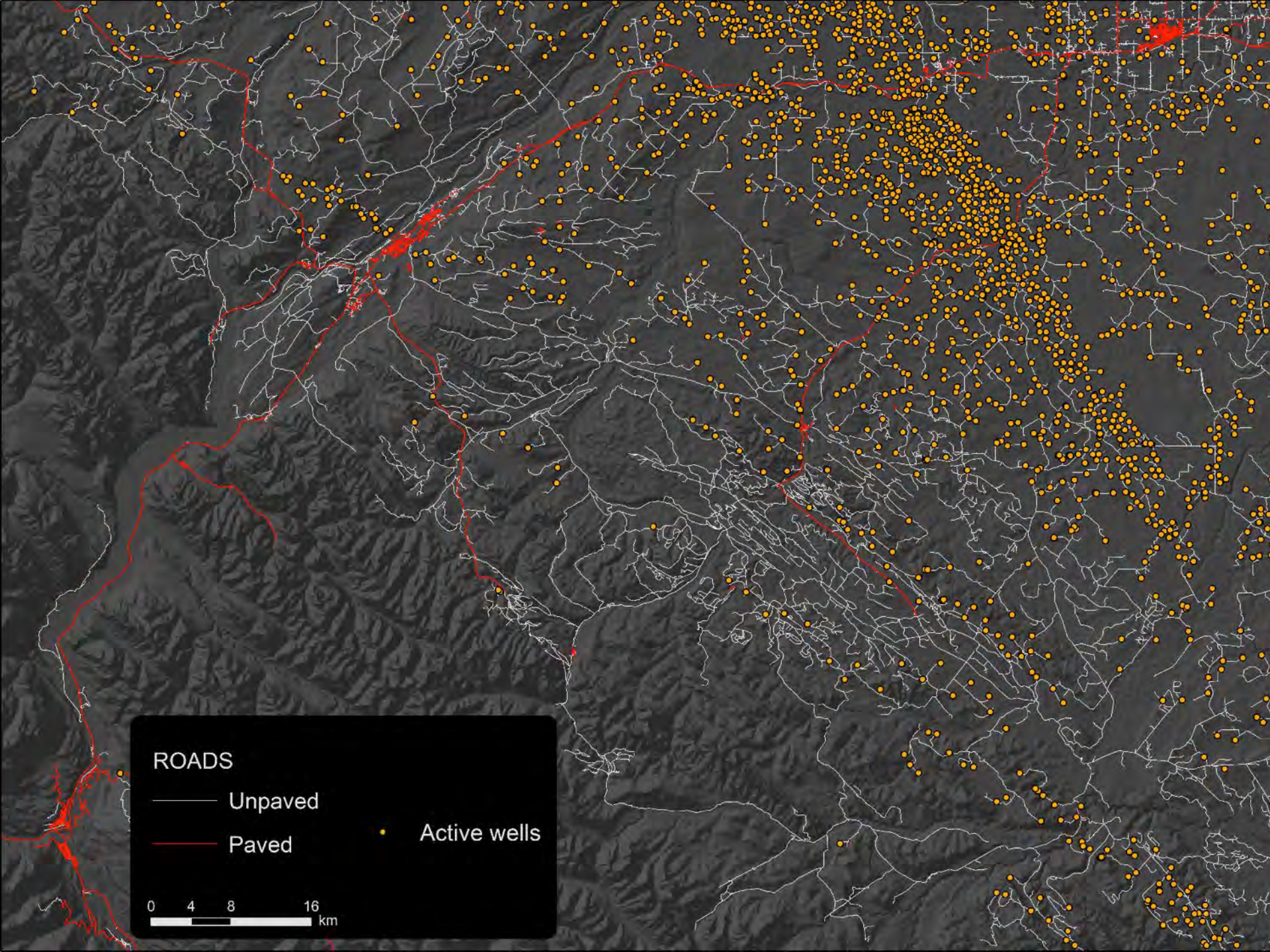


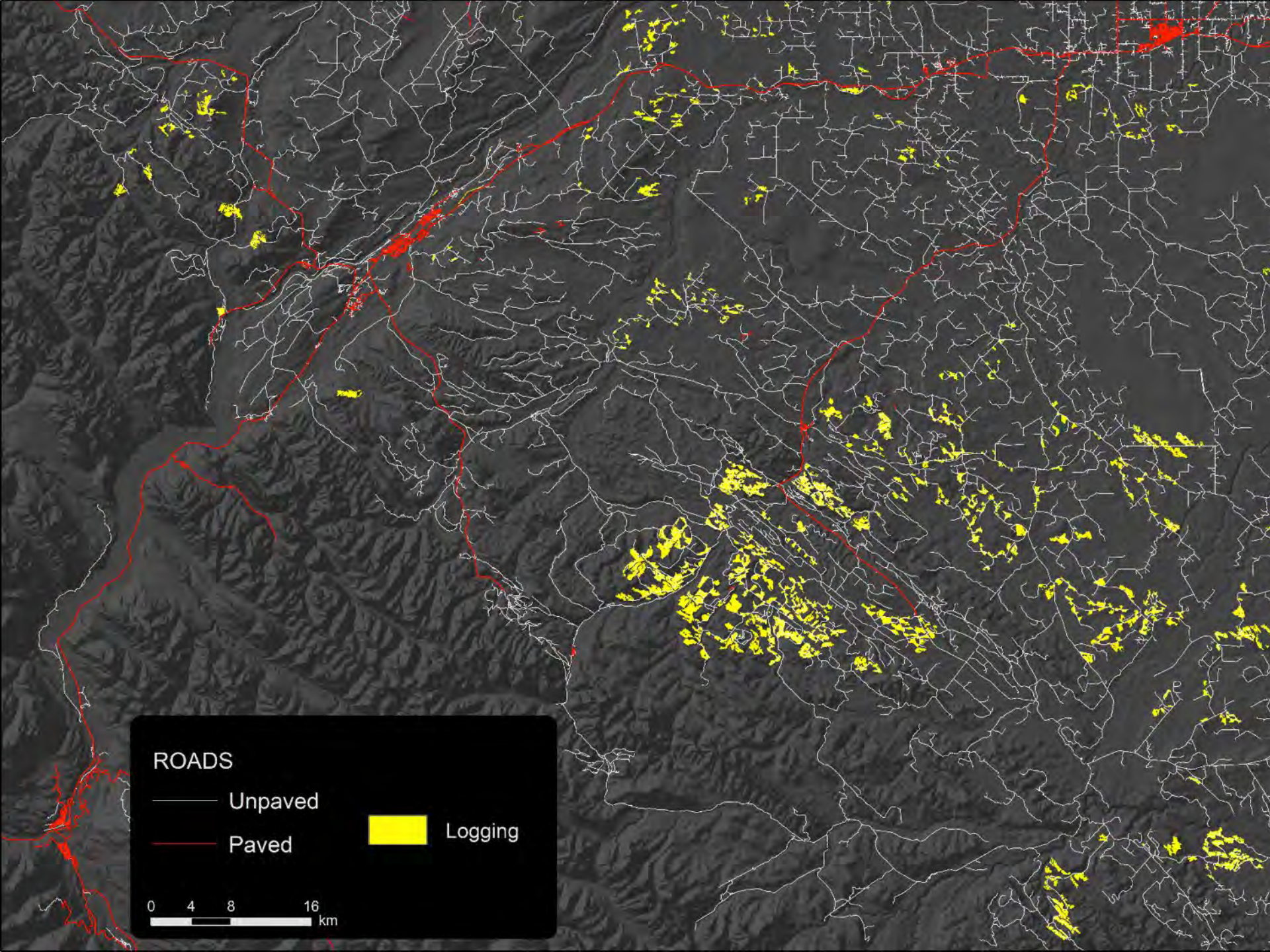

N
W
E
S
Hinton
Drayton Valley
Jasper
Rocky Mountain House
Roads
Paved
Unpaved
GBWUs
Core
Secondary
Icefield
Water
Protected area
km
0
20
40

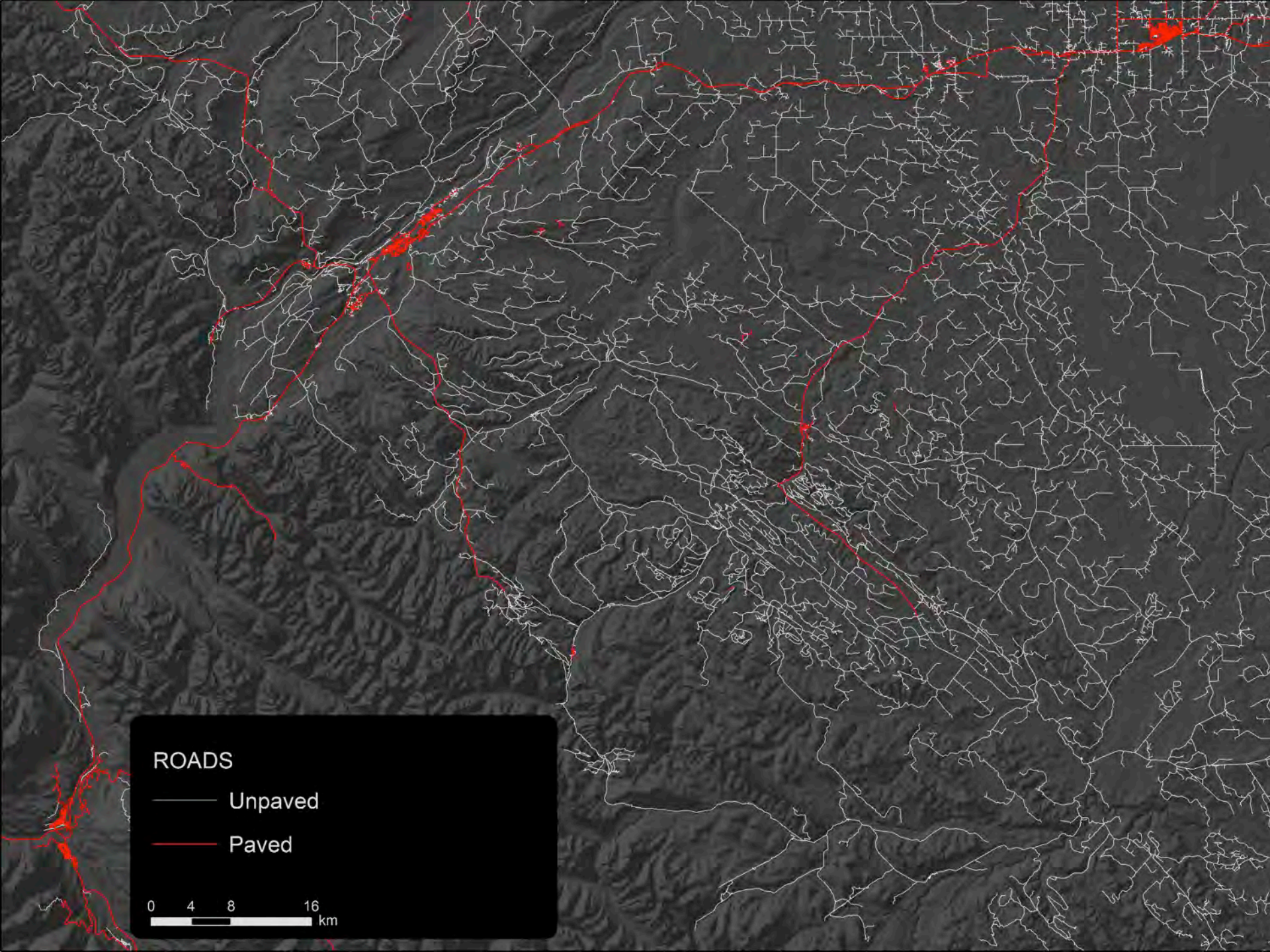

BEFORE UPDATING
Road density
km km-2
High : 1.7
Low : 0
0 25 50 km
AFTER UPDATING
Road density
km km-2
High : 1.7
Low : 0
0 25 50 km
CHANGE AFTER UPDATING
Edson
Hinton
Jasper
Road density change
km km-2
< (-0.15)
(-0.15) - (-0.075)
(-0.075) - (-0.025)
No change
0.025 - 0.075
0.075 - 0.15
> 0.15
0 30 60 km

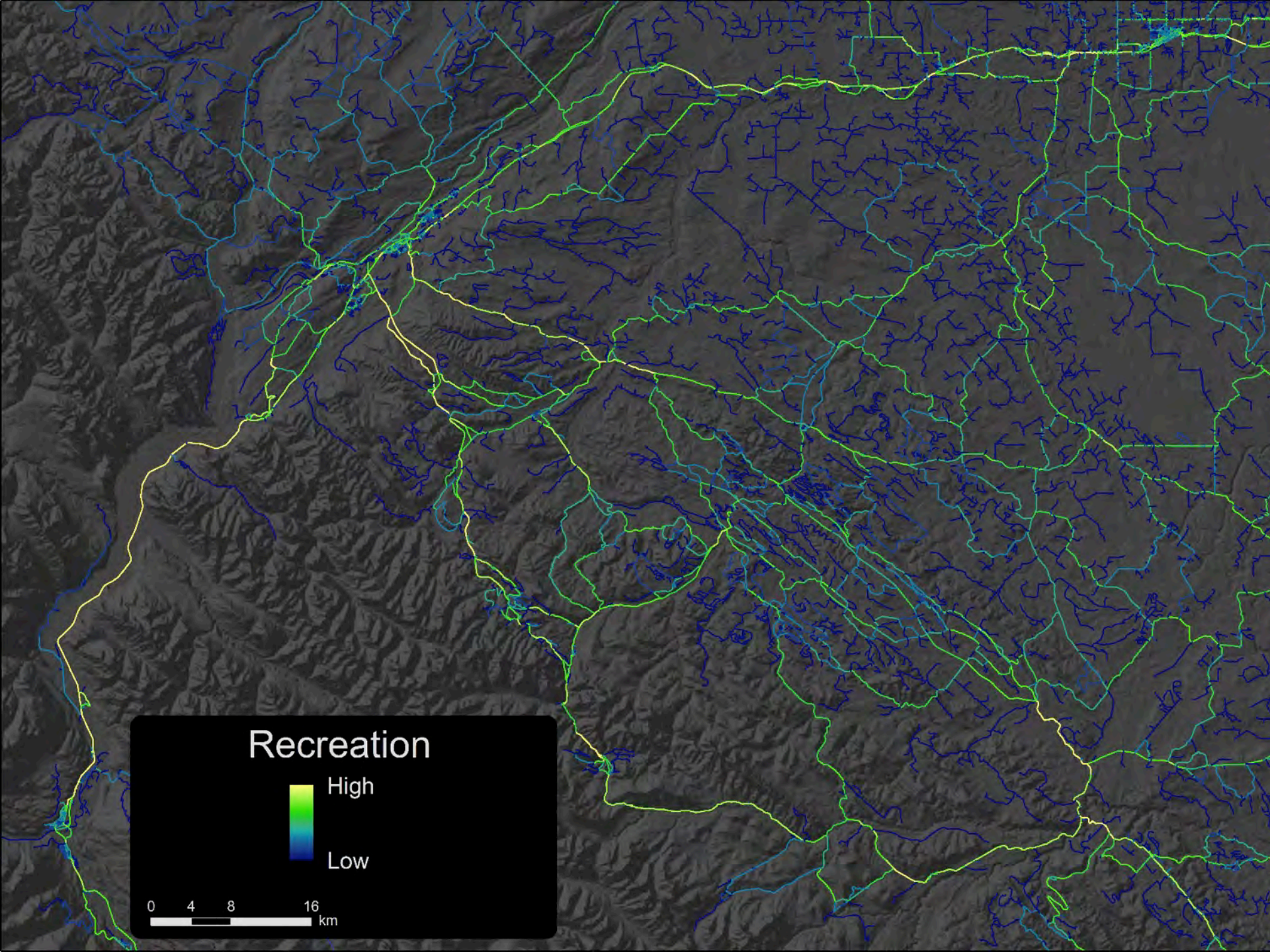

ROADS
Unpaved
Paved
0 4 8 16
km

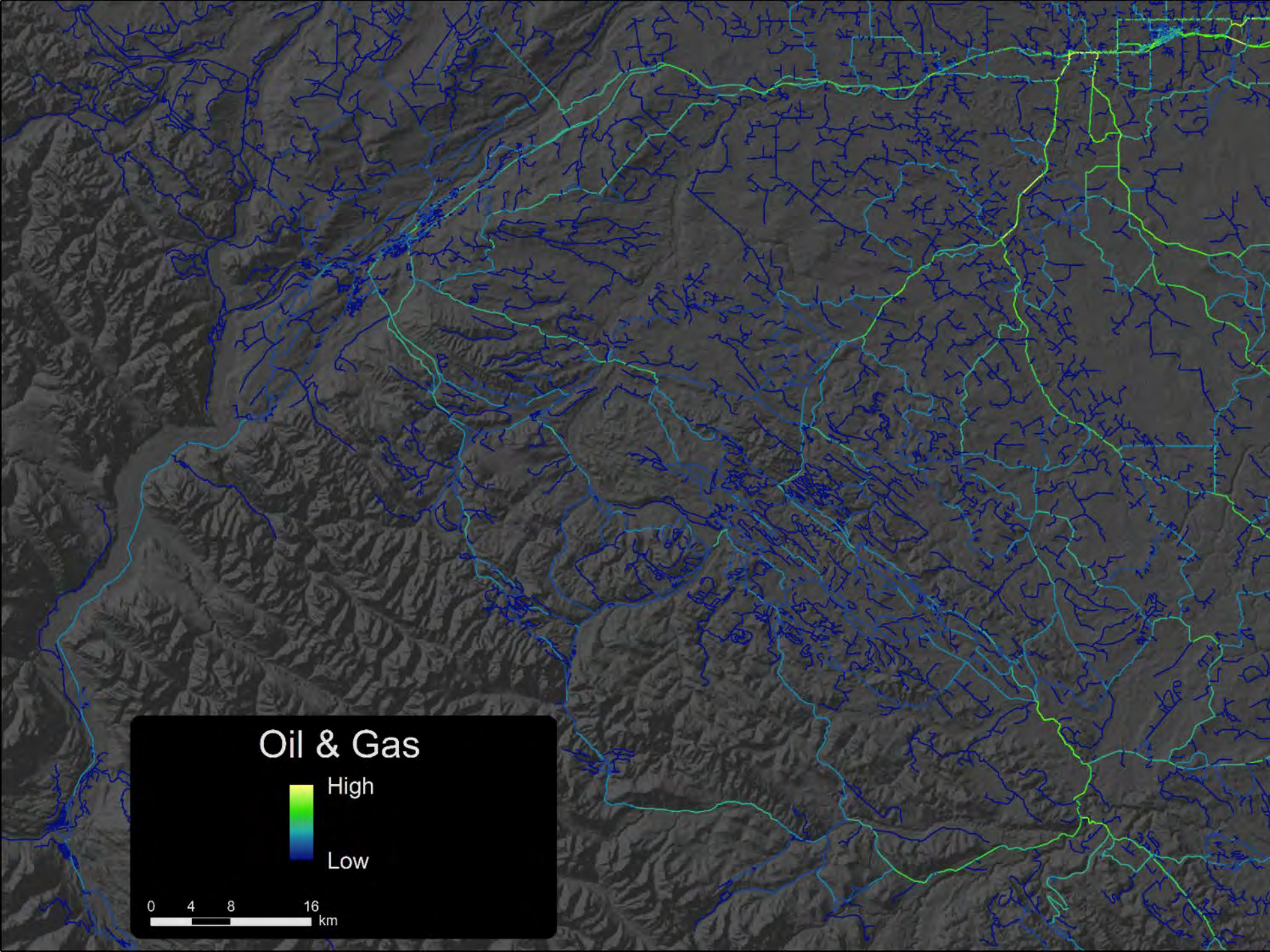

ROADS
Unpaved
Paved
0 4 8 16
km
Facebook checkins
1 or less
101 - 1000
10,000 +


ROADS
Unpaved
Paved
Active wells
0 4 8 16
km


ROADS
Unpaved
Paved
Logging
0 4 8 16
km


ROADS
Unpaved
Paved
0 4 8 16
km


Recreation
High
Low
0
4
8
16
km


Oil & Gas
High
Low
0 4 8 16
km

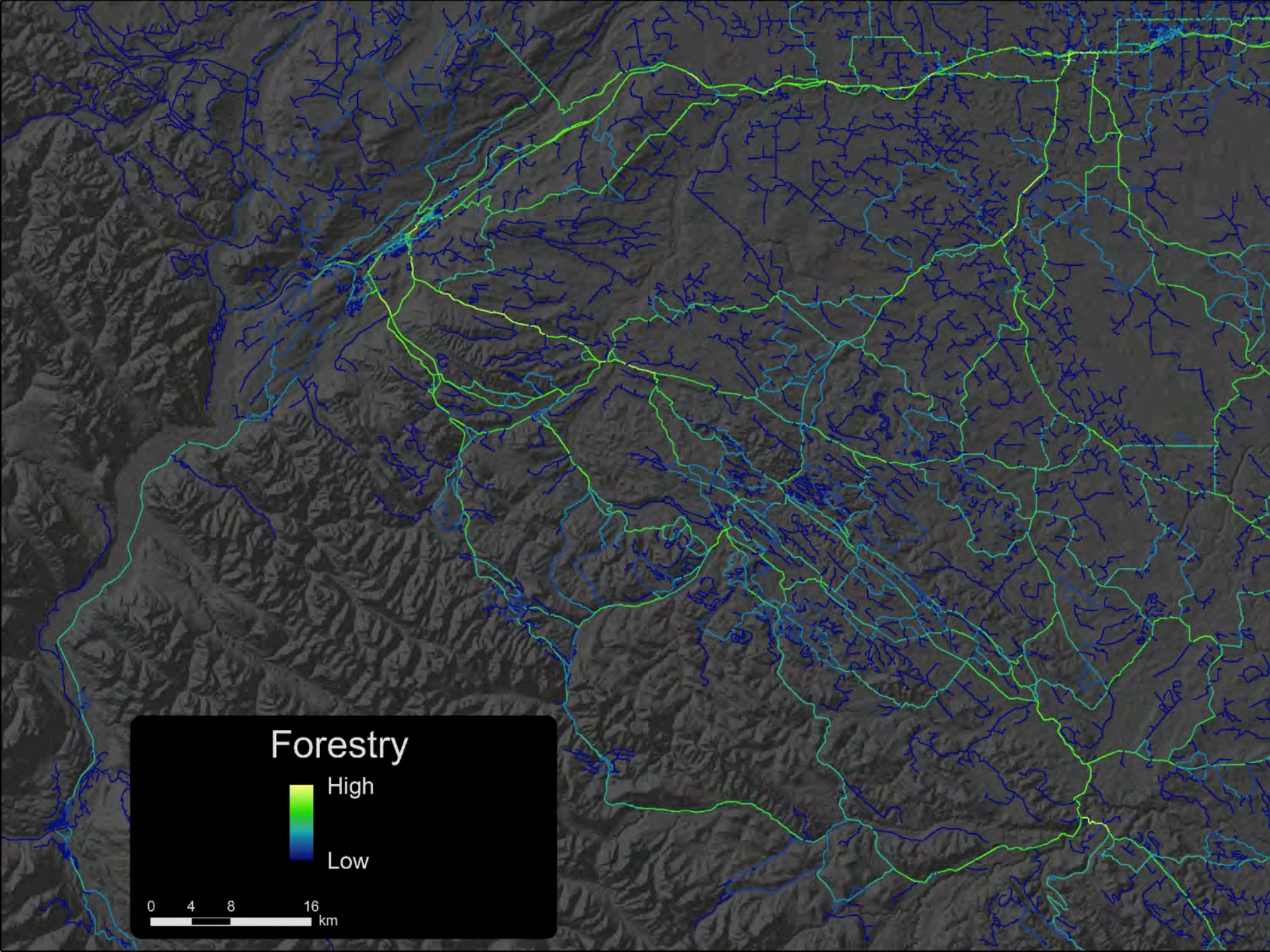
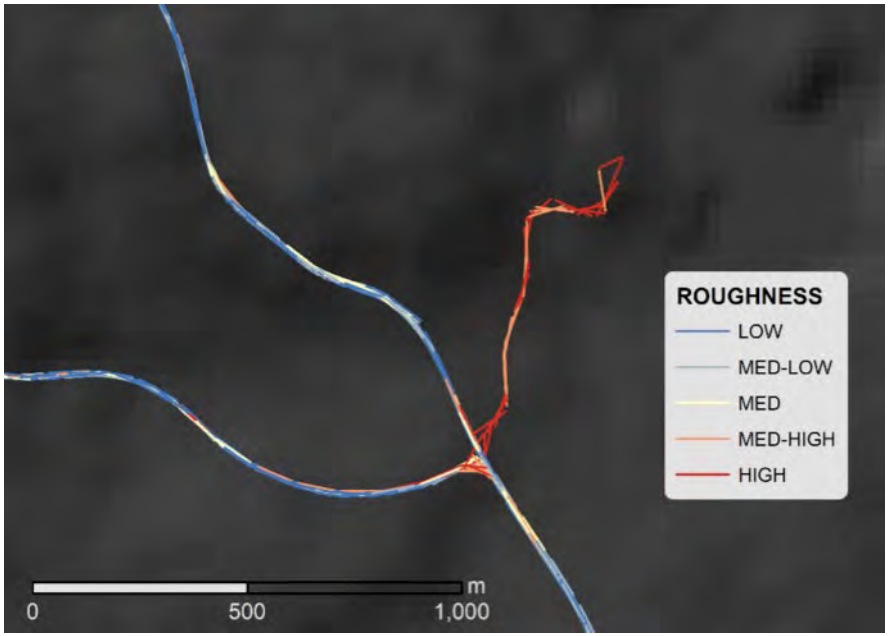
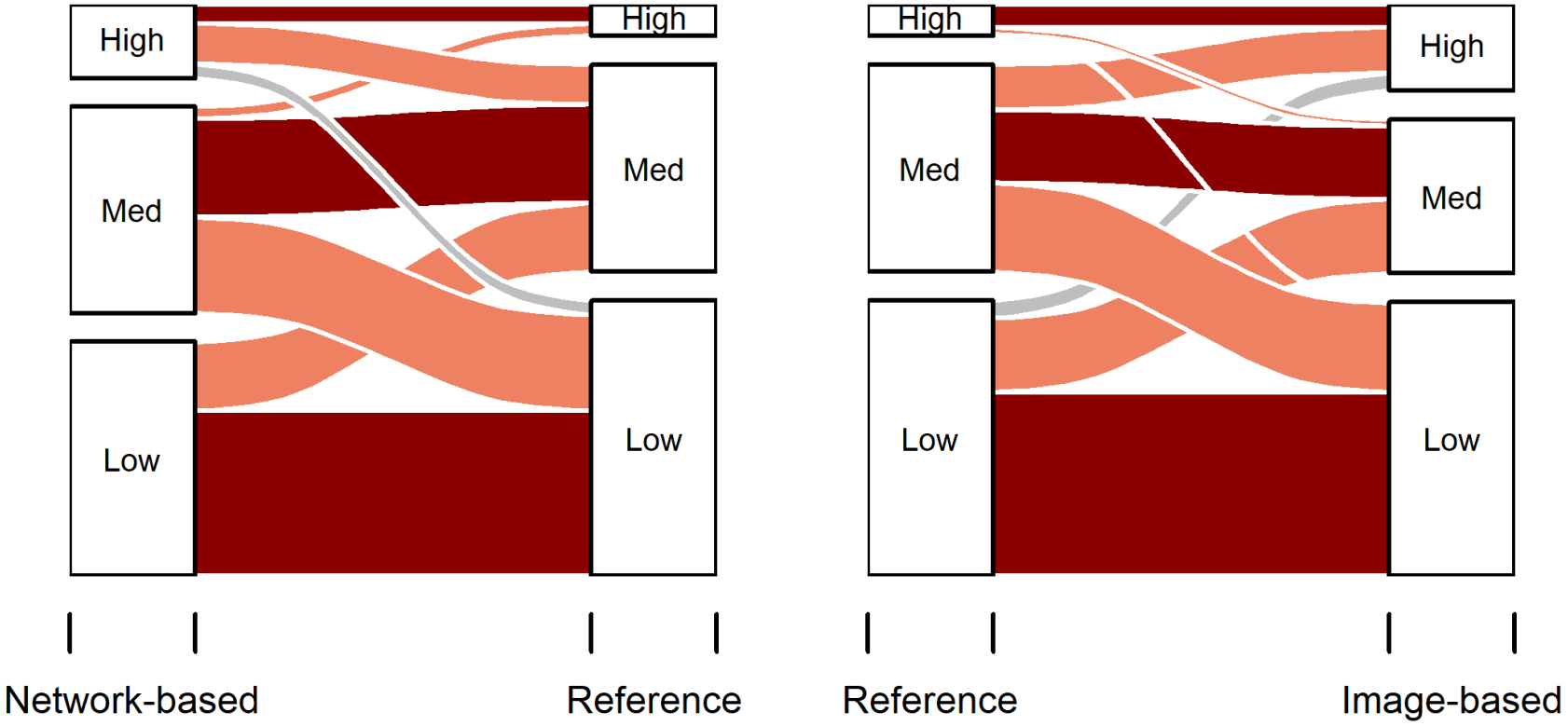

Forestry
High
Low
0
4
8
16
km

Image-based classification




High
Med
Low
High
Med
Low
Network-based
Reference
High
Med
Low
High
Med
Low
Reference
Image-based

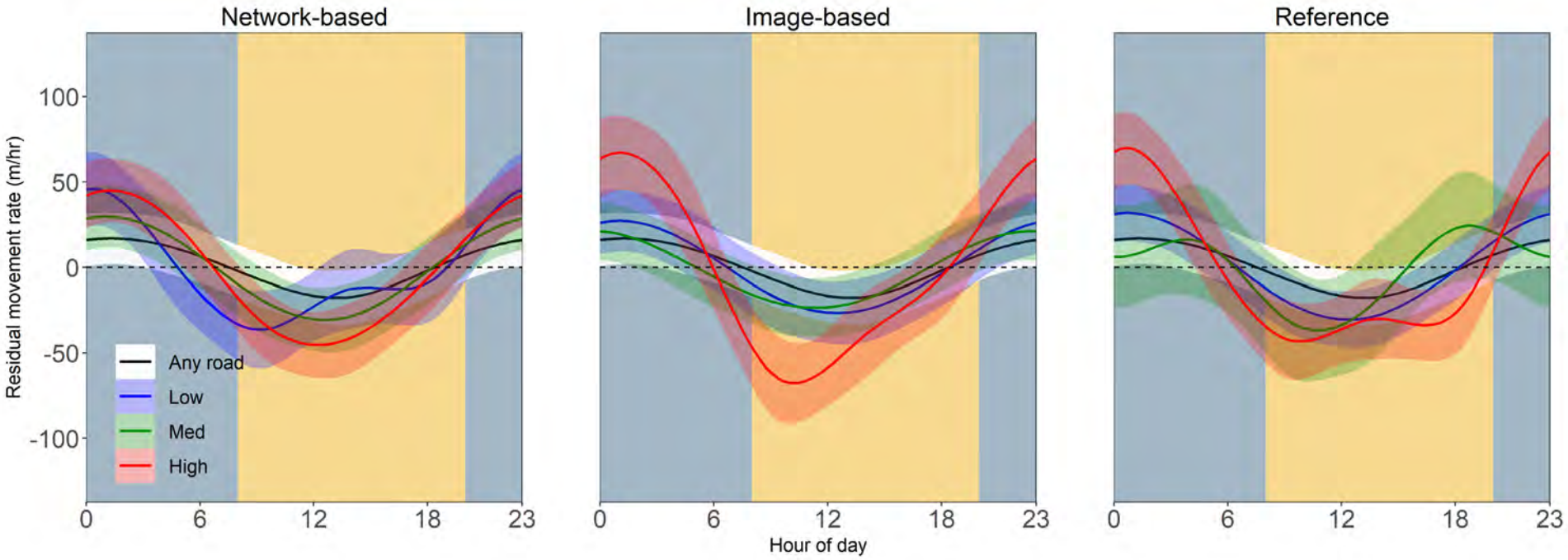
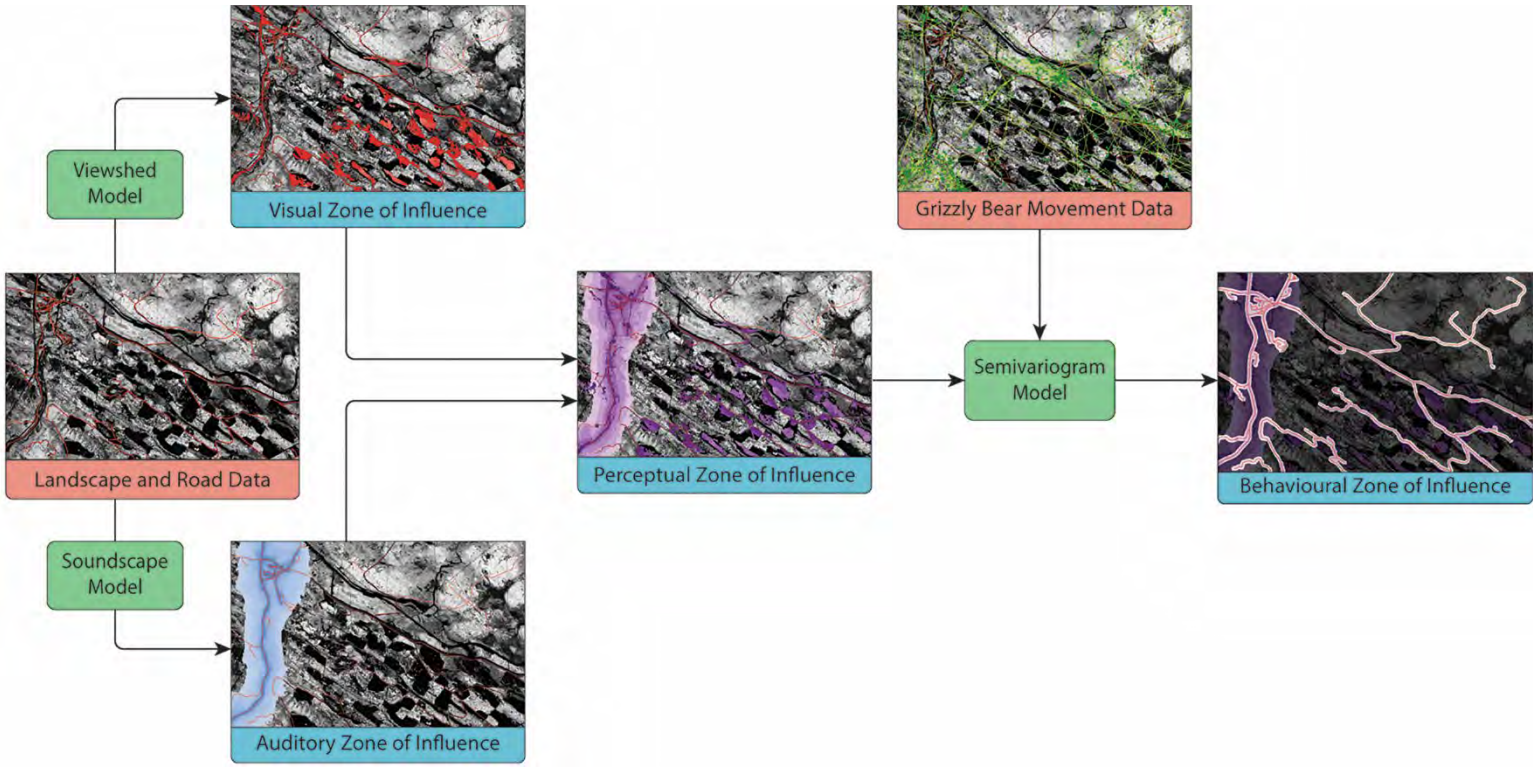


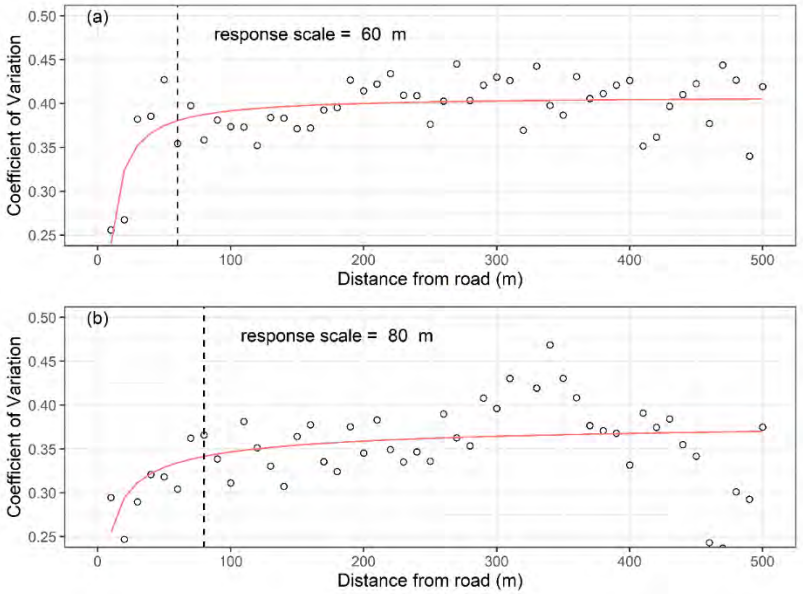
Figure: Diurnal deviation from expected movement rates by road class for the three classifications

Zones of Influence - Methods



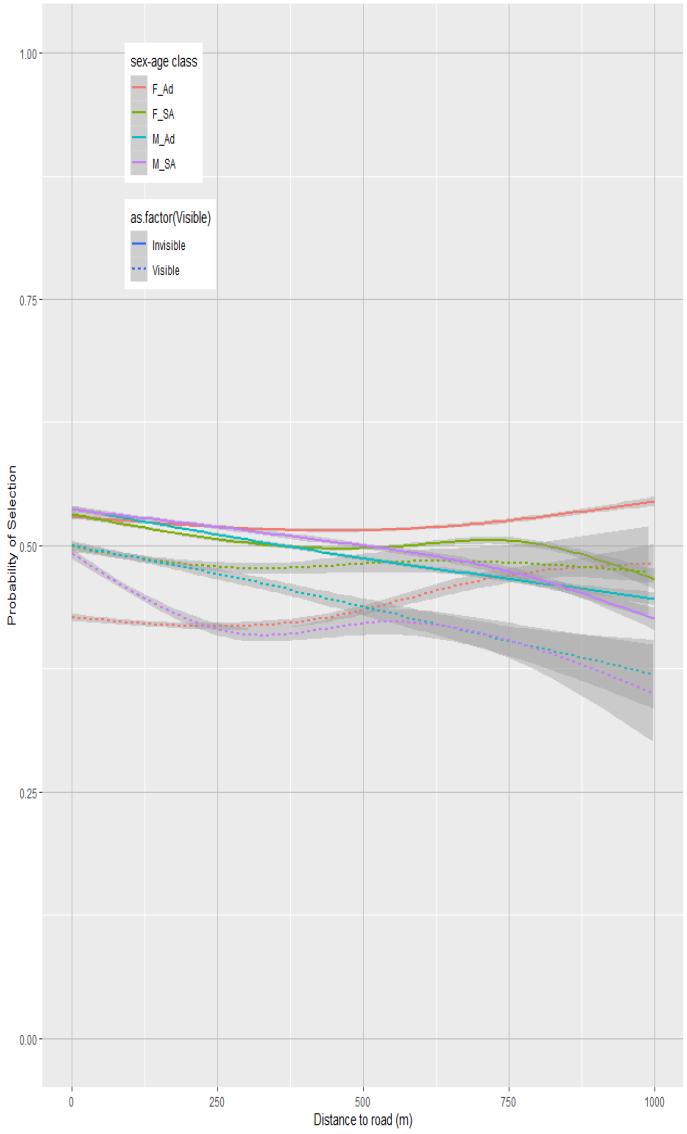
Zones of Influence - Results

- Grizzly bears responded at further distances to roads when they could perceive the road than when the road was imperceptible

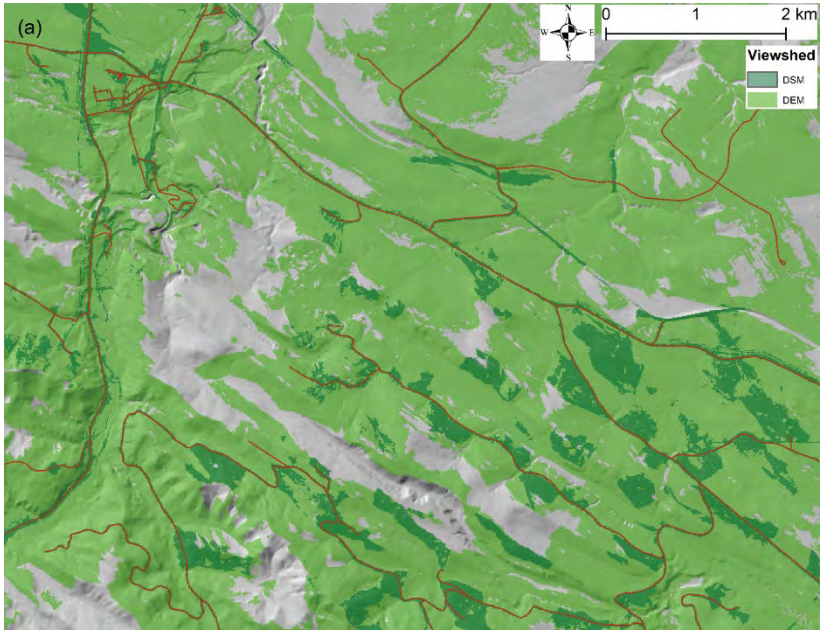


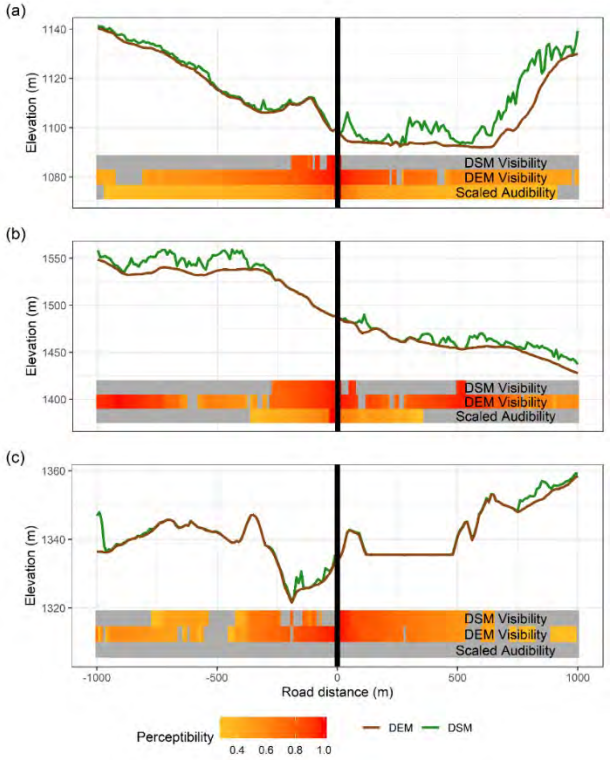
- Visibility performed better than sound or combined perception
- When compared to core and road models, visibility models are supported by 63/69 bears and 92.2% of the AIC weighting

- Grizzly bears tend to select for areas near the road, but prefer areas that are invisible to the road, indicating risk avoidance



Visibility and Forest Management





Geospatial Layers

- New approaches to map snow at fine spatial and temporal scales
- An ability to estimate the timing and phenology of understory vegetation across landscapes
- New methods to map roads in rural areas; and monitoring road development over time
- New approaches to map and perception of roads

Key Takeaways

- Clear evidence that snow accumulation and melt times and onset of vegetation greening has changed over the past 18 years
- This research has found:
  - Bears are showing a clear response in their movement to snow cover
  - **More likely to use snow free areas and areas where snow melted sooner**
  - **More likely to use lower elevation locations, especially when snow free/earlier melt**
  - **More likely to use locations closer to roads, especially after snow melt**

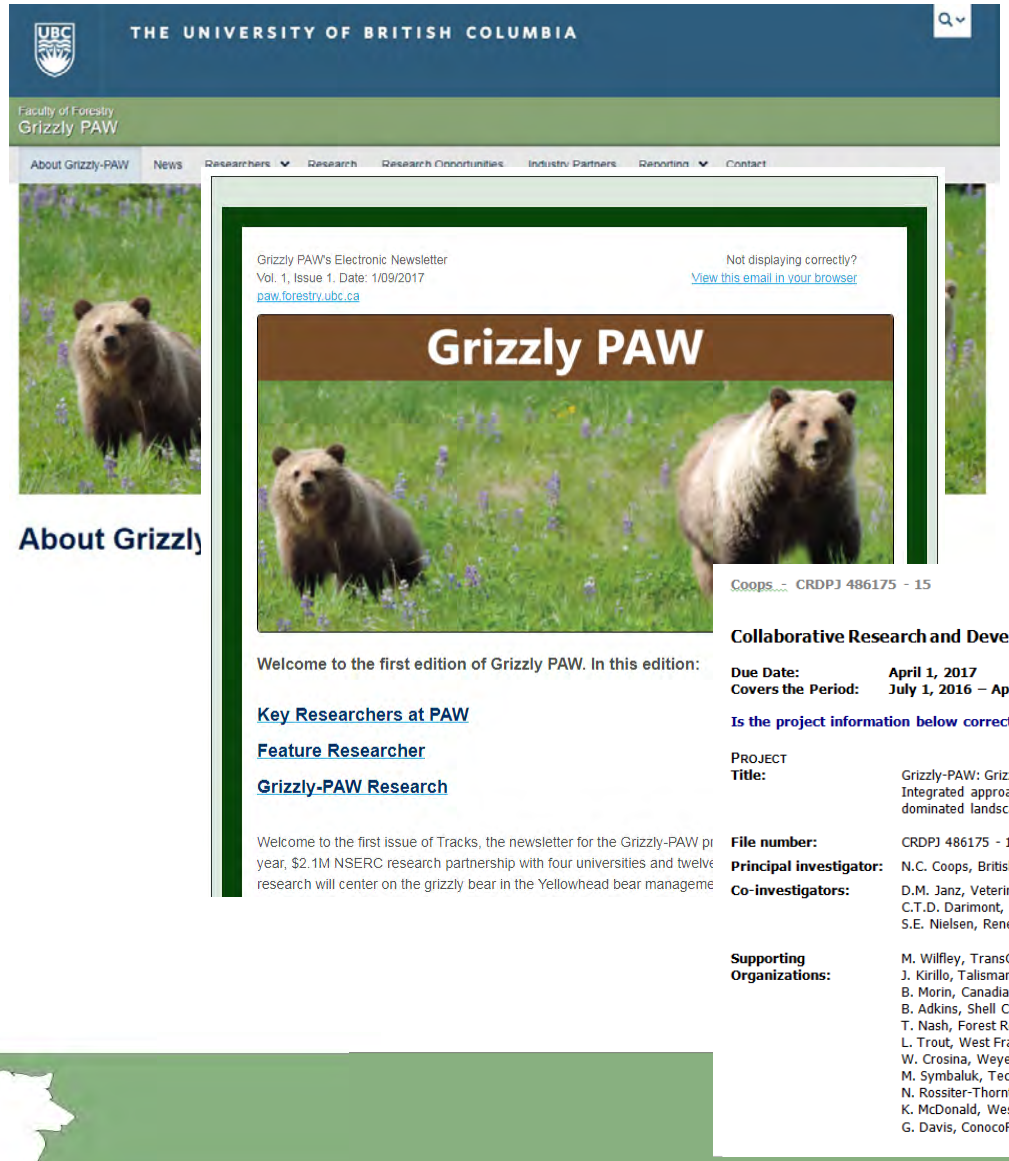
- With respect to Den emergence:
  - Earlier melt end date = earlier activity date
  - More rapid melt rate = earlier activity date
  - Less consistent melt = earlier activity date

Key Takeaways

- Bears prefer low cover conditions inside forested stands, and outside stands they prefer high cover conditions. We are developing thresholds to allow us to get a better sense of what these limits might be.

- Roads influenced grizzly movement at greater distances when perceptible from roads
- Although grizzly bears selected for areas near roads, they preferred areas invisible to roads
- More deaths occurred in areas visible to the road than expected based on landscape availability

Ongoing Communication



Website:

Paw.forestry.ubc.ca

Pass: Grizzly!PawInfo

Newsletter

NSERC reporting

- Gladys Tecson (Project Manager)
  - Gladys.Tecson@ubc.ca