Winter Recreation and Forest Carnivores: Studies of Canada Lynx and Wolverine

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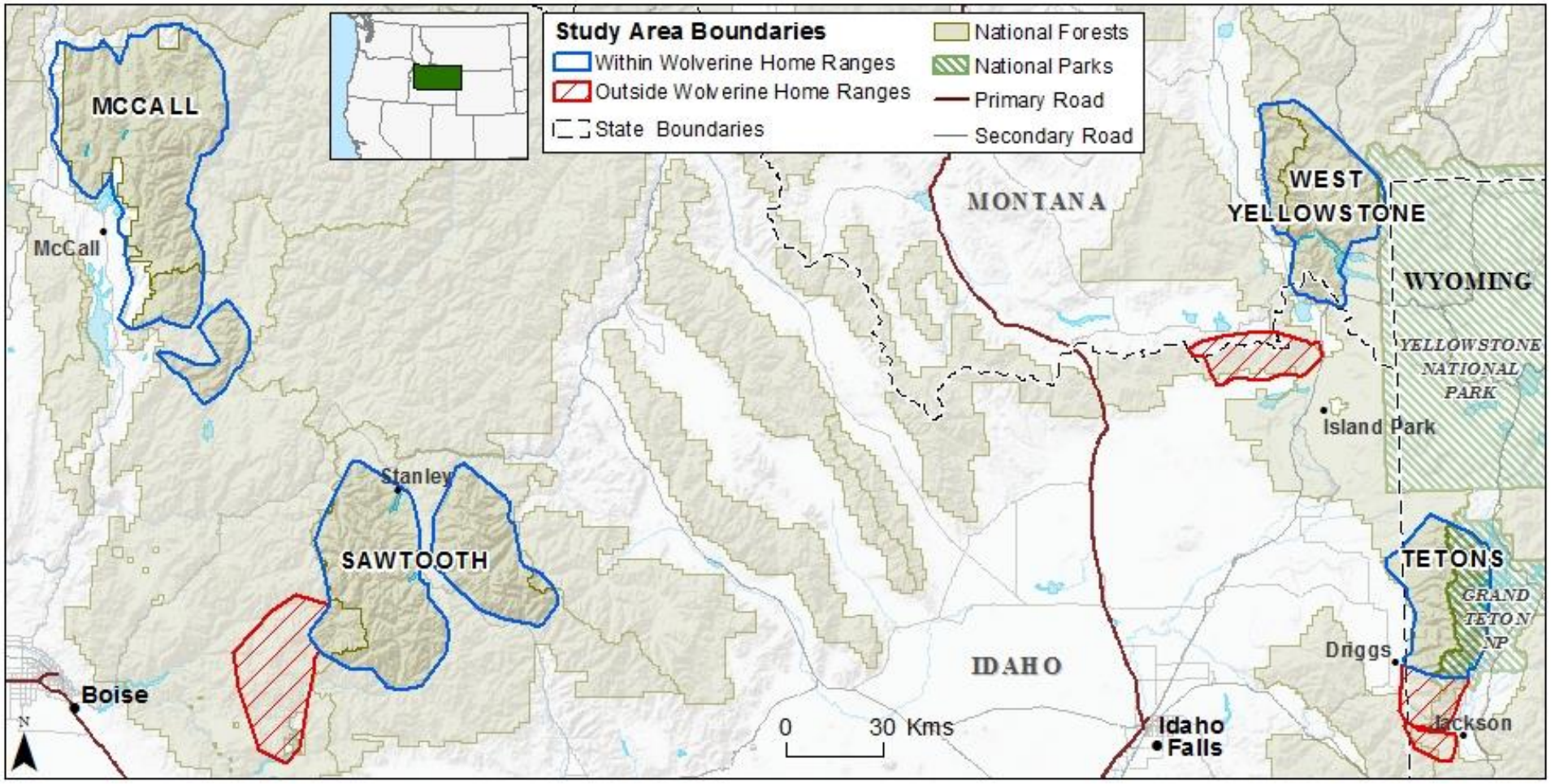
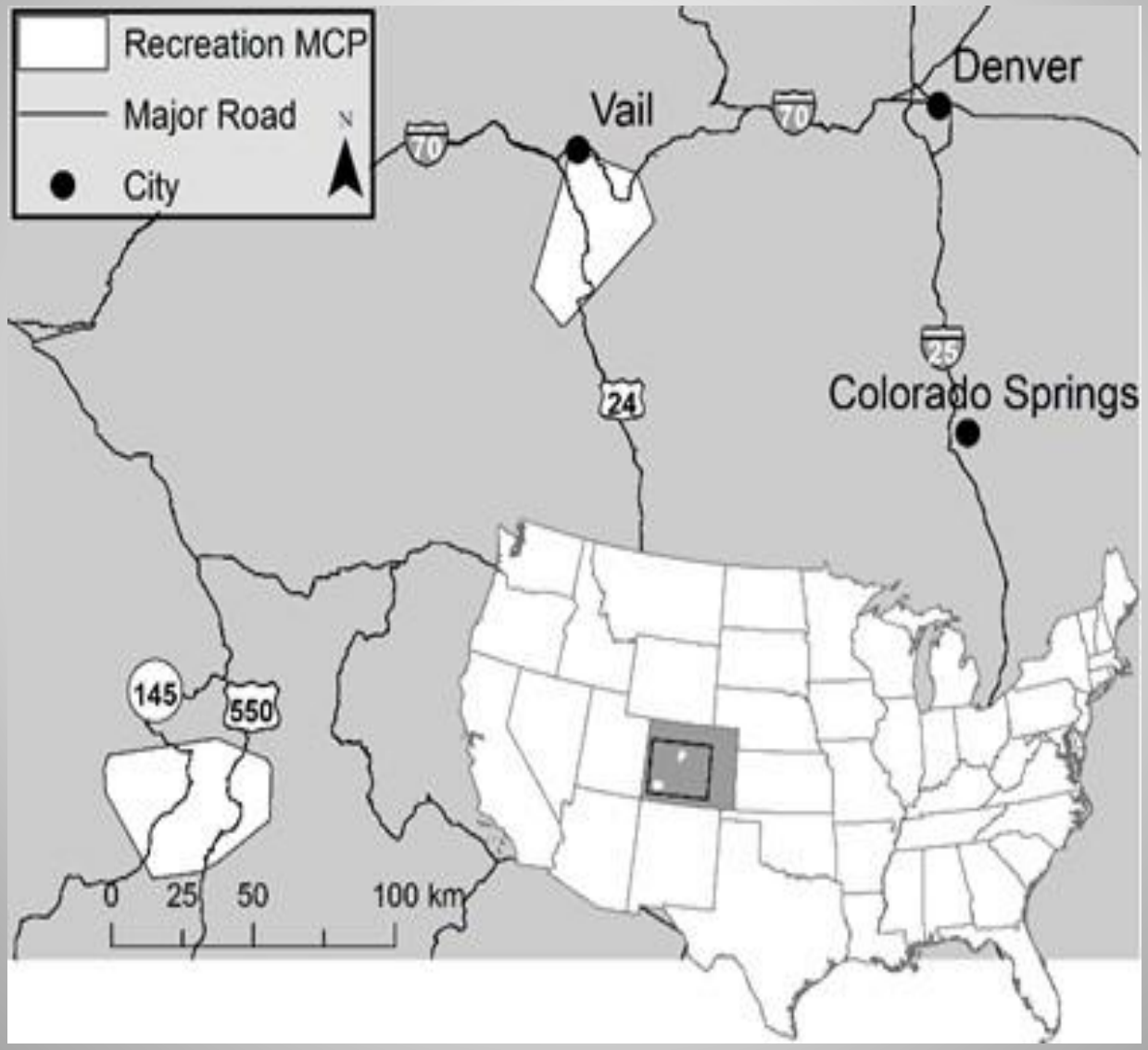
Overarching goal:

To understand how spatial movements, behaviors, resource selection and distribution of Canada lynx and wolverines are influenced by dispersed winter recreation (backcountry skiing, snowmobiling, hybrid skiing/snowmobiling)

Study Areas - Wolverine



Study Areas – Canada Lynx



Recreation Sampling

- Determined to quantify and analyze the movements of winter recreationists with same resolution as carnivores
- Evaluate spatial relationships across motorized and non-motorized activities
- Participation by recreationists was voluntary

GPS Technology

GPS Units for Recreation - **point collected every 2 seconds**

GPS Collar – **point collected every 20 minutes 24 hours a day**

Quantifying Winter Recreation – GPS approach

- Technicians distributed GPS Units to winter recreationists at recreation portals
- Stratified recreationists into:
  - snowmobile
  - hybrid snowmobile/skiing
  - ski/snowboard
  - snowshoe user
  - helicopter skiing
- One GPS unit per party
- Emailed the participant their track as an incentive


Do you still have one of these from the
Wolverine Project??
If so, please return it ASAP to one of these businesses to receive Beer, Food or Coffee Deals!
Free Drip Coffee: Cowboy Coffee Co. Jackson
Buy 1 Get 1 Free Draft: Thai Me Up Jackson
$5 off $25+ Purchase: Pinky G's Pizzeria Jackson
Buy 1 Get 1 Free Pint: Grand Teton Brewing Victor
Or Return it to local FS office: Jackson Ranger District or Teton Basin Ranger Station
291049


NRS-4

Winter recreation sample – Canada Lynx

Location	Year	Snowmobiles	Hybrid	Backcountry Ski/Snowboard	Snowshoe/ X-C Skiing	Heliski
Vail Pass	2010	134	129	73	16	0
Vail Pass	2011	226	177	213	29	0
San Juans	2011	102	23	267	95	0
San Juans Silverton	2012	69	26	258	135	0
San Juans Telluride	2012	69	0	56	55	91
San Juans Telluride	2013	62	3	165	206	12
Loveland/ Leadville	2013	31	10	176	205	0
Total	**3113**	**693**	**368**	**1208**	**741**	**103**

Total track length = 56,000 kms across 2 study areas

Winter recreation sample - Wolverine

Recreation Type	**McCall**	**Sawtooths**	**West Yellowstone**	**Tetons**
Recreation GPS Tracks	1738	1368	396	2470
# GPS tracks, motorized	93%	54%	98%	8%
# GPS tracks, non-motorized	7%	46%	2%	92%
Trail Use Counts: Ave estimated annual recreation visits	16,173	6,149	7,215	23,387

Wolverine + Lynx studies = 9,085 total tracks of winter recreationists

Canada Lynx Capture

Wolverine Capture

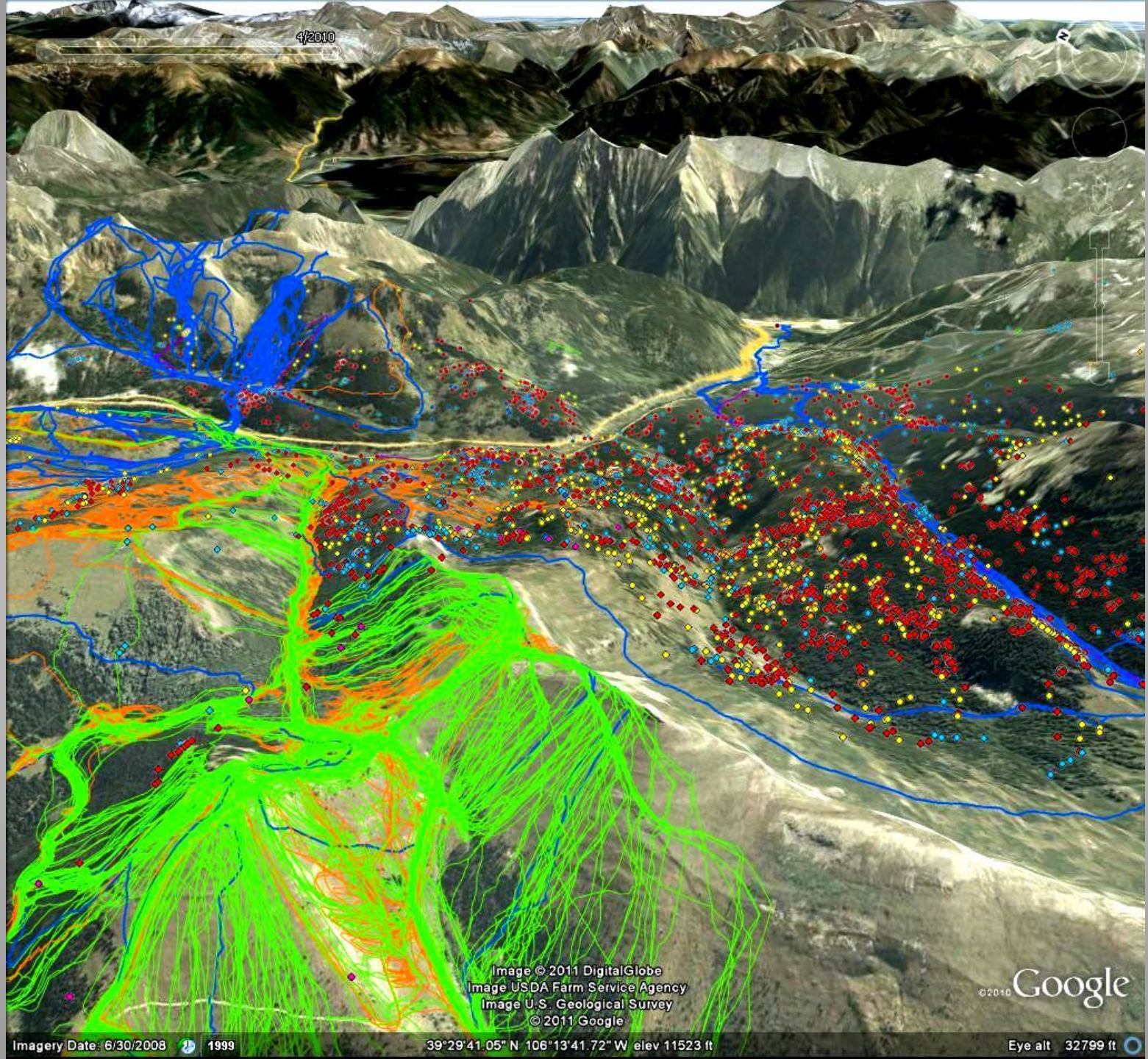
Sample size - Wolverines

- 24 wolverines collared over the 4 study areas (13 Males, 11 Females); 18 individuals with suitable data for modeling.
- 8 denning events by 8 females
- Of these, we used 18 animals to build the habitat models

	N	Animal-Years	Ave # GPS Locations/Yr	Ave HR (km^2)	Range of HR (km^2)
Males	8	12	2590	1273	401 – 2158
Females	10	13	1894	289	126 – 420
Total	**18**	**25**	**>53,000**	**>1 million ha**	**-**

Sample size – Canada lynx

- 20 Canada lynx collared over the 2 study areas (9 Males, 9 Females) from 2010 – 2013 with 4 individuals captured in successive years for a total of 22 yearly home ranges; 18 individuals with sufficient data
- Documented 64,135 GPS locations ($\bar{x}$ = 3685/lynx, SD = 2230)
- Sampling season = January - March


4/2010
Image © 2011 DigitalGlobe
Image USDA Farm Service Agency
Image U.S. Geological Survey
© 2011 Google
©2010 Google
Imagery Date: 6/30/2008
1999
39°29'41.05" N 106°13'41.72" W elev 11523 ft
Eye alt 32799 ft

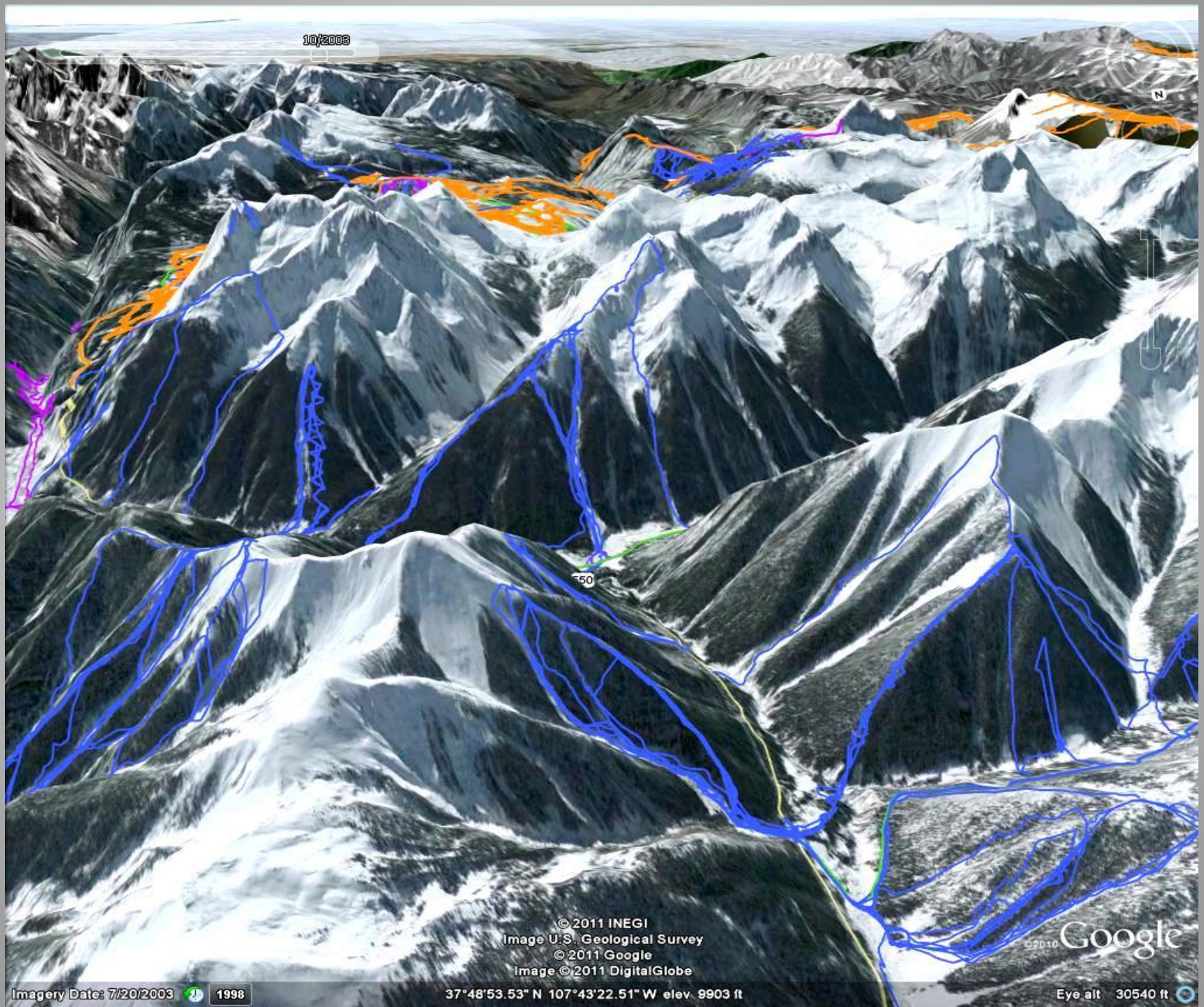

10/2003
N
© 2011 INEGI
Image U.S. Geological Survey
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Image © 2011 DigitalGlobe
©2010 Google
Imagery Date: 7/20/2003
1998
37°48'53.53" N 107°43'22.51" W elev 9903 ft
Eye alt 30540 ft

Minnehaha Basin- Silverton

Recreation / Canada lynx overlap

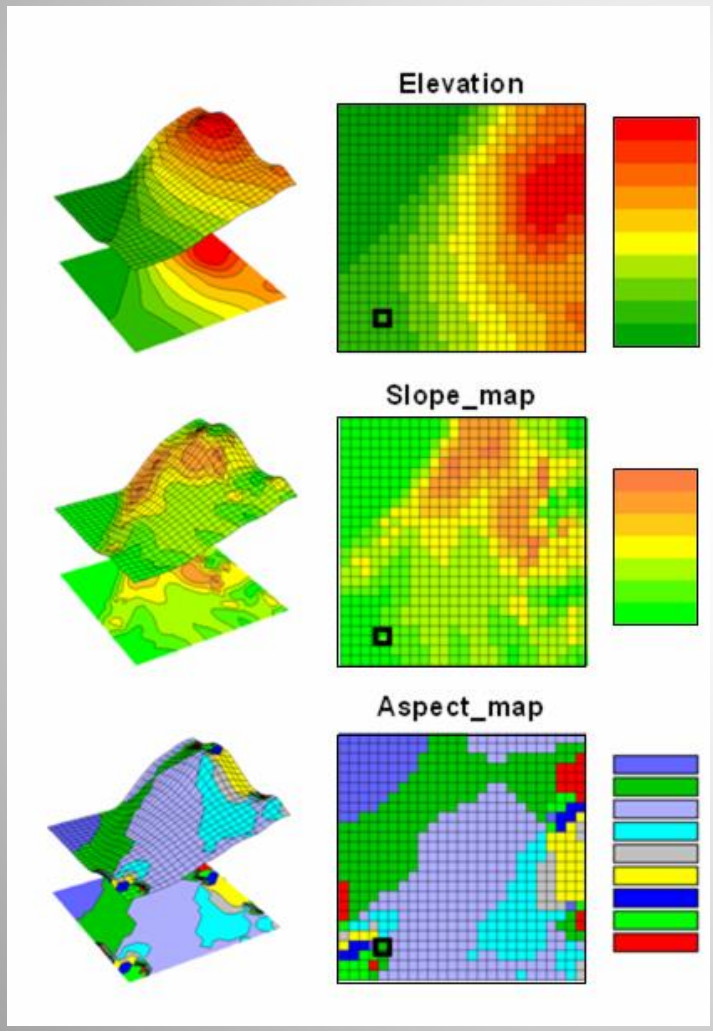
- Canada lynx - low spatial correlation with areas selected by on-trail and hybrid snowmobilers (Pearson correlations of $|r| = 0.18$ and $|r| = 0.14$, respectively),

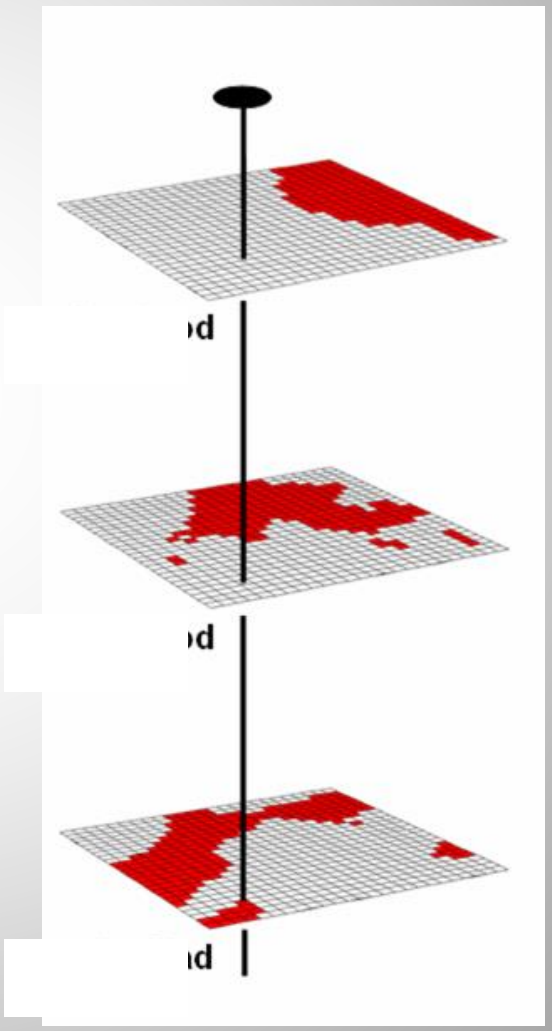
  Low overlap in how winter recreationists when engaged in motorized activities selected environmental features.

- Canada lynx exhibited the second lowest spatial correlations with hybrid skiers ($|r| = 0.23$) when skiing and off-trail snowmobilers ($|r| > 0.22$).

- Lynx exhibited the highest spatial correlation with backcountry skiers ($|r| = 0.34$).

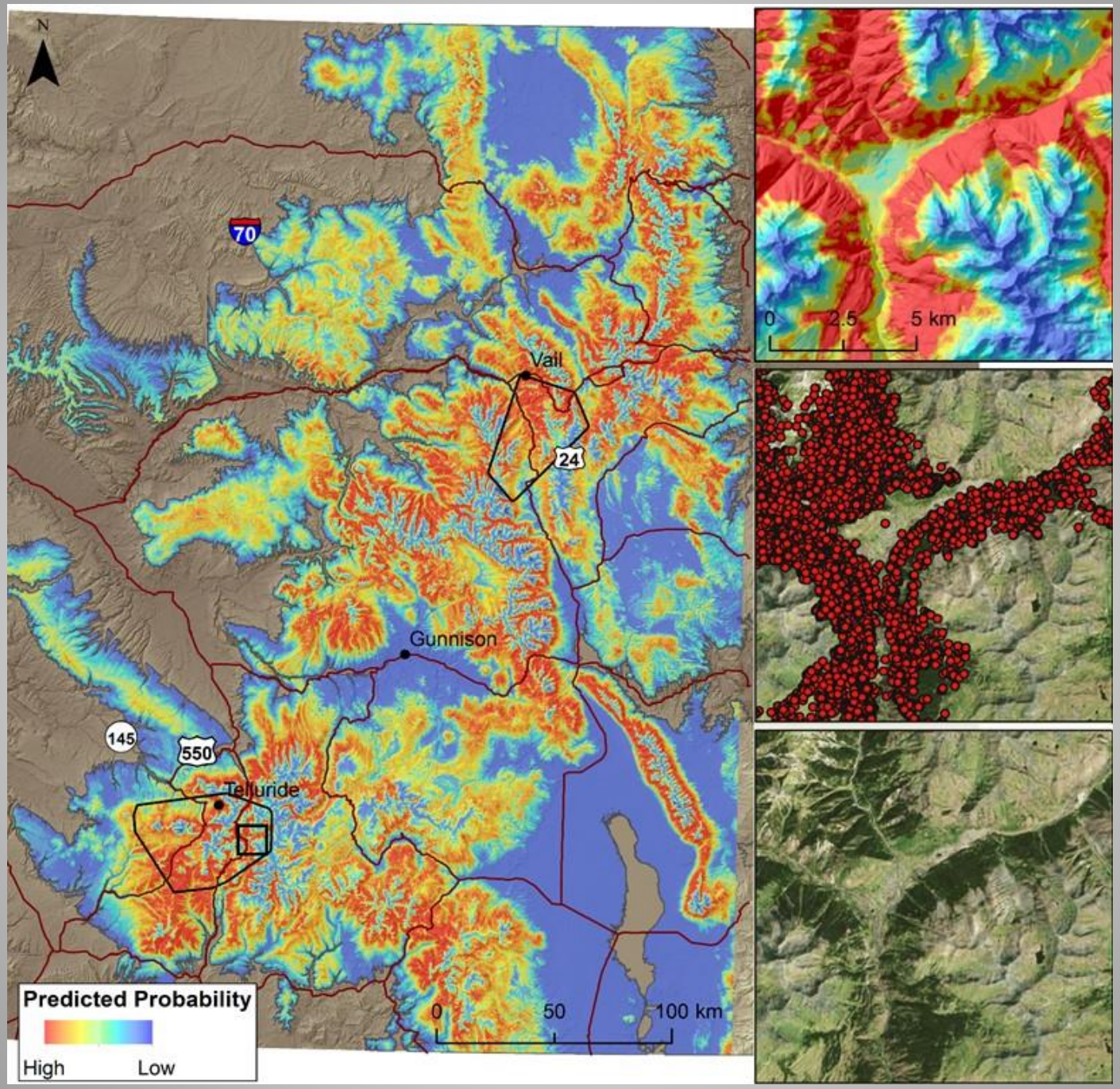
Resource selection modeling



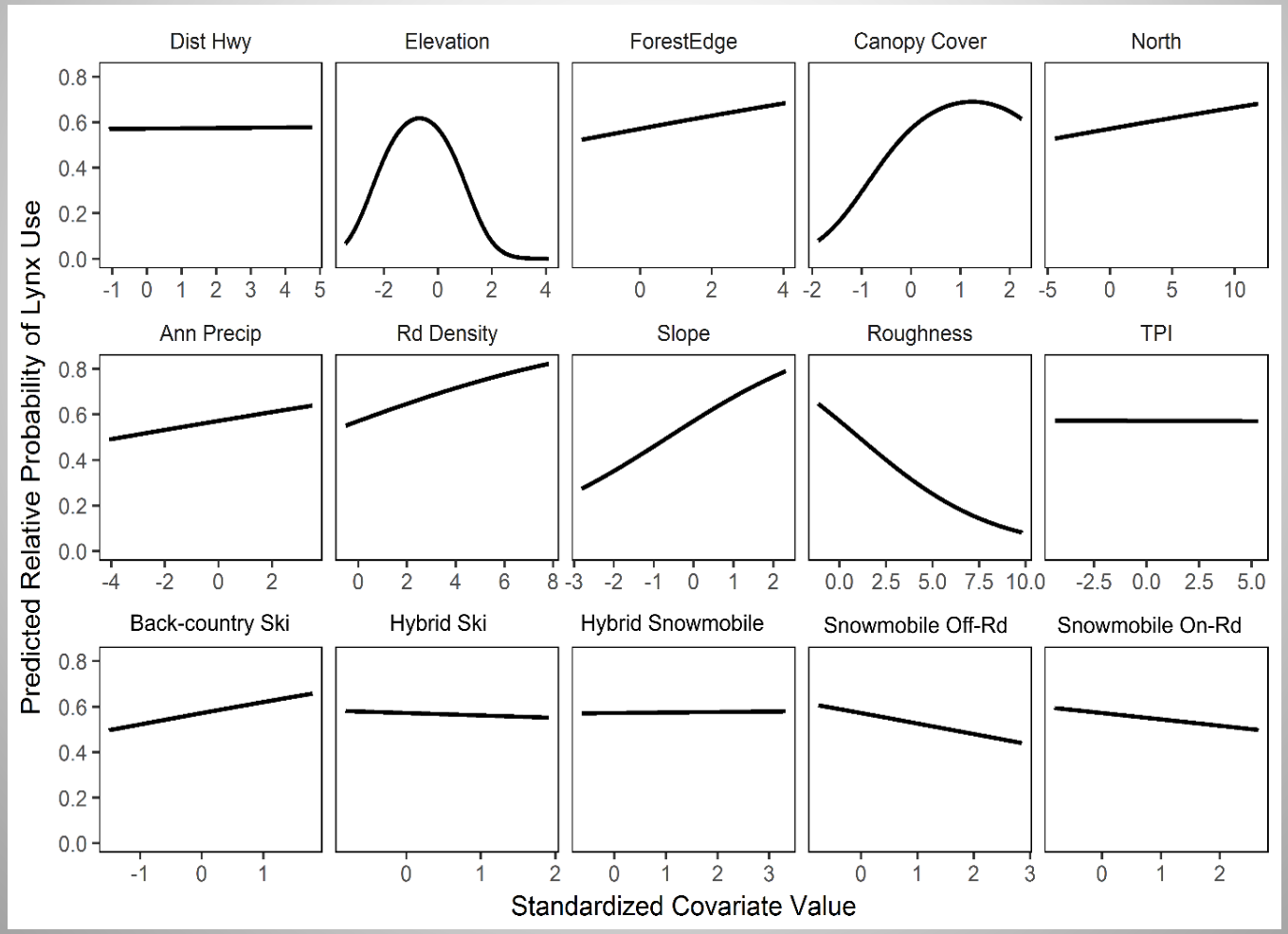


Beta coefficients (β) and standard errors (SE) of covariates from the top-performing resource selection model (RSF) for Canada lynx in the southern Rocky Mountains, Colorado, 2010 to 2013; spatial scales (m) are appended to covariate names in subscript.

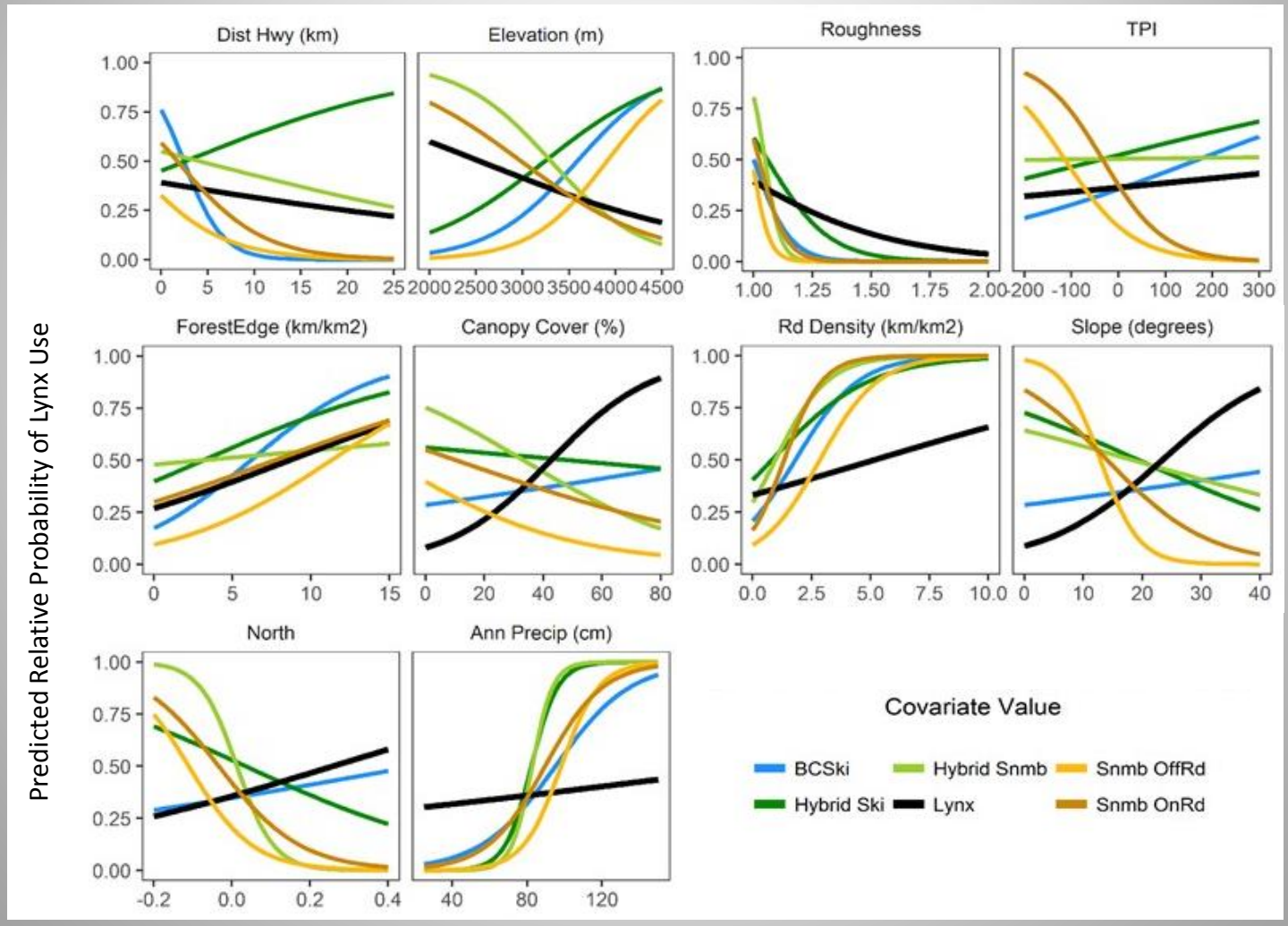
	β	SE
Dist Hwy_{500}	-0.06	0.01
$Elevation_{125}$	-0.49	0.02
$Elevation^2_{125}$	-0.43	0.01
Forest $Edge_{500}$	0.12	0.01
Canopy $Cover_{125}$	0.90	0.01
Canopy $Cover^2_{125}$	-0.33	0.01
$North_{1250}$	0.03	0.01
Ann Precip	0.05	0.01
Rd $Density_{500}$	0.15	0.01
$Slope_{2500}$	0.56	0.01
$Roughness_{125}$	-0.26	0.01
TPI_{500}	0.04	0.01


N
70
Vail
24
Gunnison
145
550
Telluride
Predicted Probability
High
Low
0
50
100 km
0
2.5
5 km

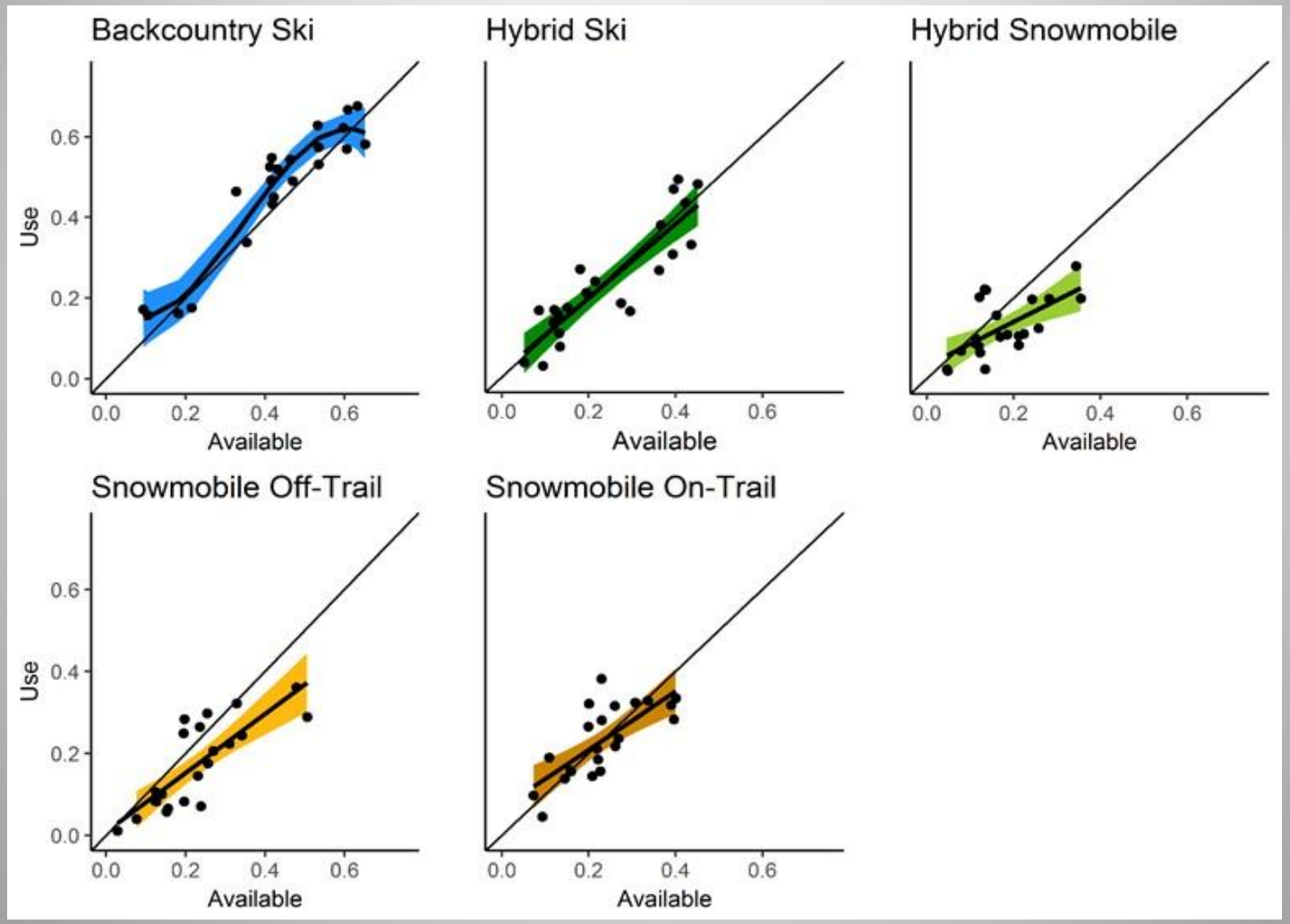
Marginal response curves for each covariate in top RSF model for Canada lynx with Winter Recreation



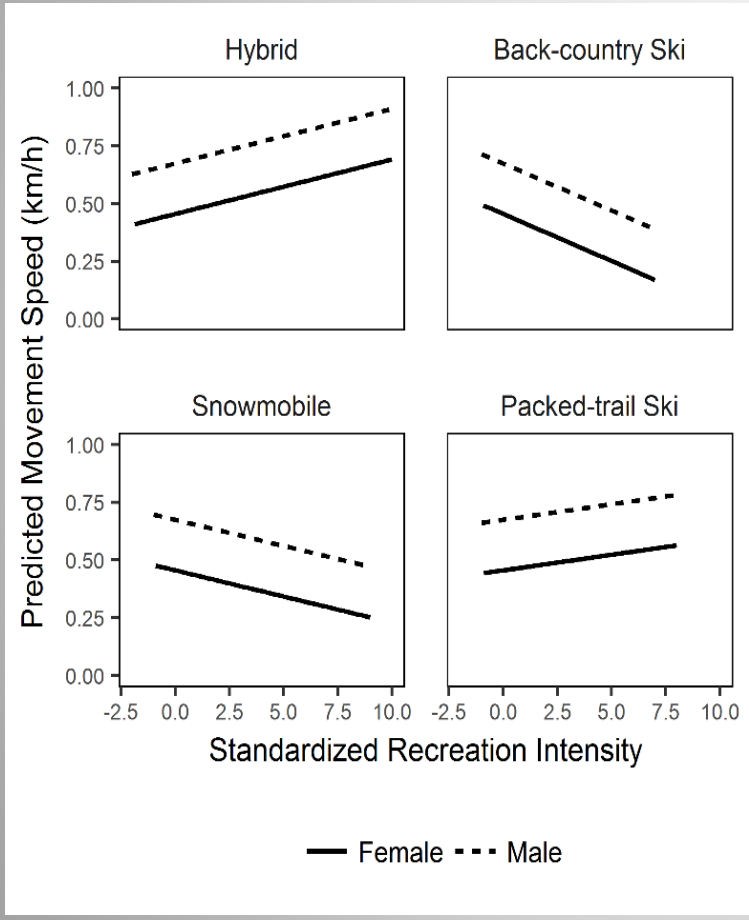
Generalized Linear Mixed Model with Interaction Terms Relative to Canada Lynx and Winter Recreation



Functional responses of Canada lynx to Winter Recreation Activities



Differences in Lynx Movement Behavior in Response to Recreation Intensity

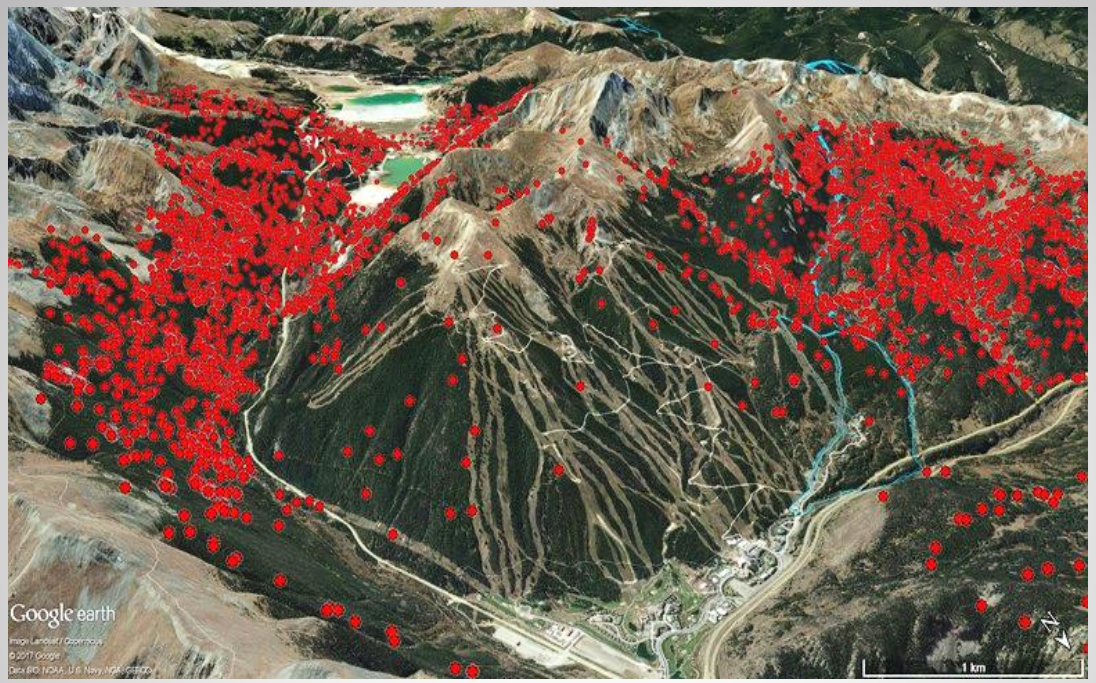


- Lynx slowed their movement rate in the presence of greater snowmobile and back-country ski activity.
- At high hybrid and packed-trail ski intensities, lynx generally moved faster.

Temporal Differences in Lynx Activity in Response to Recreation Intensity

- Recreation intensity was low = Proportion of time active was similar day and night across study areas
- But, activity decreased during the day with increased intensity of all recreation types (Vail study area)
- Lynx activity increased (or remained constant) with increased back-country ski or snowmobile during day and night in the San Juan and during the night in Vail.

Lynx Response to Developed Ski Resorts



- Lynx were more likely to enter the ski area boundary during night than day.
- Lynx use of ski areas was greater on weekdays than on weekends.
- Lynx use of the ski area during weekends changed over time, so that weekend use was higher in spring and summer, when the ski season had ended, than it was in winter.

Conclusions - Canada lynx

- Canada lynx do tolerate winter recreation in home ranges.
- Dichotomy in how Canada lynx selected resources in responded to areas selected by motorized versus non-motorized winter recreation - increasing avoidance as areas preferred by motorized recreationists were more present (functional response)
- In contrast, Canada lynx exhibited either no functional response (use proportional to available – hybrid-ski) to non-motorized recreationists or they selected areas also used by non-motorized recreationists

Conclusions – Canada lynx

- The environmental gradients that most spatially segregate Canada from winter recreationists across activities are forest canopy closure, annual precipitation (i.e. elevation), road density, and slope - management actions that alter (roads, canopy) or relate to these gradients are most likely to alter spatial relationships between lynx and recreationists

  Examples:
  - Canopy cover
  - Roads
  - slope
  - elevation

Conclusions – Canada lynx

- While lynx did not exhibit strong temporal avoidance of recreation- may have adjusted the proportion of time they spent active (e.g. high-intensity Vail study area -less active during the day).
- However, there is an upper threshold = developed ski areas

Conclusions – Canada lynx

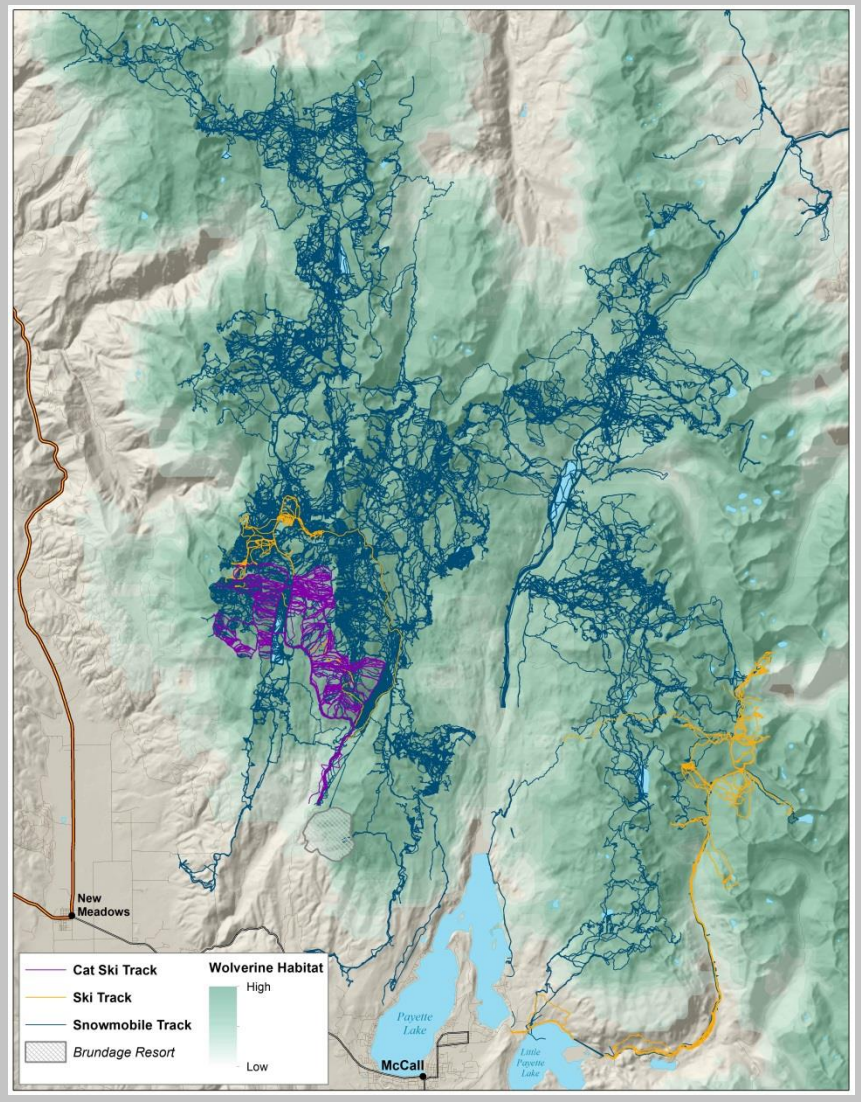
Are observed patterns of space-use by Canada lynx in the presence of winter recreation an expression of habitat preferences or a “landscape of fear” from human disturbance?

Caveats :

- demographic response
- new technology – motorized snow bikes
- short-term study

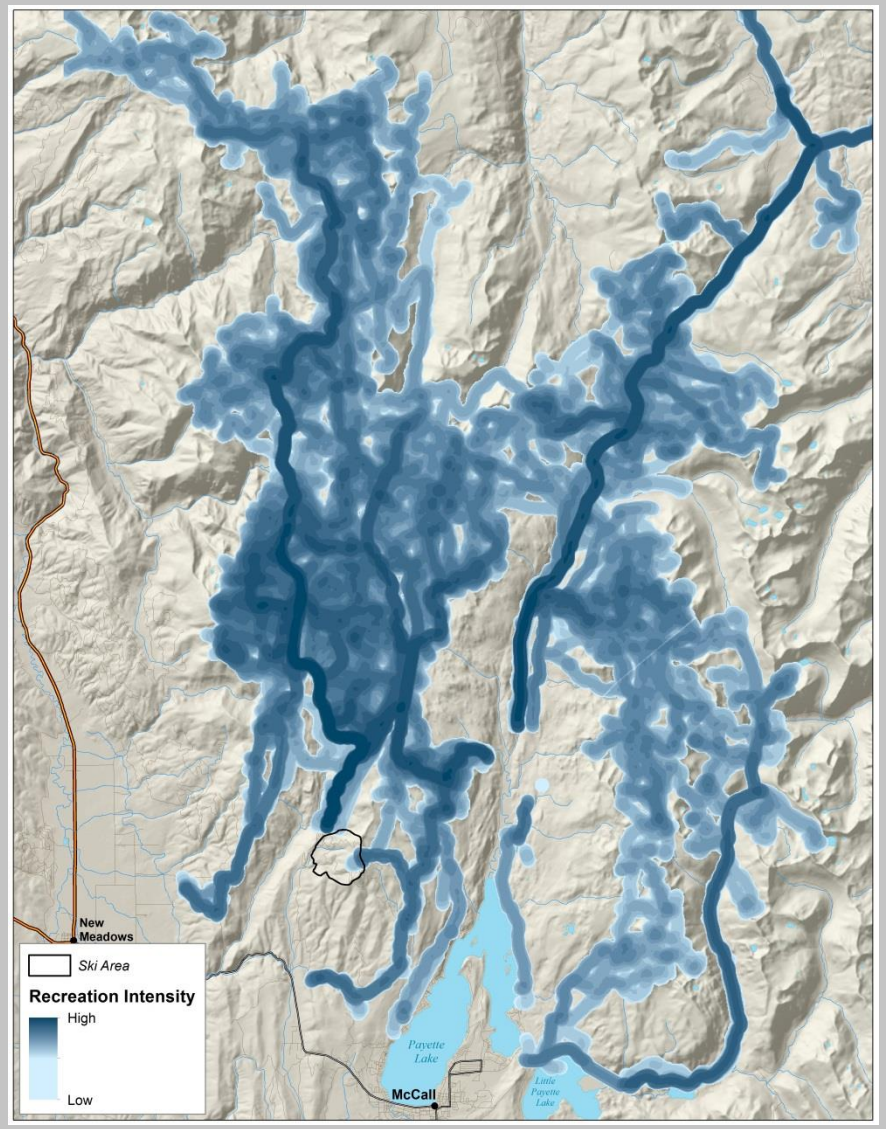
Mapping Winter Recreation

Backcountry winter recreation overlaps potential wolverine habitat



Mapping Winter Recreation

- Mapped recreation footprint and relative intensity for:
  - All recreation combined
  - Off-Road Motorized recreation
  - Off-Road Non-motorized recreation
- Validate with aerial surveys
- Covariates in wolverine habitat models



Winter Habitat Modeling

Resource Selection Functions: Relative probability of use

Mixed effects logistic regression controlling for differences between individuals and years

First: *'potential habitat'* models ignoring the possible effects of winter recreation

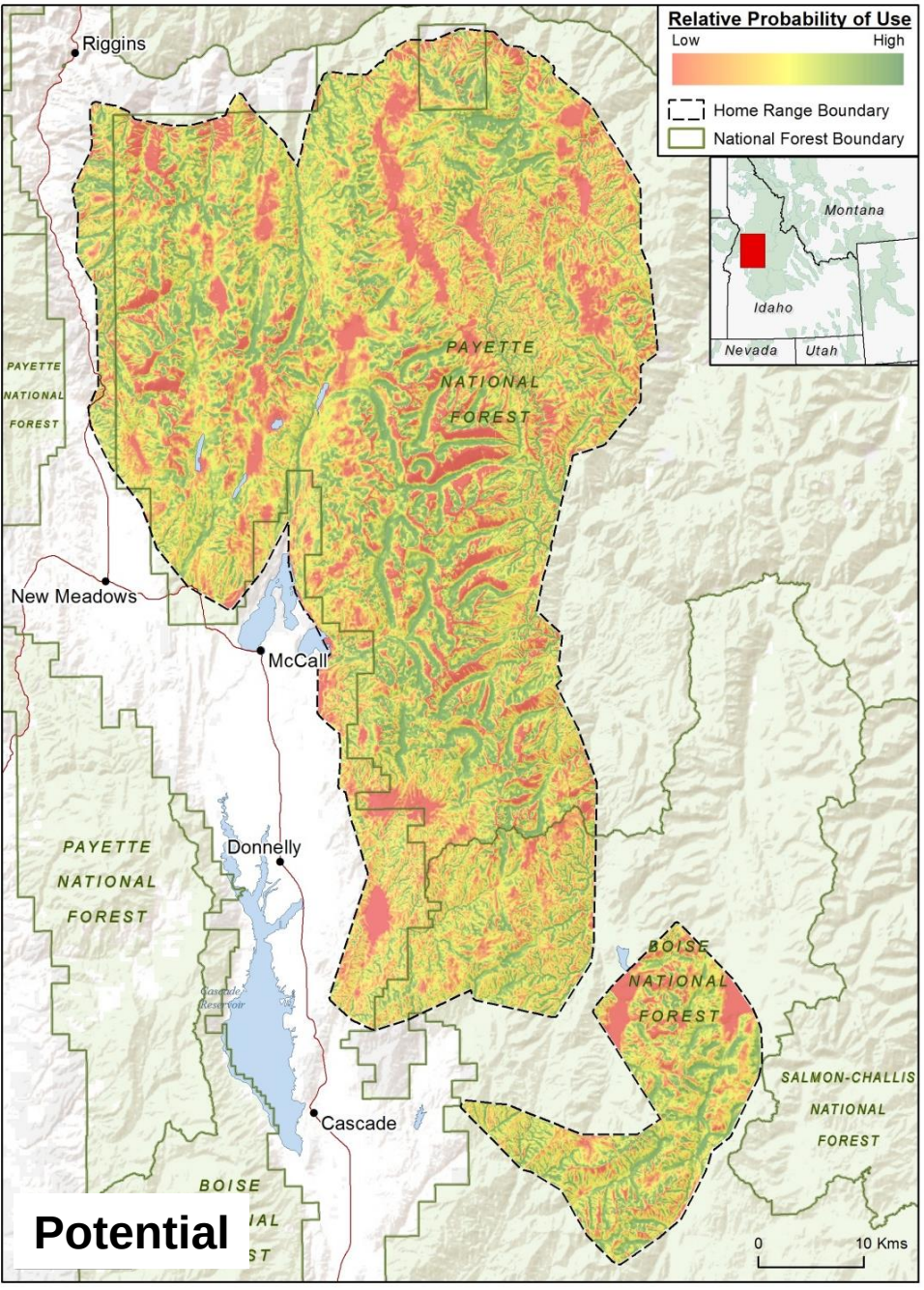
- Determined better models if sex-specific

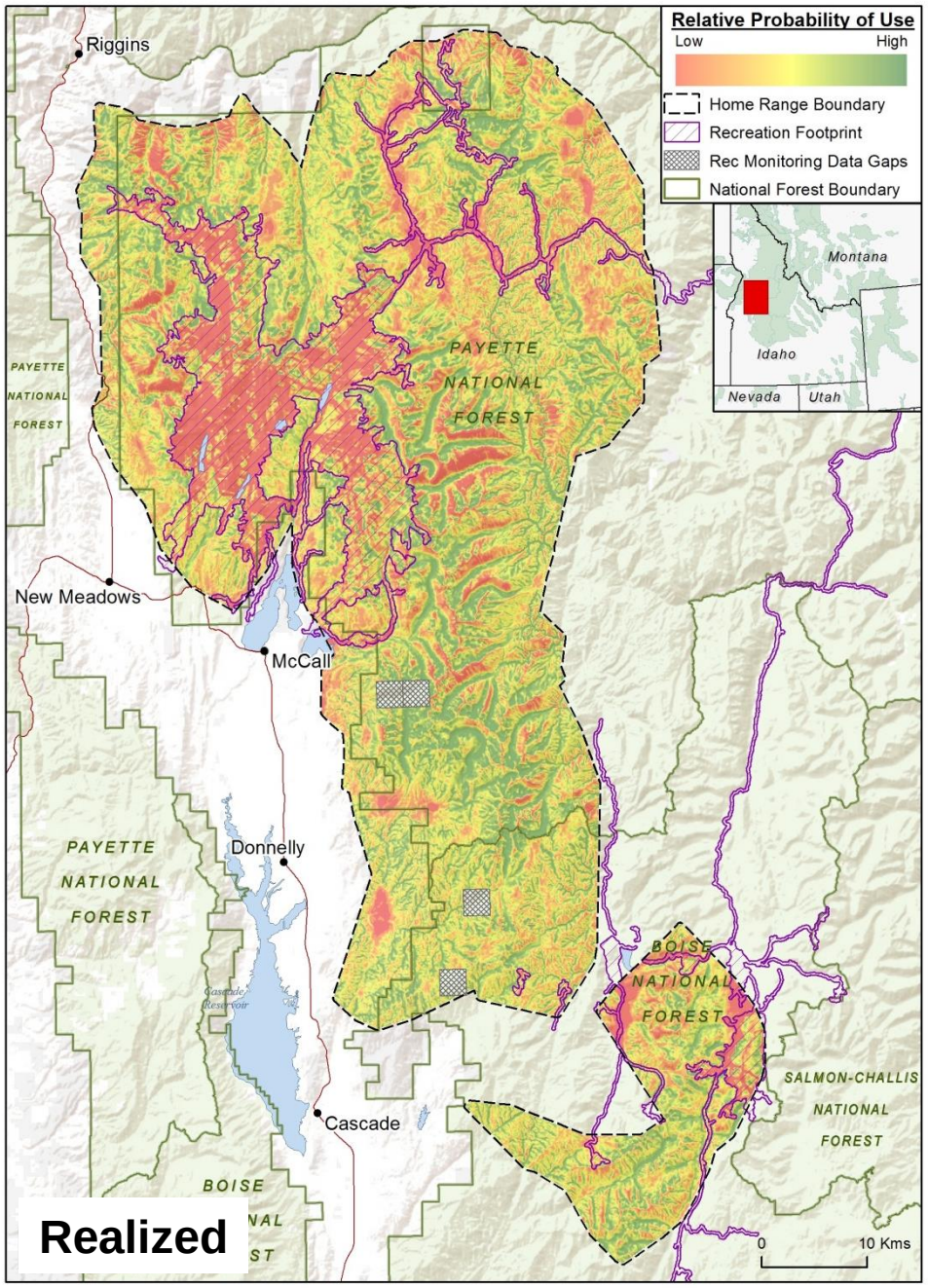
Second: include winter recreation covariates to model *'realized habitat'*

Realized Habitat Model for Females Wolverines

Model Covariates	Female Wolverine Response	Rank
TPI (Topographic position)	Prefers drainage bottom	1
Off-Road Motorized Intensity	Avoids off-road motorized rec	2
Slope^2	Avoids steep slopes	3
Distance to forest edge	Close to forest edges	4
Off-Road Non-Motor. Intensity	Avoids off-road non-motor. Rec	5
Solar insolation	Prefers cooler aspects	6
Spring snow	Prefers consistent spring snow	7
Talus	Prefers Talus	8
Forest edge:area	Prefers higher forest edge ratio	9
Distance to Recreated Roads	Avoids areas close to recreated roads	10
Riparian	Prefers Riparian	11
Slope	Prefers low and moderate slopes	12
Montane shrub & grass	Avoids open	13
Fir forest	Prefers Fir	14

Female Winter Habitat Model





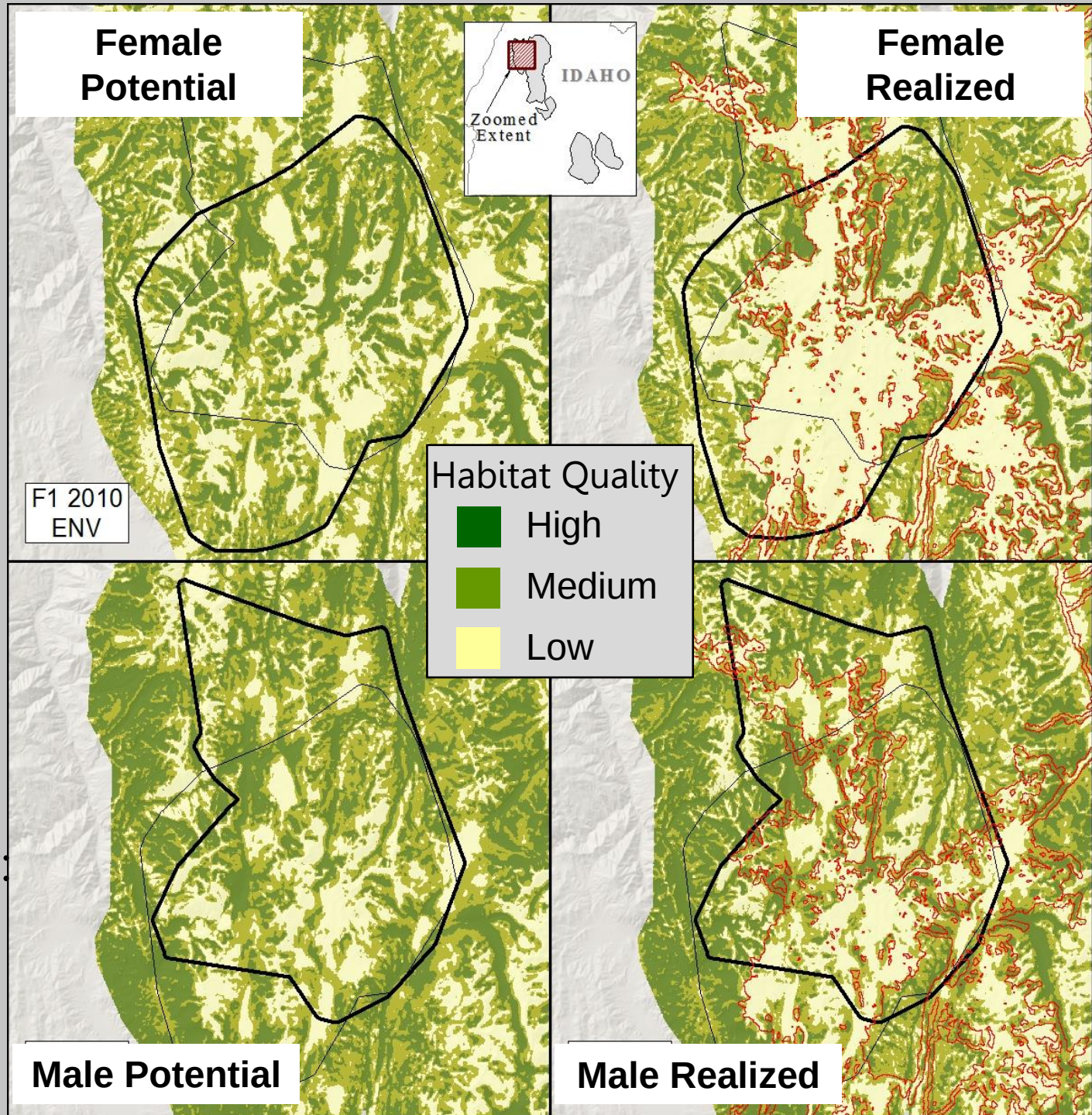
Indirect Habitat Loss

Calculated as reduction in habitat class from potential to realized habitat

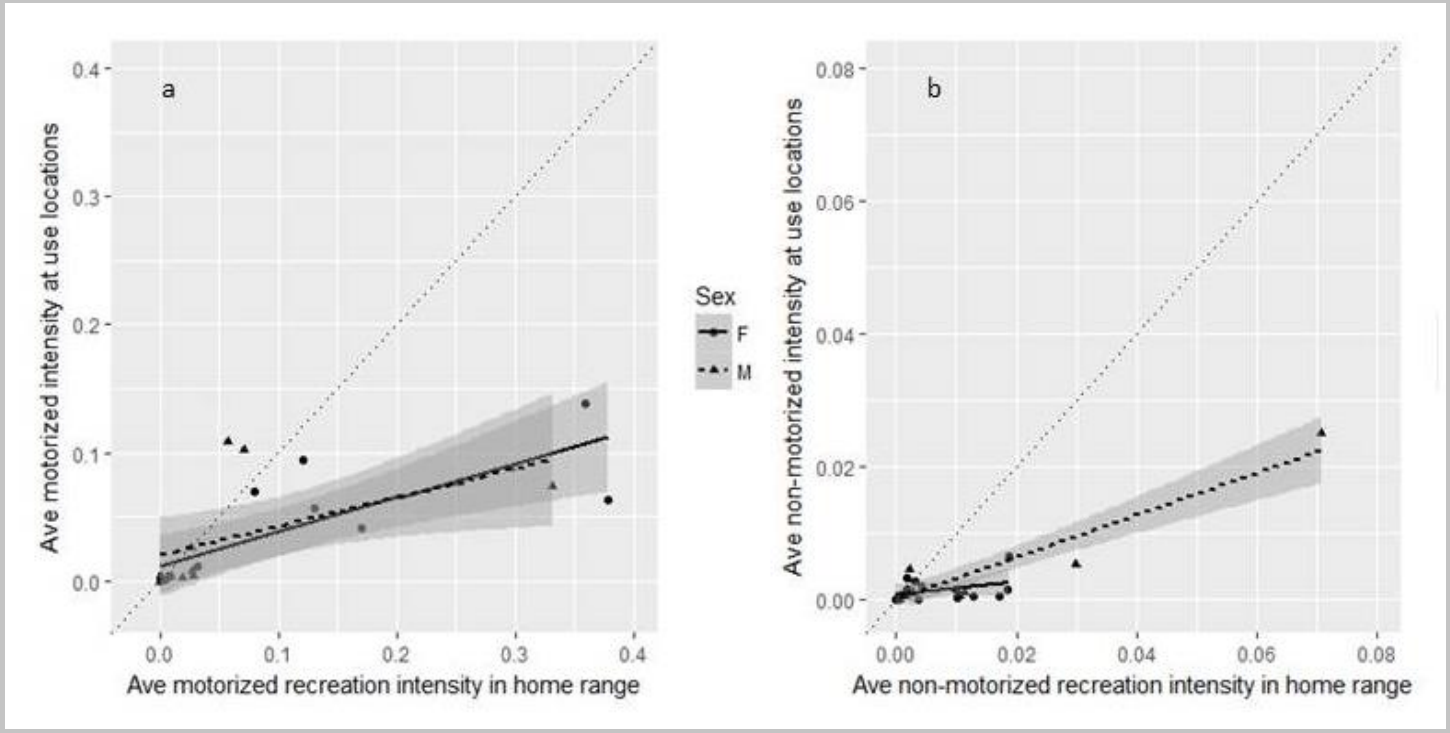
Example: High and Medium degraded to Low:

- Female: 74%
- Male 40%

Range 10->70%



Functional Responses - Wolverines



- The more recreation there is, the stronger the avoidance
- The less recreation there is, the weaker the avoidance
- True for both motorized recreation and non-motorized recreation
- True for both males and females

Conclusions

- Wolverines reside in some of our highly recreated winter landscapes
- Wolverines generally avoid recreation
- Female wolverines strongly avoid off-road recreation
- Males are less sensitive than females
- Wolverines less sensitive to road-based recreation
- Strong avoidance + functional response + larger footprint of motorized recreation ~ higher amounts of indirect habitat loss to females
- Need creative, collaborative approaches for management

Report available at
www.roundriver.org/wolverine

Thank You
Technicians and Volunteers
Recreation Community

Partners & Collaborators

Rocky Mountain Research Station
Forest Service
U.S. Department of Agriculture
Round River Conservation Studies
Idaho Fish & Game
Wyoming Game & Fish Department
U.S. Fish & Wildlife Service
National Park Service
Defenders of Wildlife
The University of Montana
Jackson Hole
Liz Claiborne Art Ortenberg Foundation
The Wolverine Foundation, Inc.
Idaho State Snowmobile Association
Central Idaho Recreation Coalition
CIRC
Active People for Recreational Planning
P.O. Box 607 McCall, ID 83638
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Grand Targhee Resort


Thank you !