

Current Distribution, Status, and Threats of Canada Lynx in Montana and Wyoming



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Basis of Assessment - Montana:

- a) Lynx Research Program at RMRS initiated in 1998
- b) Captured and collared 175 individuals
- c) Recorded 169,782 GPS and 3043 VHF locations that document lynx movements and resource-use
- d) Investigated the following topics regarding lynx in Montana:

Basis of Assessment:

- Resource selection

Squires, J. R., N. J. DeCesare, J. A. Kolbe, and L. F. Ruggiero. 2008. Hierarchical den selection of Canada lynx in western Montana. *Journal of Wildlife Management* 72:1497-1506.

Squires, J. R., N. J. DeCesare, J. A. Kolbe, and L. F. Ruggiero. 2010. Seasonal Resource Selection of Canada Lynx in Managed Forests of the Northern Rocky Mountains. *Journal of Wildlife Management* 74:1648-1660.

- Prey Selection

Squires, J. R. and L. F. Ruggiero. 2007. Winter prey selection of Canada lynx in northwestern Montana. *Journal of Wildlife Management* 71:310-315.

- Competition

Kolbe, J. A., J. R. Squires, D. H. Pletscher, and R. F. Ruggiero. 2007. The effect of snowmobile trails on coyote movements within lynx home ranges. *Journal of Wildlife Management* 71:1409-1418.

Basis of Assessment:

- **Activity Patterns**

Kolbe, J. A. and J. R. Squires. 2007. Circadian activity patterns of Canada lynx in western Montana. *Journal of Wildlife Management* 71:1607-1611.

Olson, L. E., J. R. Squires, N. J. DeCesare, J. A. Kolbe. 2011. Den use and activity patterns in female Canada lynx (*Lynx canadensis*) in the Northern Rocky Mountains. *Northwest Science* 85(3):455-462.

- **Detection/Monitoring**

Squires, J. R., K. S. McKelvey, L. F. Ruggiero. 2004. A snow-tracking protocol used to delineate local lynx, *Lynx canadensis*, distributions. *Canadian Field-Naturalist* 118:583-589.

McKelvey, K. S., J. Von Kienast, K. B. Aubry, G. M. Koehler, B. T. Maletzke, J. R. Squires, E. L. Lindquist, S. Loch, M. K. Schwartz. 2006. DNA analysis of hair and scat collected along snow tracks to document the presence of Canada lynx (*Lynx canadensis*). *Wildlife Society Bulletin* 34:451-455.

Squires, J. R., L. E. Olson, D. L. Turner, N. J. DeCesare, and J. A. Kolbe. 2012. Estimating detection probability for Canada lynx using snow-track surveys in the Northern Rocky Mountains. *Wildlife Biology* 18:215-224.

Basis of Assessment:

- Connectivity

Squires, J. R., Nicholas J. DeCesare, Lucretia E. Olson, Jay A. Kolbe, Mark Hebblewhite, and Sean A. Parks. 2013. Combining resource selection and movement behavior to predict corridors of Canada lynx at their southern range periphery. *Biological Conservation* 157:187–195.

Basis of Assessment - Wyoming:

a) Wyoming Game and Fish Department (WGF), in cooperation with the Shoshone National Forest (SNF), initiated lynx surveys during winter 1995/96

- no lynx detected on SNF
- Impetus for WGF to fund additional surveys, trapping, and telemetry in the Wyoming Range

b) During 1997-98, WGF searched approximately 2055 km of maintained snowmobile routes and 2400 km of non-maintained trails for lynx tracks in 12 areas (Laurion and Oakleaf 1998) – 6 lynx tracks detected

Basis of Assessment - Wyoming:

c) During winter 1998-99, three general areas were searched (Laurion and Oakleaf 1999) - 6 tracks located in Wyoming Range.

d) RMRS, in cooperation with WGD, conducted lynx surveys in 2000, 2001, and 2002

- 2000 – Wyoming Range: 5 lynx tracks - kitten and female
- 2001 – Wyoming Range: 5 lynx tracks
- 2002 – no detections

Basis of Assessment - Wyoming:

e) Yellowstone Park Lynx survey from 2001 – 2004 (1,143 km ski-based snow tracks, 749 km snowmobile-based survey, 693 km aircraft survey, and 35 hair snare transects - 105-175 stations; Murphy et al. 2006. Distribution of Canada Lynx in Yellowstone National Park. Northwest Science 80:199-206)

f) DNA confirmed detections of 3 lynx – 1 female, 1 female with male kitten, and 1 male. All detections on east side of Yellowstone Park – east shore Yellowstone Lake.

Basis of Assessment - Wyoming:

g) Endeavor Wildlife Research Foundation conducted track/DNA surveys between 2004-2005 in southern GYA (Bridger-Teton Nat. Forest including Gros Ventre and Teton Wilderness areas) – searched 4,320 miles and detected (DNA confirmed) 18 lynx tracks. Confirmed presence in Wyoming Range.

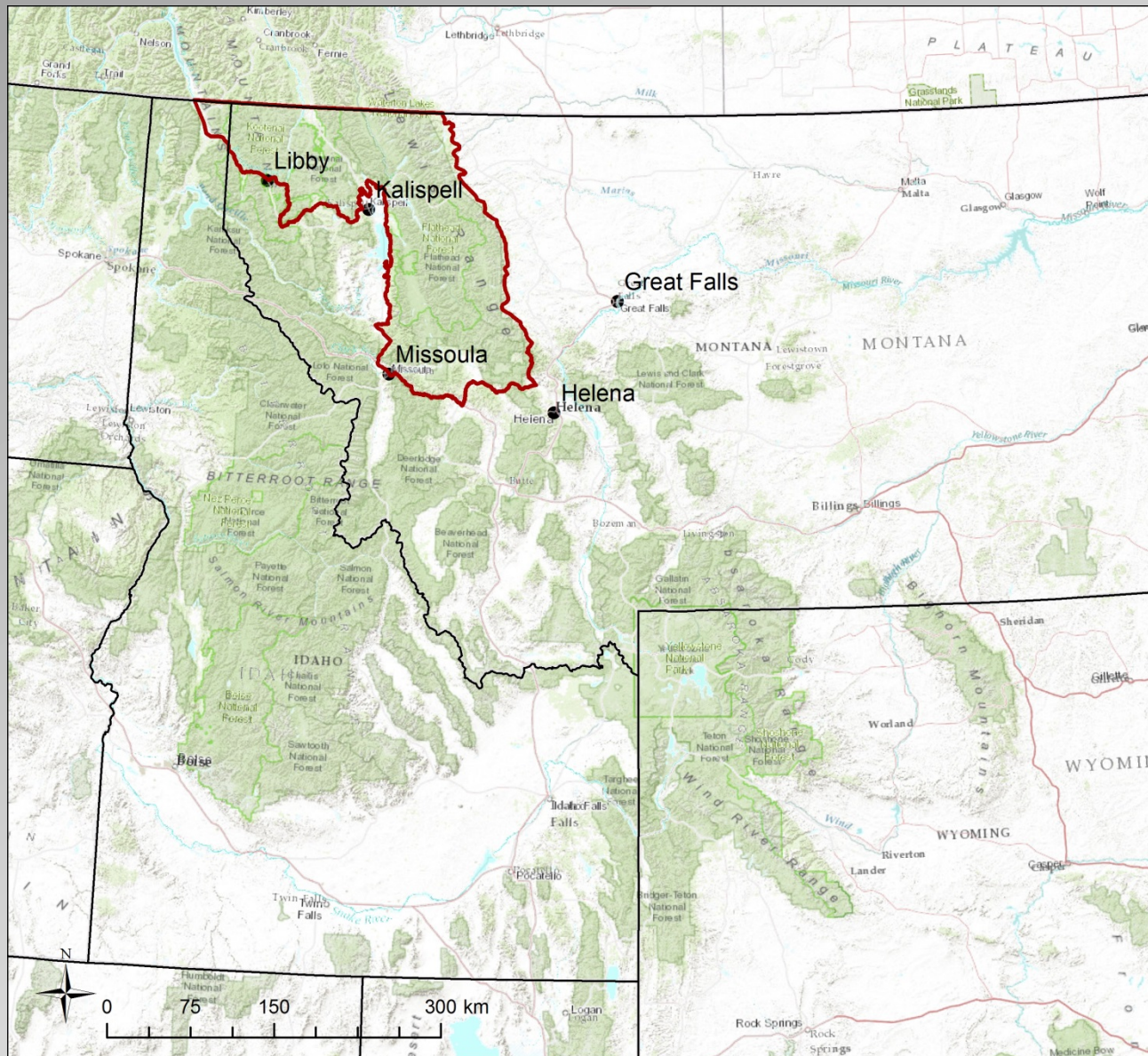
h) In 2008-2009, Endeavor Wildlife Research searched 2,854 miles for winter tracks throughout the GYA – documented 6 detections on Togwotee Pass, 2 possible detections in Yellowstone National Park, and 1 possible detection on the Beartooth Plateau.

Basis of Assessment – Wyoming (telemetry):

e) From 2006-2007, WGF collared 2 lynx (one male, 1 female) in Wyoming Range – monitored throughout the year with conventional ground and aerial telemetry (1996 – 2001) – (N=219 locations – male, N = 212 - female)

f) In 2000, female died. WGF asked RMRS to replace the collar on male with ARGOS (N = 258). Documented summer exploratory movements of male (1999 –2001) based on conventional and Argos telemetry (Squires and Oakleaf. 2005. Movements of a male Canada lynx crossing the Greater Yellowstone Area, including highways. Northwest Science 79:196-201).

Status - Montana



Status - Montana

Litter size of lynx in western Montana, 1999 – 2007

Year	Seeley Lake			Purcell Mountains			Combined		
	Litters	Kittens	Kittens / litter	Litters	Kittens	Kittens / litter	Litters	Kittens	Kittens / litter
1999	2	4	2.00				2	4	2.00
2000	4	6	1.50				4	6	1.50
2001	3	8	2.67				3	8	2.67
2002	3	4	1.33				3	4	1.33
2003	5	14	2.80				5	14	2.80
2004	5	15	3.00	5	16	3.20	10	31	3.10
2005	5	12	2.40	6	19	3.17	11	31	2.82
2006	3	5	1.67	3	8	2.67	6	13	2.17
2007	3	7	2.33	8	22	2.75	11	29	2.64
MLE									
Mean¹	33	75	2.24	22	65	2.95	55	140	2.53
MLE Var¹			0.002			0.084			0.008
95% CI			2.21-2.27			2.67-3.23			2.51-2.55

Status - Montana

Proportion of successful adult Canada lynx

Year	Seeley Lake (N=52 breeding-age females)			Purcell Mountains (N=28)			Combined (N = 80)		
	Females	Females w kittens	Prop	Females	Females w kittens	Prop	Females	Females w kittens	Prop
1999	4	2	0.50				4	2	0.50
2000	6	4	0.67				6	4	0.67
2001	9	3	0.33				9	3	0.33
2002	6	2	0.33				6	2	0.33
2003	5	3	0.60				5	3	0.60
2004	6	4	0.68	5	5	1.00	11	9	0.82
2005	6	5	0.83	7	7	1.00	13	12	0.92
2006	3	3	1.00	6	4	0.67	9	7	0.78
2007	3	3	1.00	10	7	0.70	13	10	0.77
MLE¹									
Mean			0.61			0.83			0.67
MLE									
Var¹			0.01			0.01			0.02
95% CI			0.42-0.81			0.43-0.98			0.45-0.82

Model-selection results for 8 *a priori* models of monthly survival rate based on three categorical covariates (age, sex, site), each having two levels.

Model	AICc	Delta	AIC Weight	Model Likelihood	Number of Parameters
{S(age + site)}	510.261	0	0.4374	1	3
{S (age + sex + site)}	511.204	0.9425	0.2731	0.6242	4
{S (age)}	512.838	2.5766	0.1206	0.2757	2
{S (age+ sex)}	513.74	3.4792	0.0768	0.1756	3
{S (site)}	515.287	5.0255	0.0355	0.081	2
{S (sex+ site)}	515.414	5.1528	0.0333	0.0761	3
{S (.)}	517.458	7.1965	0.0120	0.0274	1
{S (sex)}	517.556	7.2954	0.0114	0.0261	2

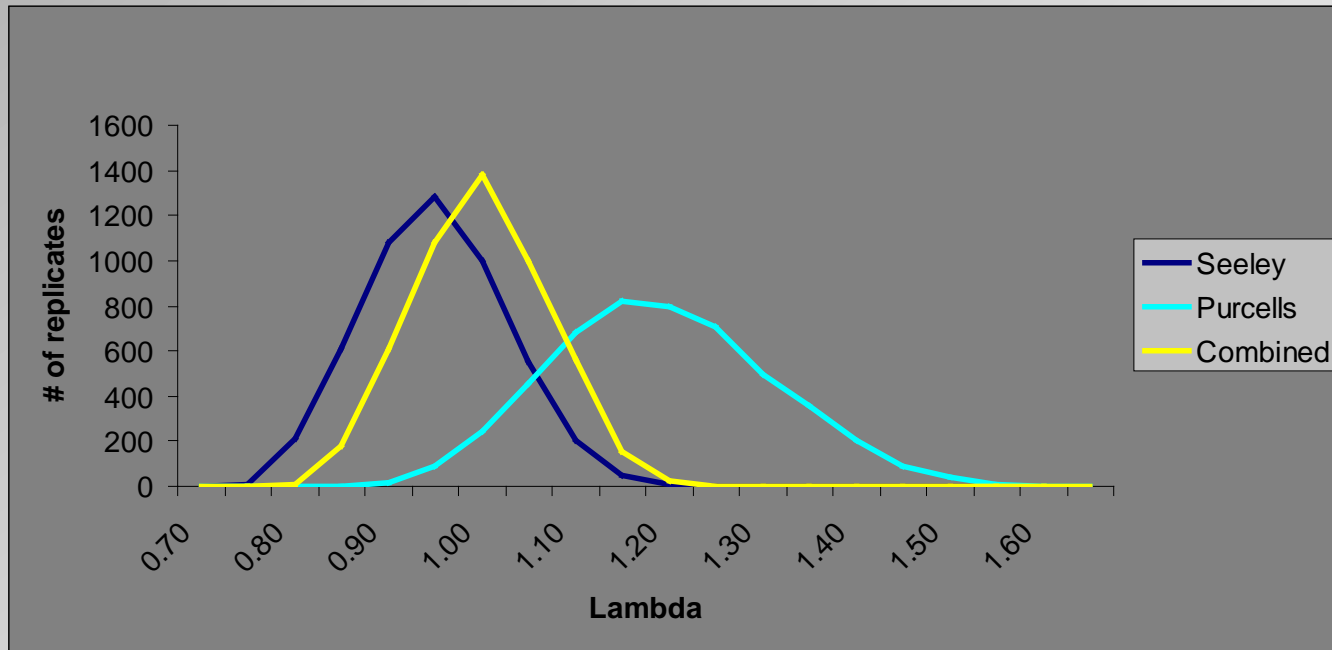
We estimated survival based on 125 lynx monitored monthly from 1999-2007 using a staggered entry design; we documented 2376 lynx-use months during this period.

Annual Survival Rate of female lynx on the Seeley Lake(1999-2007) and Purcell (2003-2007) Study Areas including a combined estimate.

		Female Subadult Survival ¹	Female Adult Survival ¹
Seeley	Mean	0.515	0.747
	Variance	0.014	0.003
	95% CI	0.283 - 0.746	0.648 - 0.846
Purcells	Mean	0.683	0.846
	Variance	0.017	0.004
	95% CI	0.428 - 0.937	0.721 - 0.970
Combined	Mean	0.520	0.753
	Variance	0.010	0.002
	95% CI	0.322 - 0.718	0.659 - 0.847

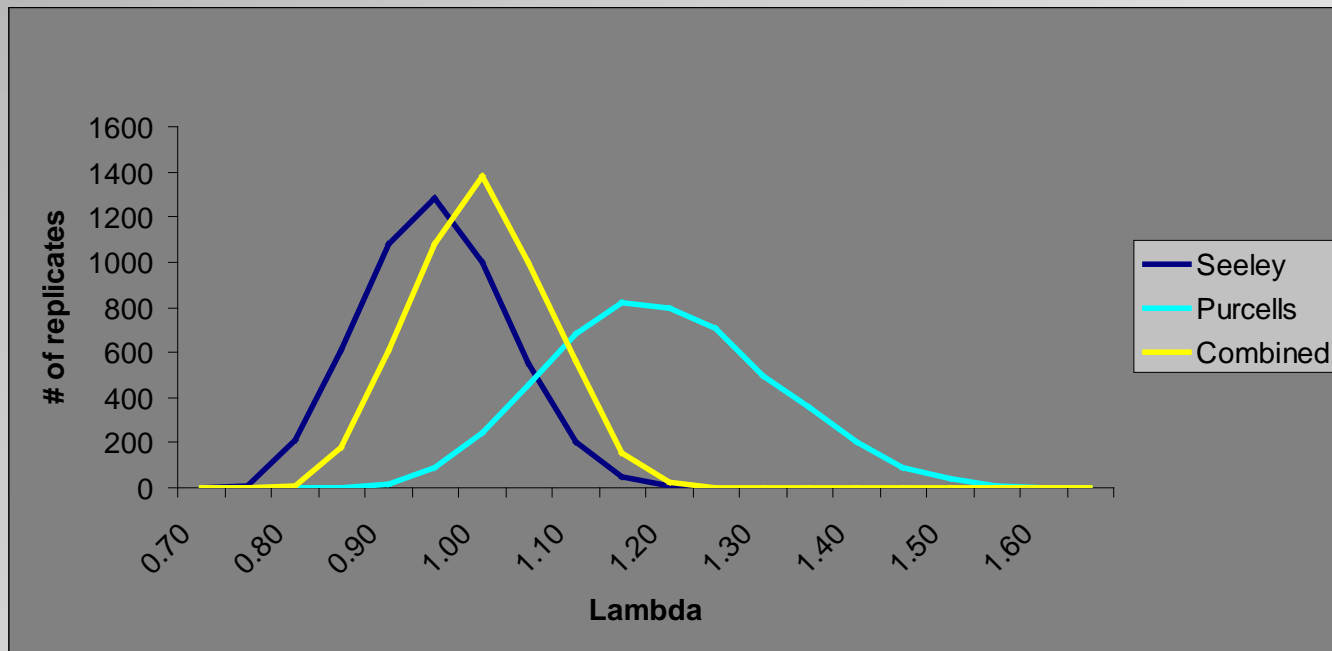
Status - Montana

Frequency distribution of λ values from 5000 replicates in which lynx vital rates were chosen from a uniform distribution bounded by their 95% confidence intervals



Status - Montana

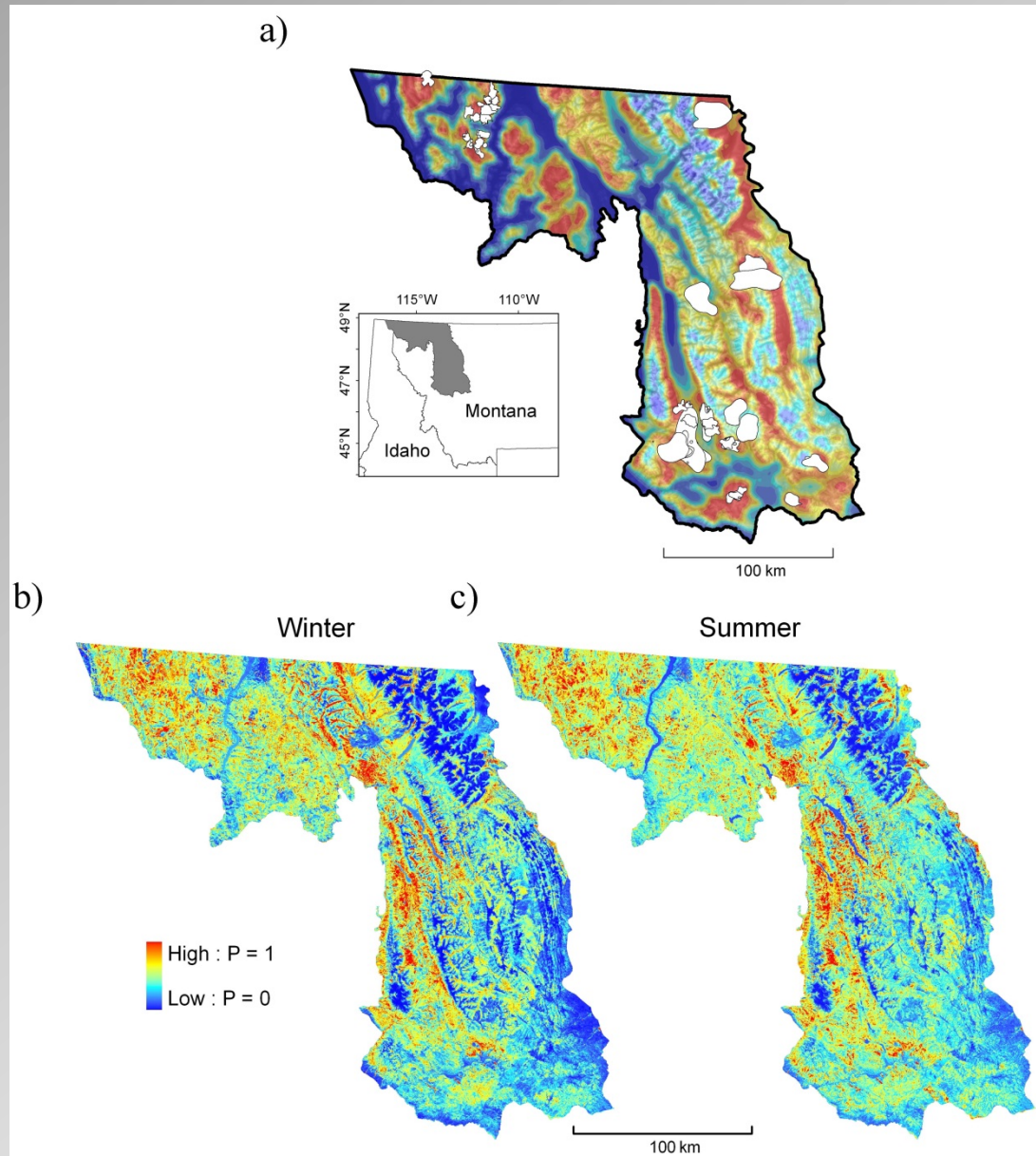
- Mean λ for Seeley Lake was 0.925 (95 % CI = 0.923 - 0.927) compared to 1.168 (95% CI = 1.165-1.171) in the Purcell Mountains
- Combined λ from both study areas was 0.973 (95% CI = 0.971-0.975)



Status - Montana

- Distribution in Montana remained generally unchanged since the 2000 listing
- Understanding of distribution has been refined with surveys conducted in Salish, Purcell, Seeley-Swan, Garnet and Bitterroot Mountains and northern GYA.

Status - Montana



Status - Montana

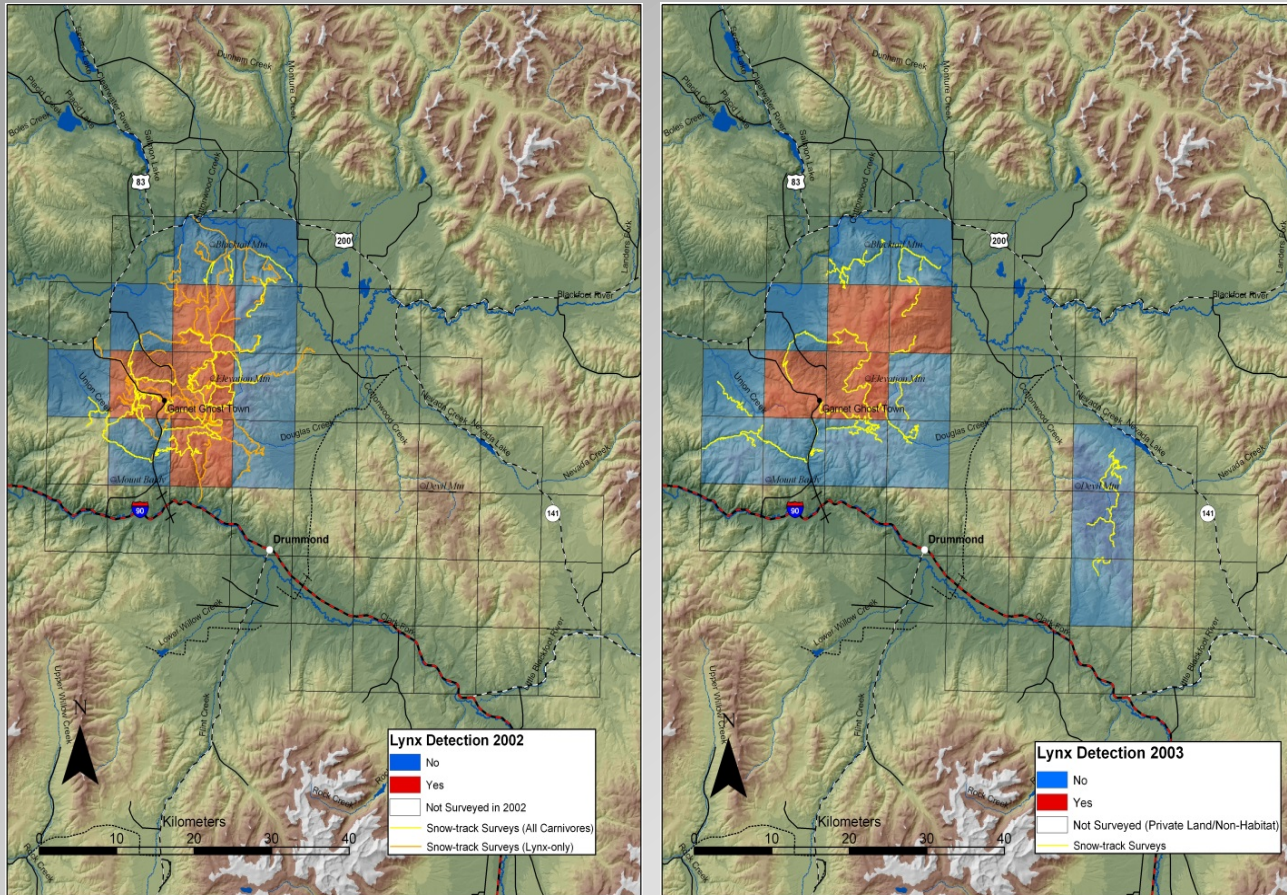
- Garnet Range has supported lynx populations since the 1980s (research documented)
- It appears that lynx recently contracted from the Garnet Range, Montana

Status - Montana

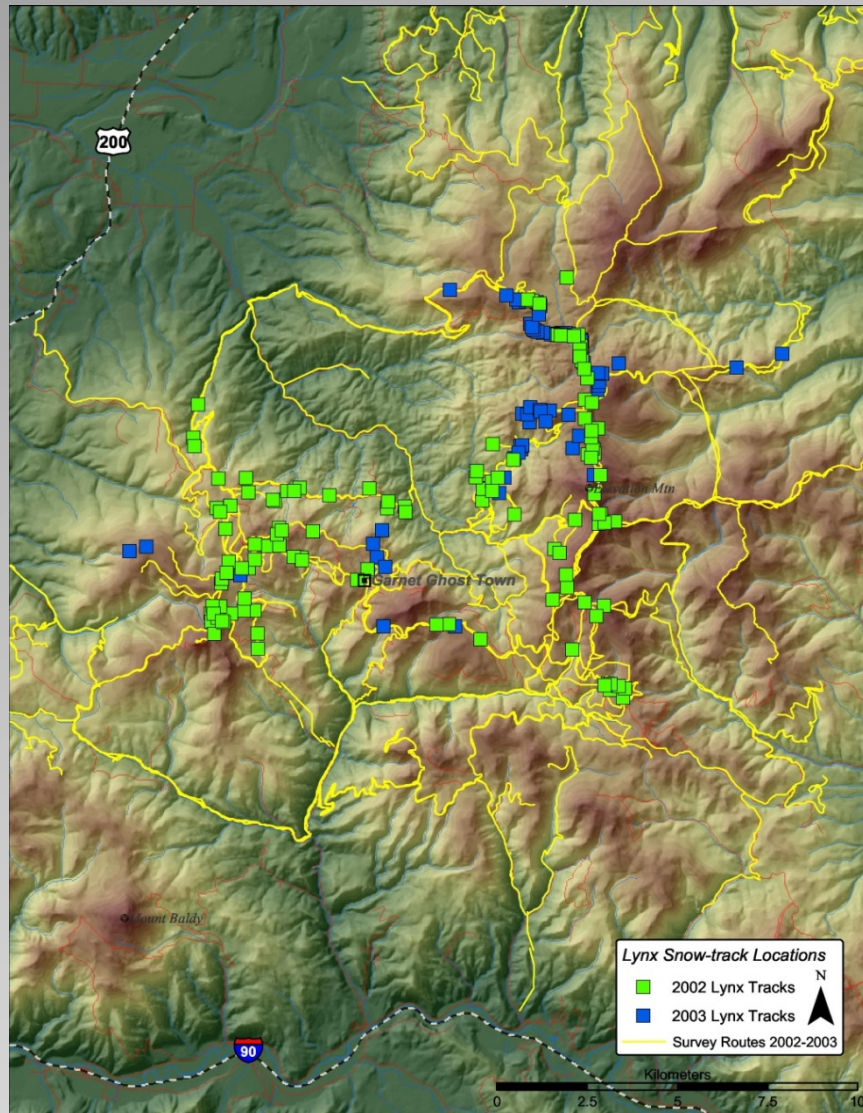
- RMRS surveyed 242 km of roads and trails for all carnivores and an additional 220 km of lynx-only surveys in Garnets in 2002-03.
- Documented lynx (n = 37 detections) in 4 of 12 pixels searched . We detected 115 additional lynx tracks during lynx-only surveys that extended the spatial extent and intensity of our search.

Status - Montana

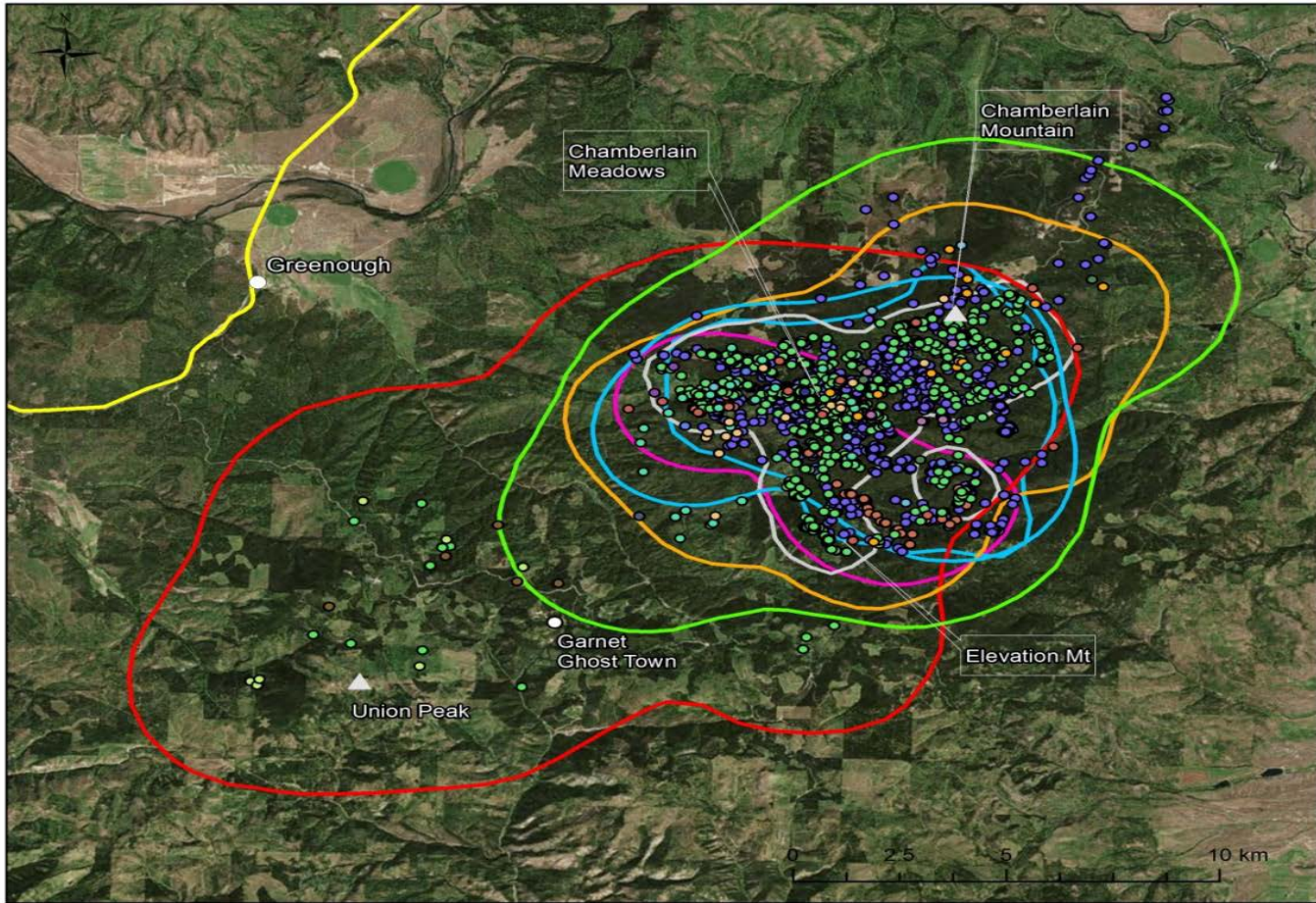
- In 2003, we expanded our effort and detected lynx ($n = 37$) in Garnets in similar areas to those of 2002 in 4 of 16 pixels surveyed .



Survey pixels and snow-track survey routes where lynx were detected in the Garnet Range, Montana, 2002 and 2003.



All lynx tracks documented during snow-track surveys in the Garnet Range, Montana, winters 2002 and 2003.



- | | | | | |
|--------------|--------------|------------|------------|-----------|
| ● F104, 2003 | ● F96, 2002 | VHF | GPS | — Highway |
| ● F104, 2004 | ● M101, 2003 | ▭ 2002 | ▭ 2005 | ○ Town |
| ● F104, 2005 | ● M101, 2004 | ▭ 2003 | ▭ 2006 | |
| ● F90, 2002 | ● M120, 2005 | ▭ 2004 | ▭ 2010 | |
| ● F90, 2003 | ● M120, 2007 | ▭ 2005 | | |
| ● F90, 2004 | ● M82, 2002 | | | |
| ● F95, 2002 | ● M94, 2002 | | | |
| | ● F104, 2006 | | | |
| | ● M120, 2005 | | | |
| | ● M149, 2010 | | | |

Status - Montana

- In 2010, RMRS conducted follow-up surveys and trapping in the Garnet Range.
- Captured only 2 males in the Garnets despite an extensive trap effort - 1 individual was a recapture from 2007 and 1 new capture.
- In 2010, lynx restricted spatially in Garnet Range

Status - Montana

- Recent surveys (winter 2014-2015) that incorporated track surveys and cameras failed to detect lynx in Garnet

Status - Montana

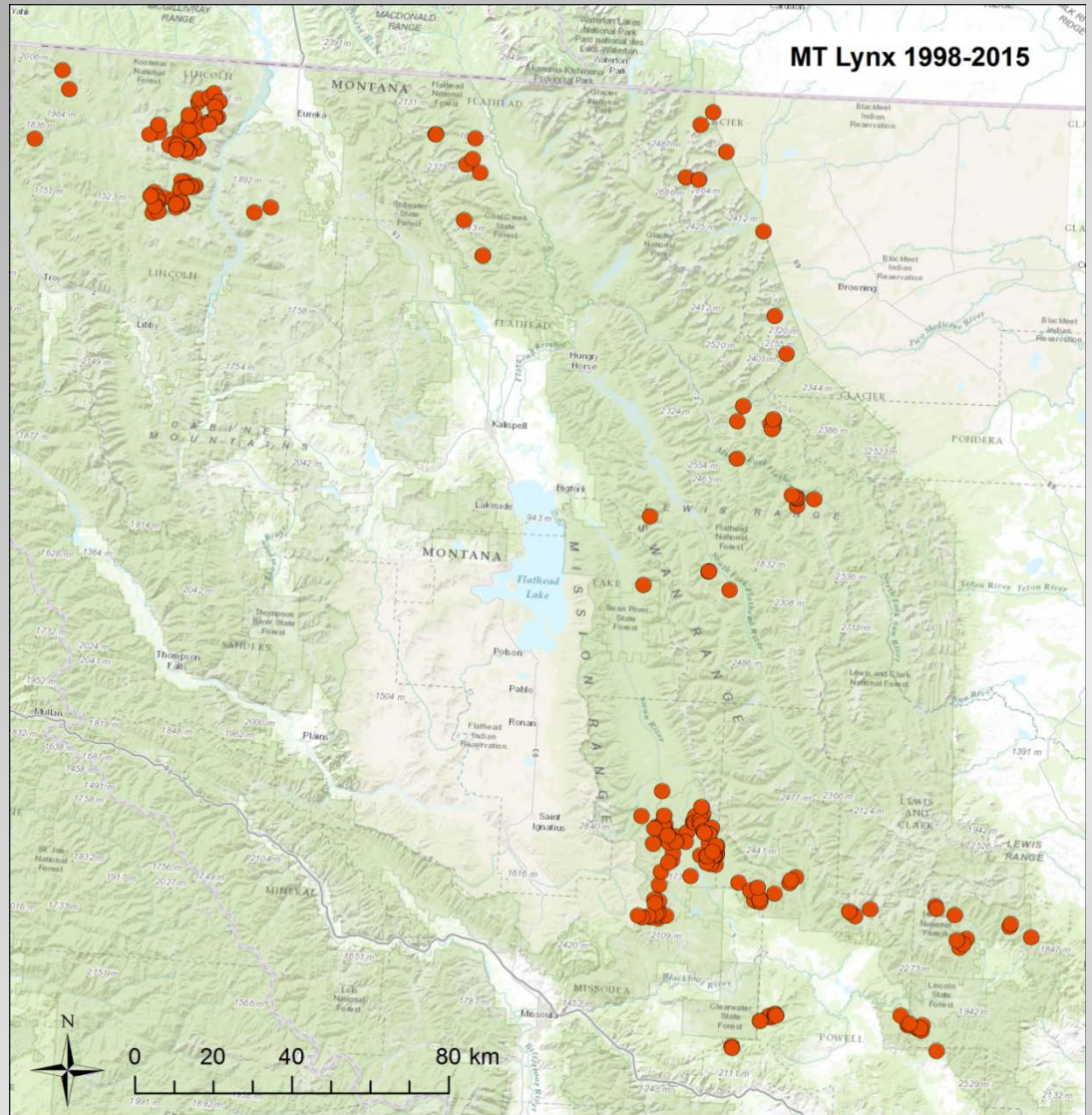
Purcell Mountains =

111 lynx

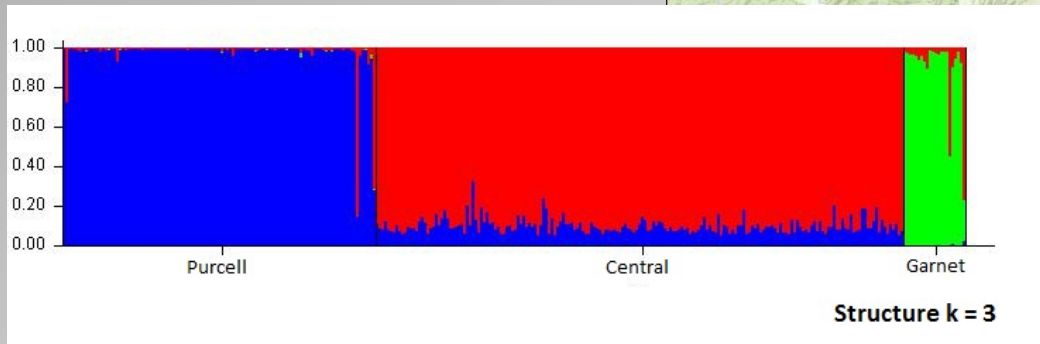
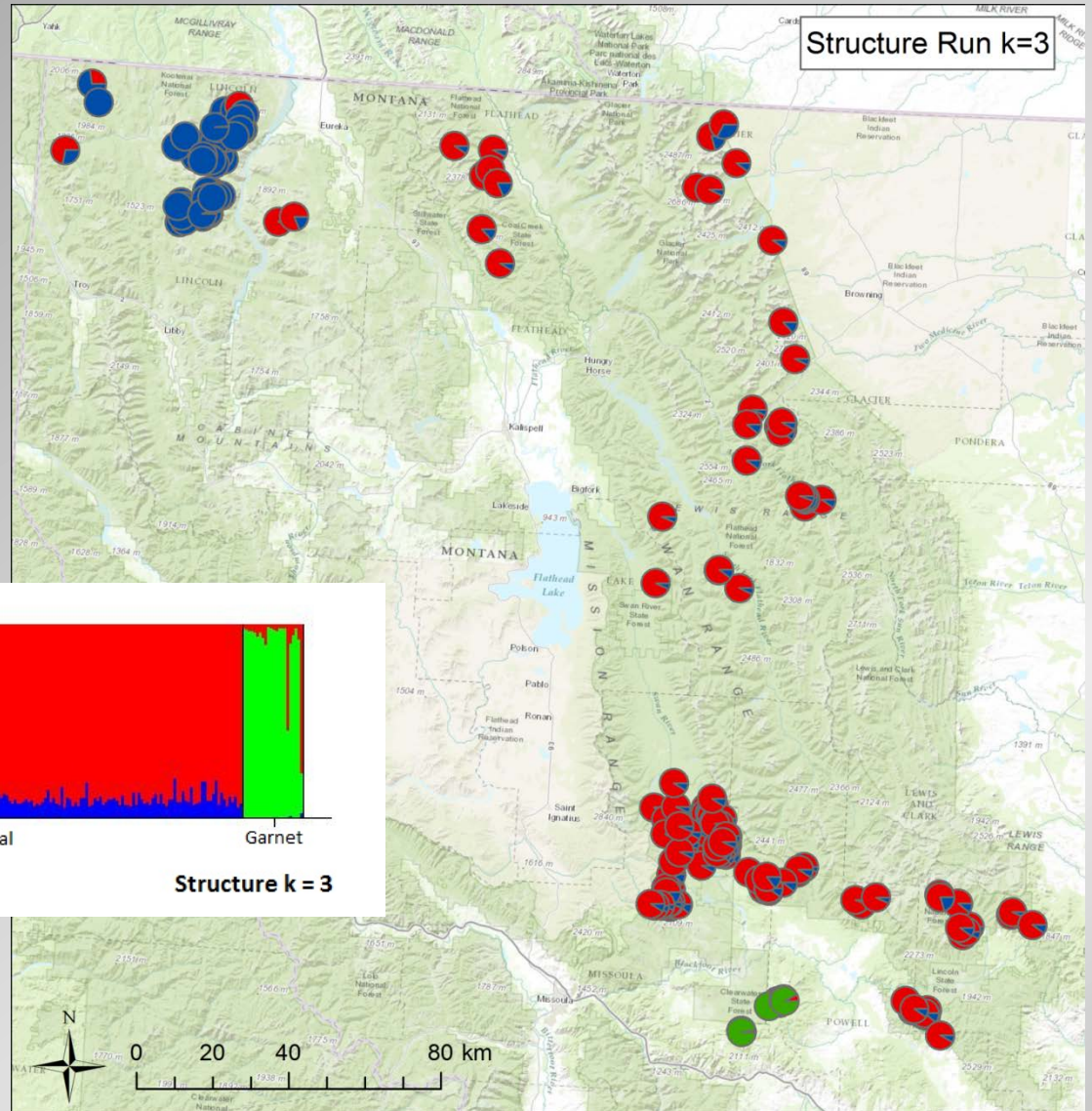
Central = 187

Garnett = 22

Total = 320



Status - Montana



Status - Montana

- However, in lynx core-habitat near Seeley Lake, MT, conservation land purchases increased protection across >100,000 acres of land.



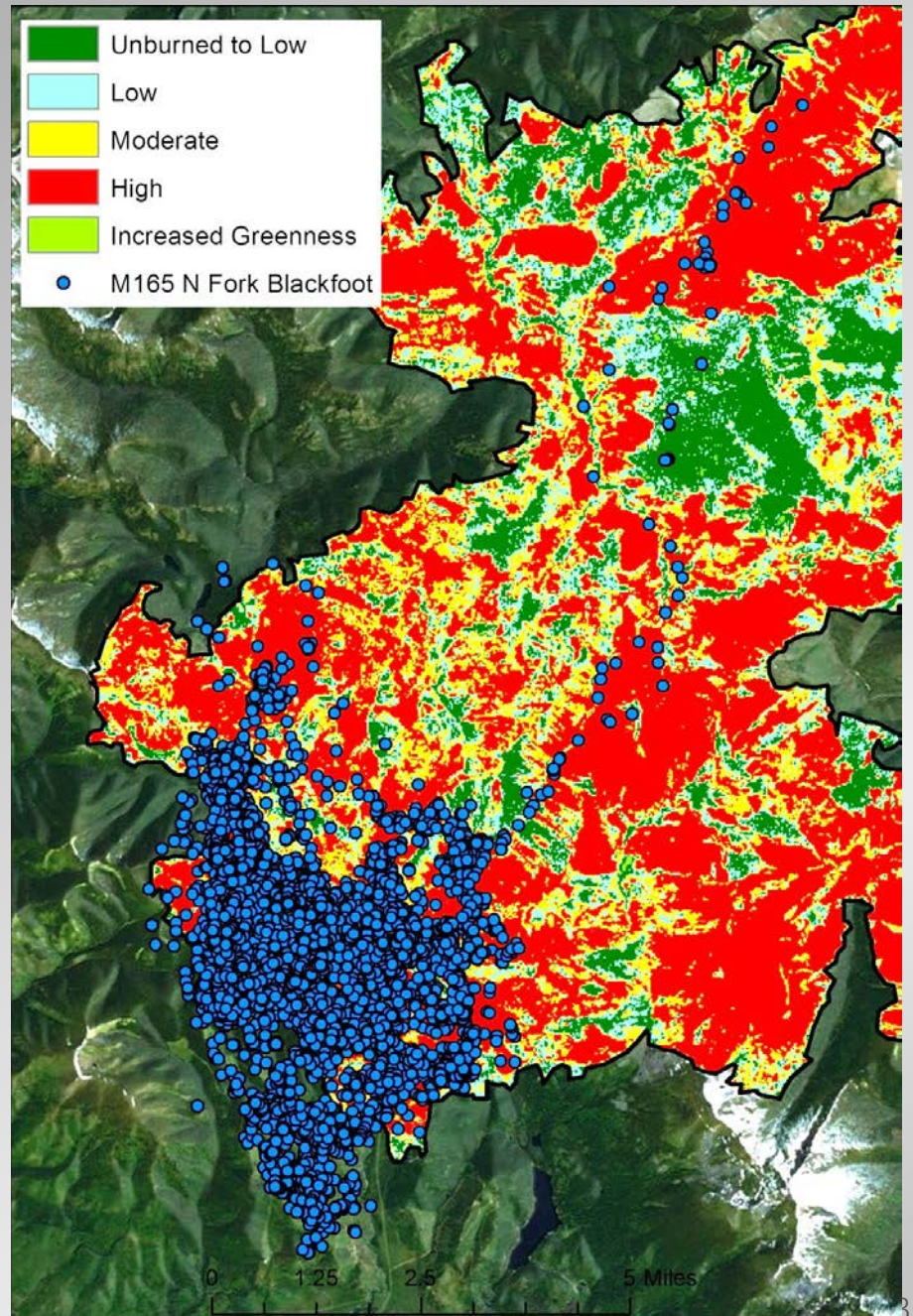
Image © 2008 DigitalGlobe

2.89° N 113°50'53.86" W

Streaming ||||| 100%

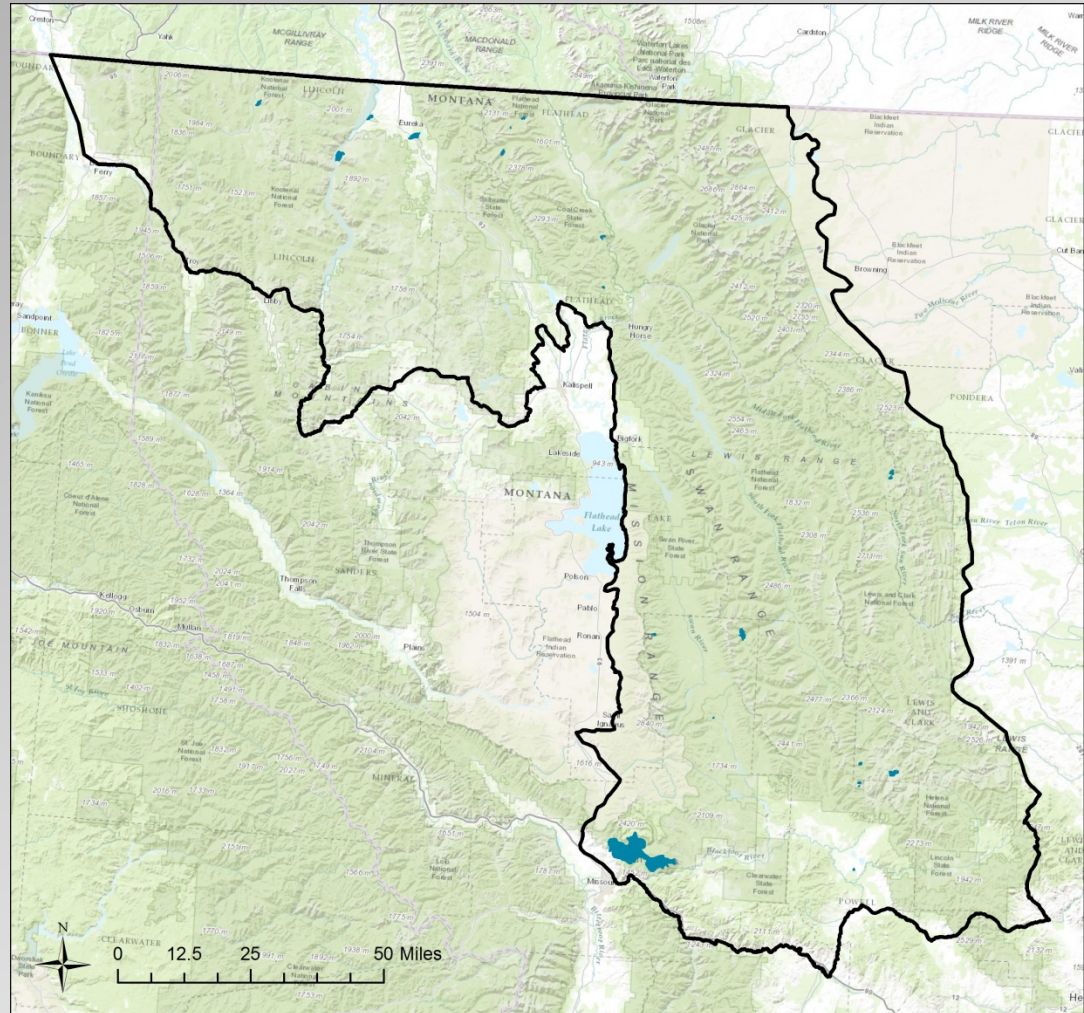
Risk factors - Montana

Lynx use of burns by severity



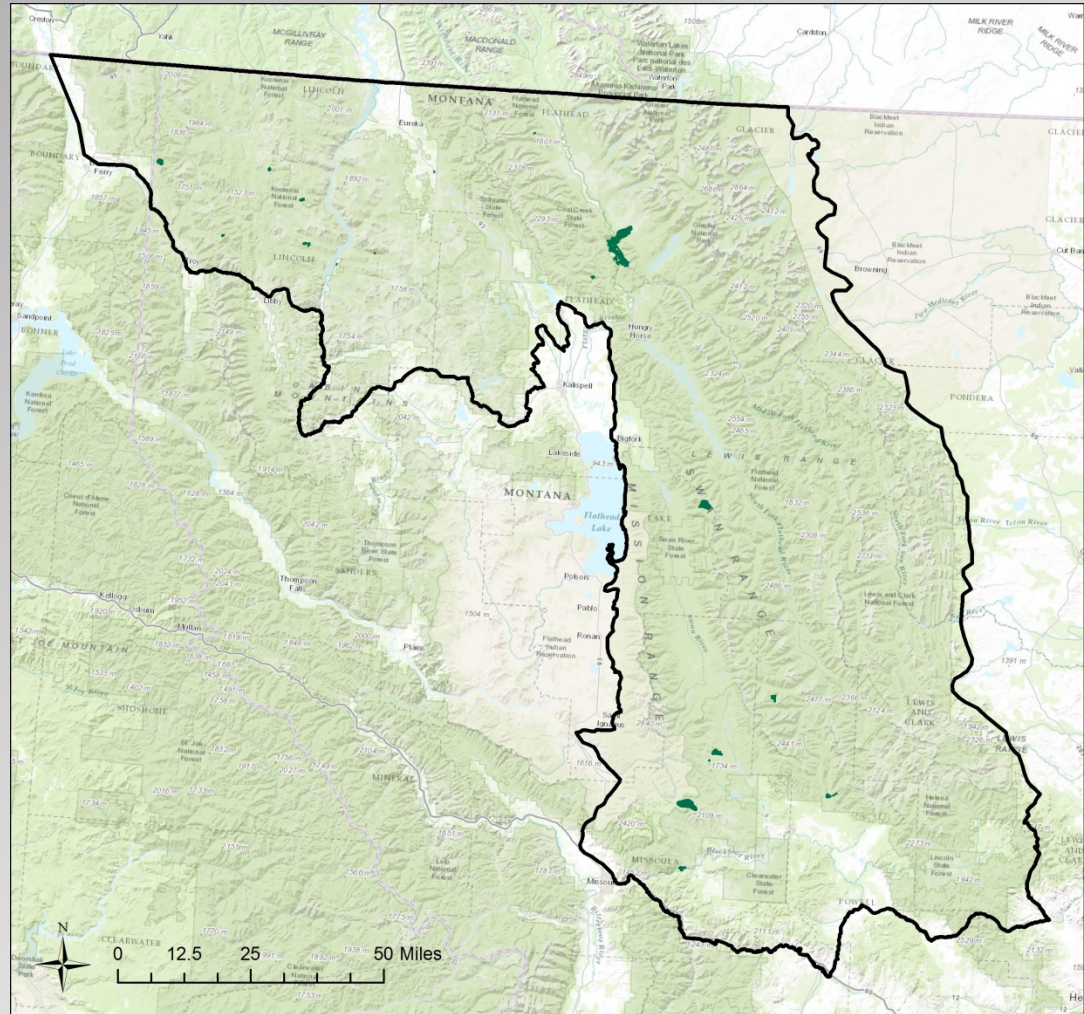
1950

29,777 acres



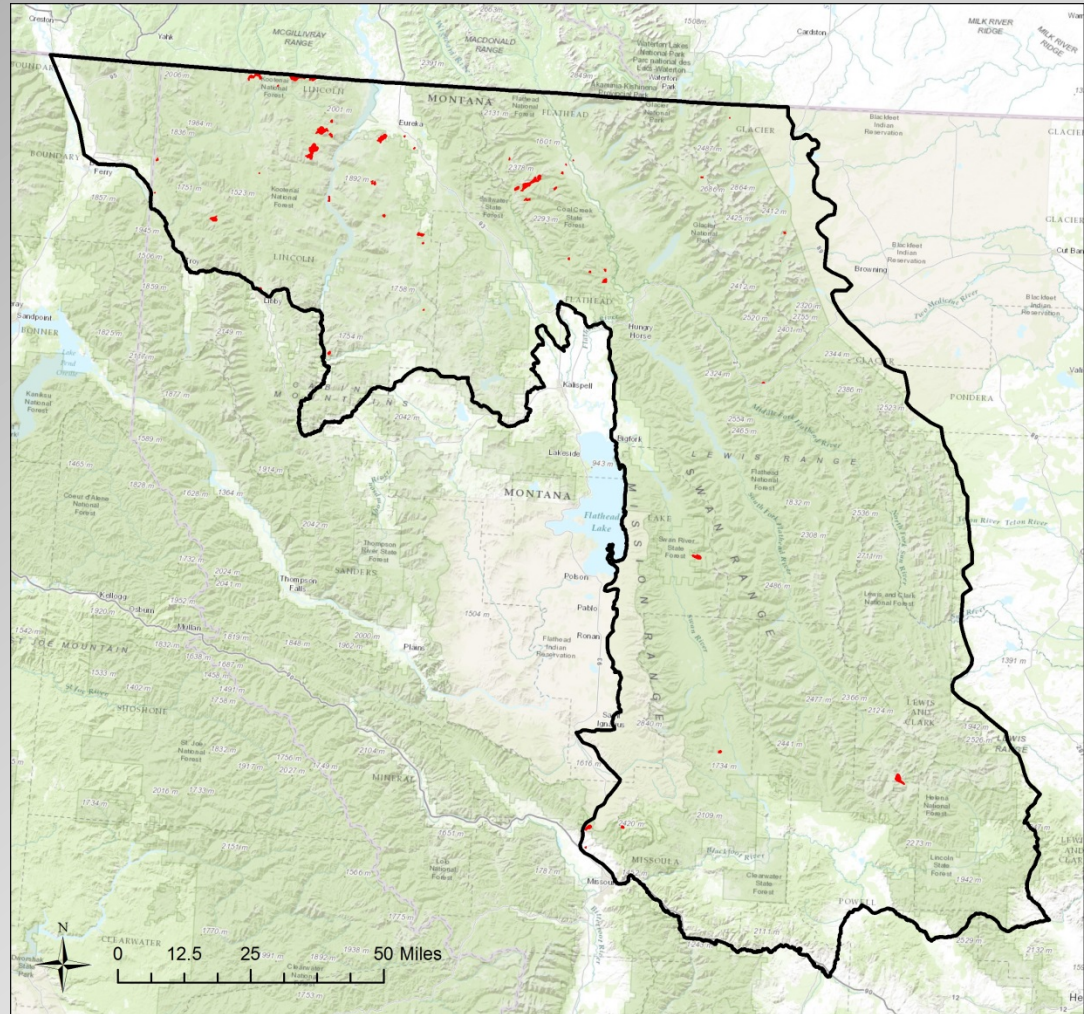
1960

17, 230 acres



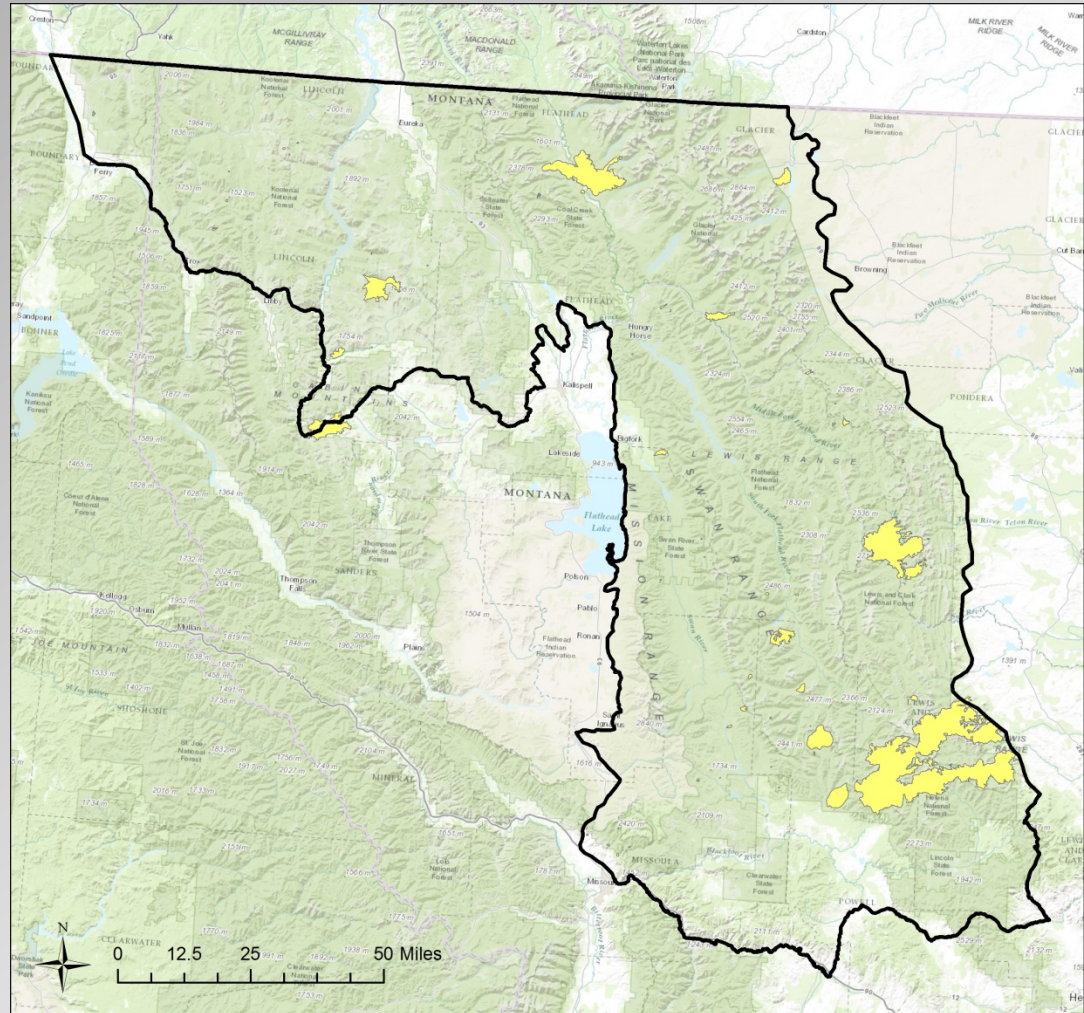
1970

14, 112 acres



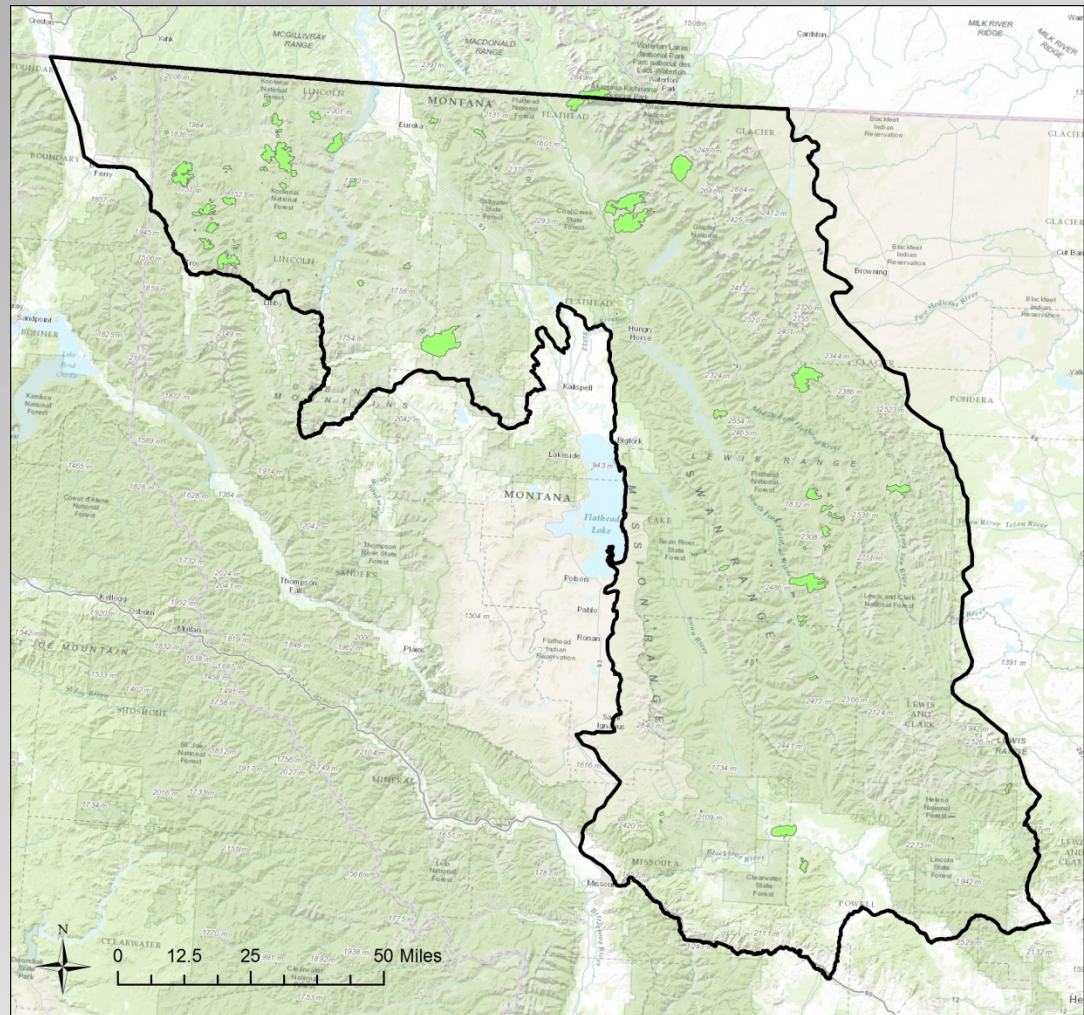
1980

307,310 acres



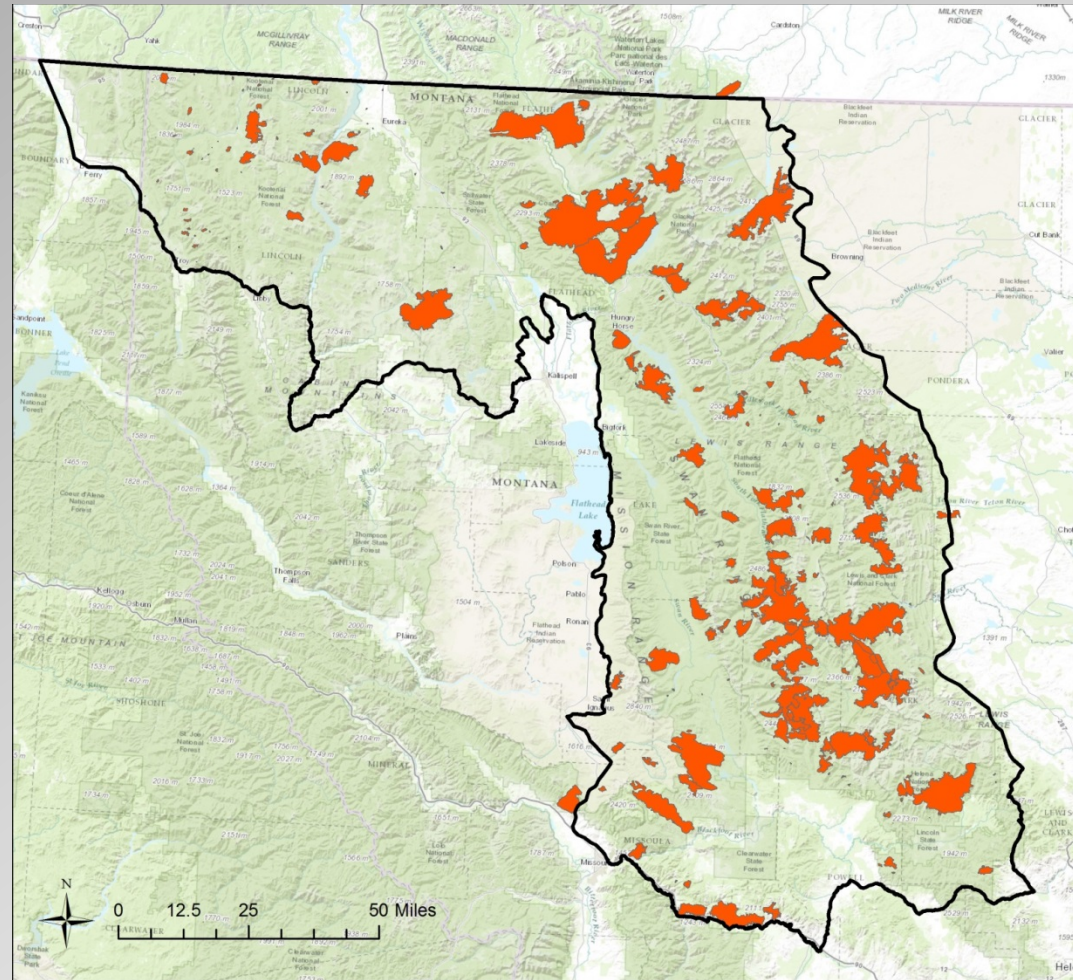
1990

143,123 acres



2000-2013

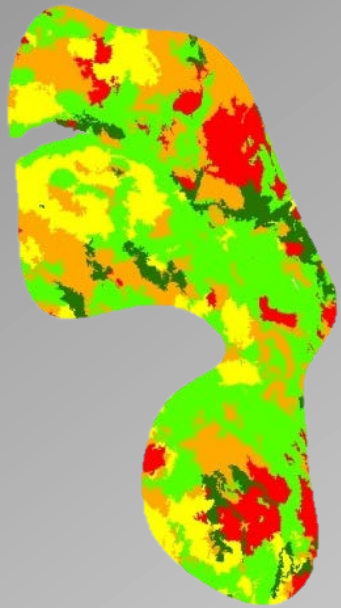
1,030,892 acres



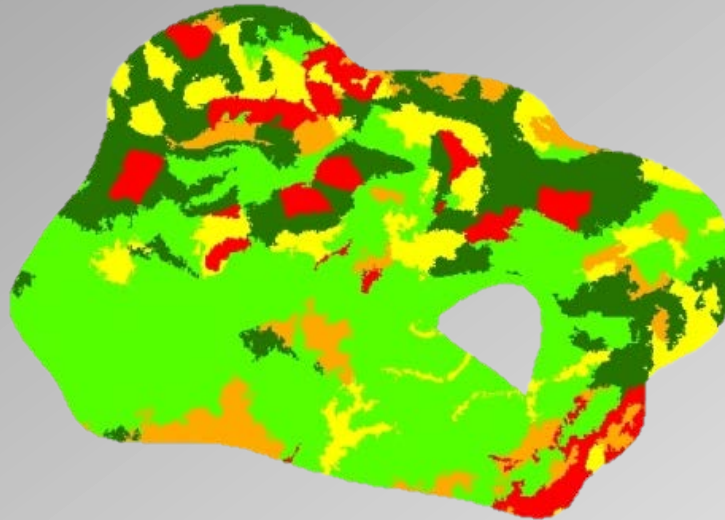
Risk factors - Montana

- Lynx exhibit both positive and negative effects from forest silviculture
- Habitat relationships vary dramatically across contiguous US populations

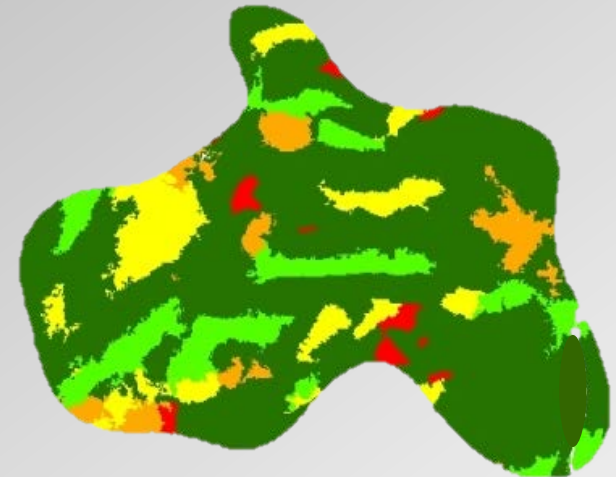
Index of Connectivity (IC) of **Mature Forest**



IC = 0.09



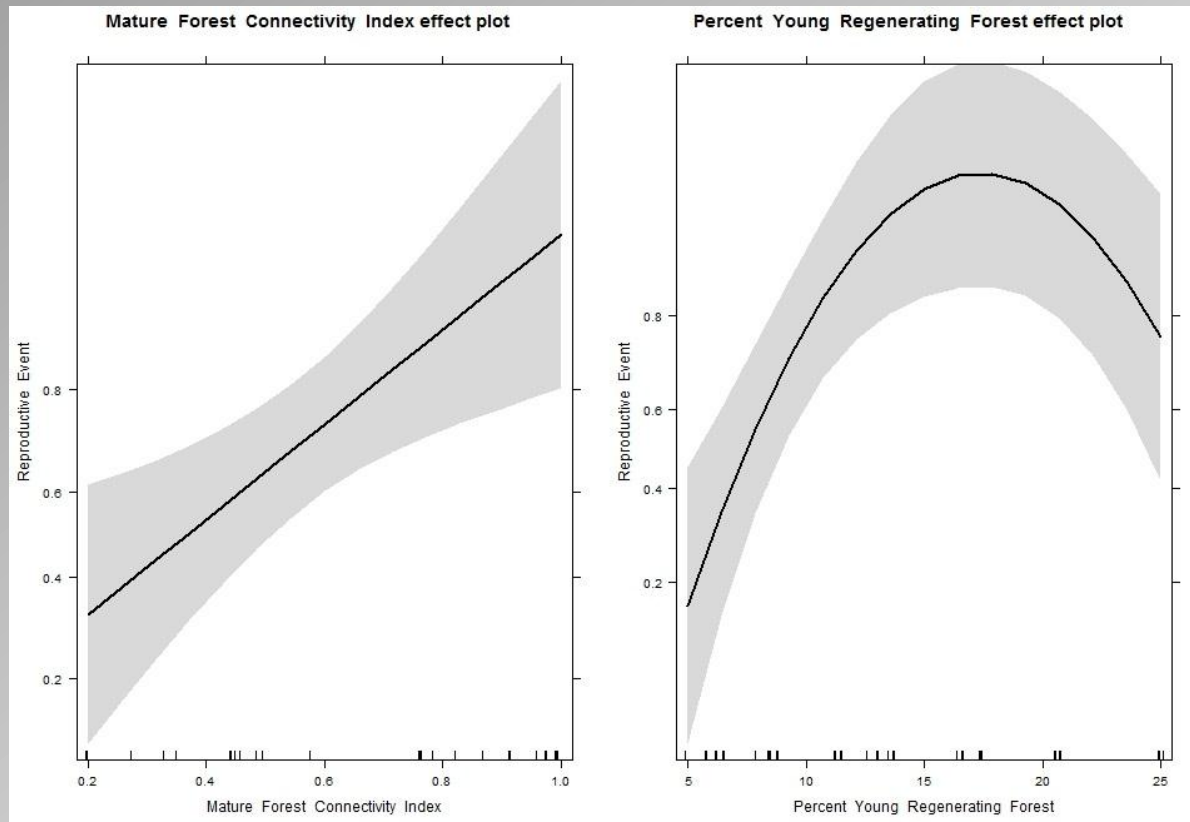
IC = 0.48



IC = 0.81

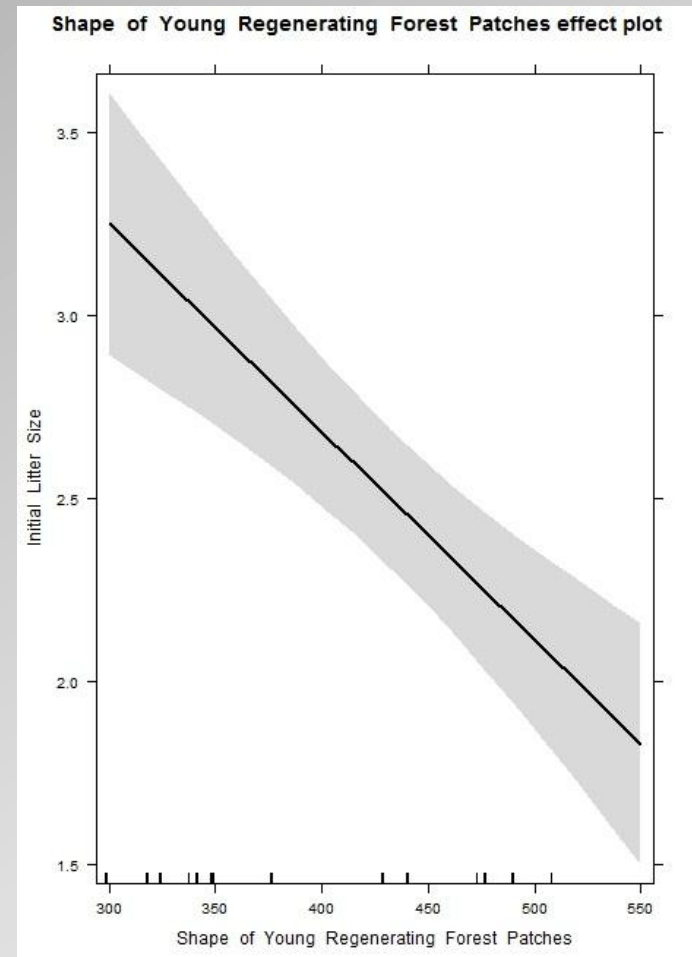
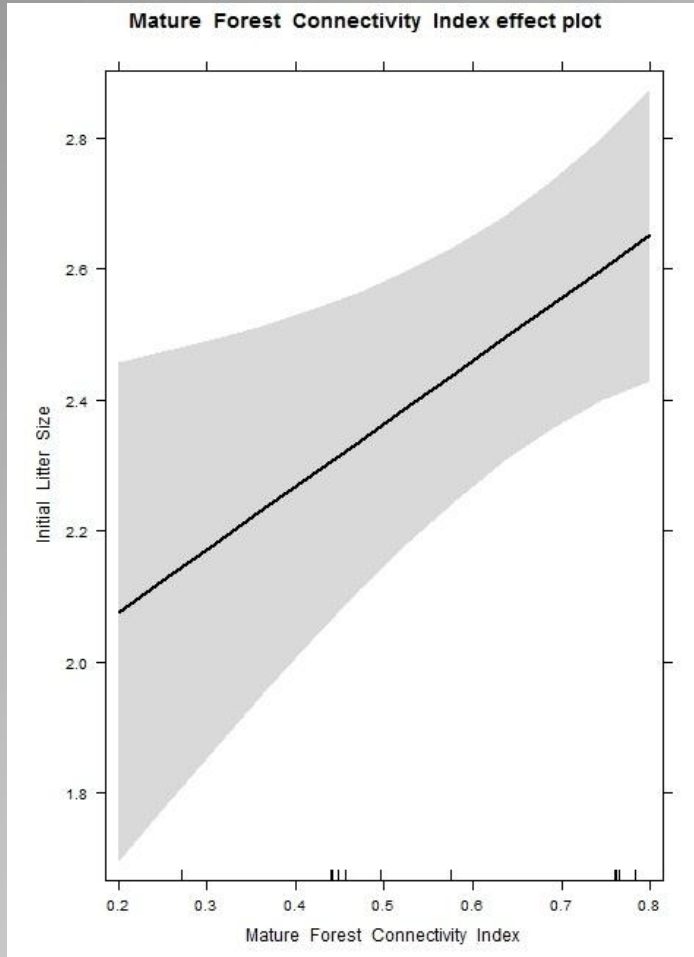


Produce a Litter (Kosterman 2014) ?



Top Multivariate Model	β	SE	95% CI	p-value
Connectivity mature forest	4.560	1.5345	1.552, 7.568	0.003
Percent young forest	1.019	0.2614	0.507, 1.532	≤ 0.001
Percent young forest ²	-0.029	0.0081	-0.045, -0.014	≤ 0.001

Initial Litter Size

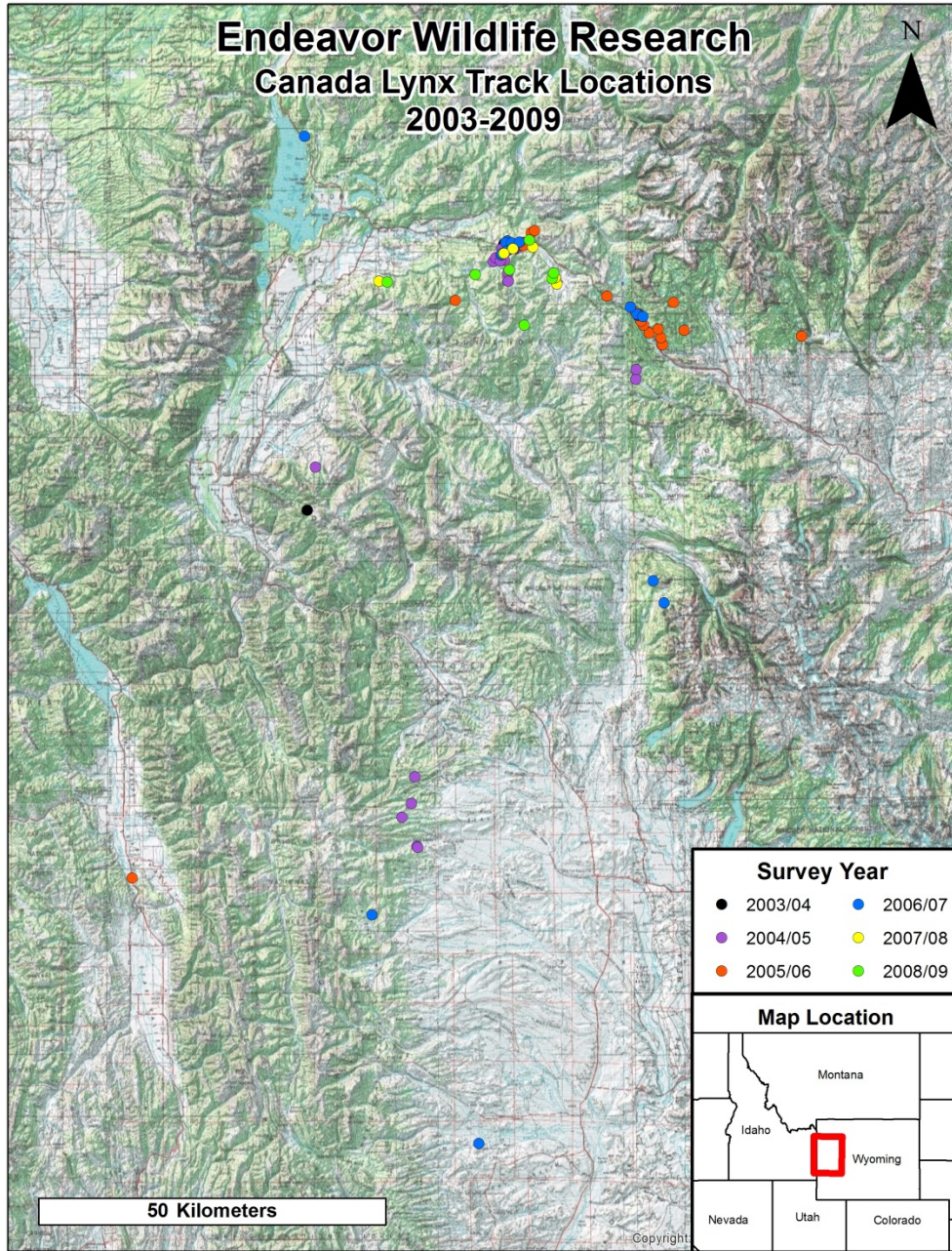


Top Multivariate Model:	β	SE	95% CI	p-value
Connectivity mature forest	0.959	0.3739	0.214, 1.705	0.013
Shape young forest	-0.006	0.0011	-0.008, -0.003	≤ 0.001

Status – Wyoming

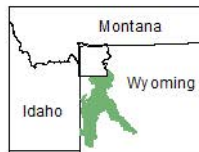
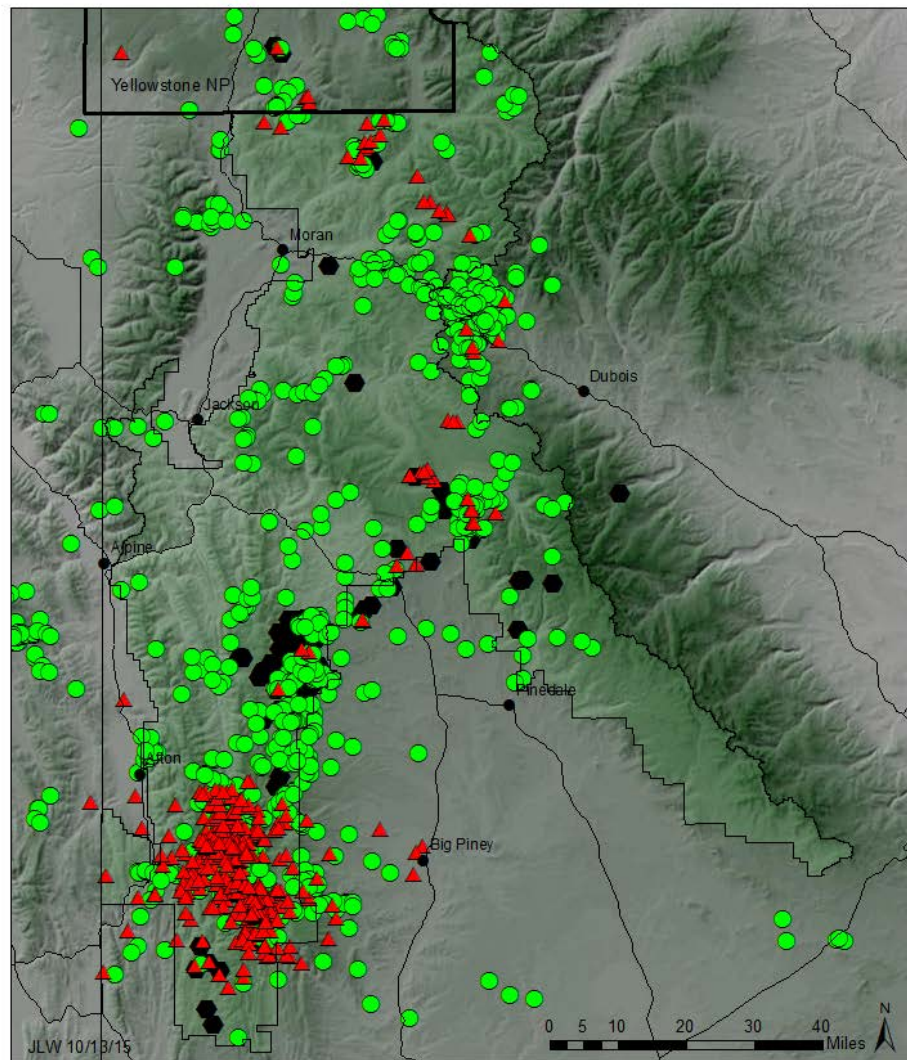
- Documentation of lynx in GYA since early 1900's
- Wyoming Range extending north to Togwotee Pass and east side of Yellowstone Lake former range

Endeavor Wildlife Research Canada Lynx Track Locations 2003-2009



Southern GYA Mesocarnivore Monitoring 2015-2016

BTNF, RMRS, GTNP, SNF



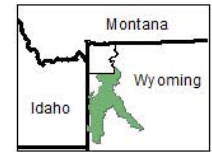
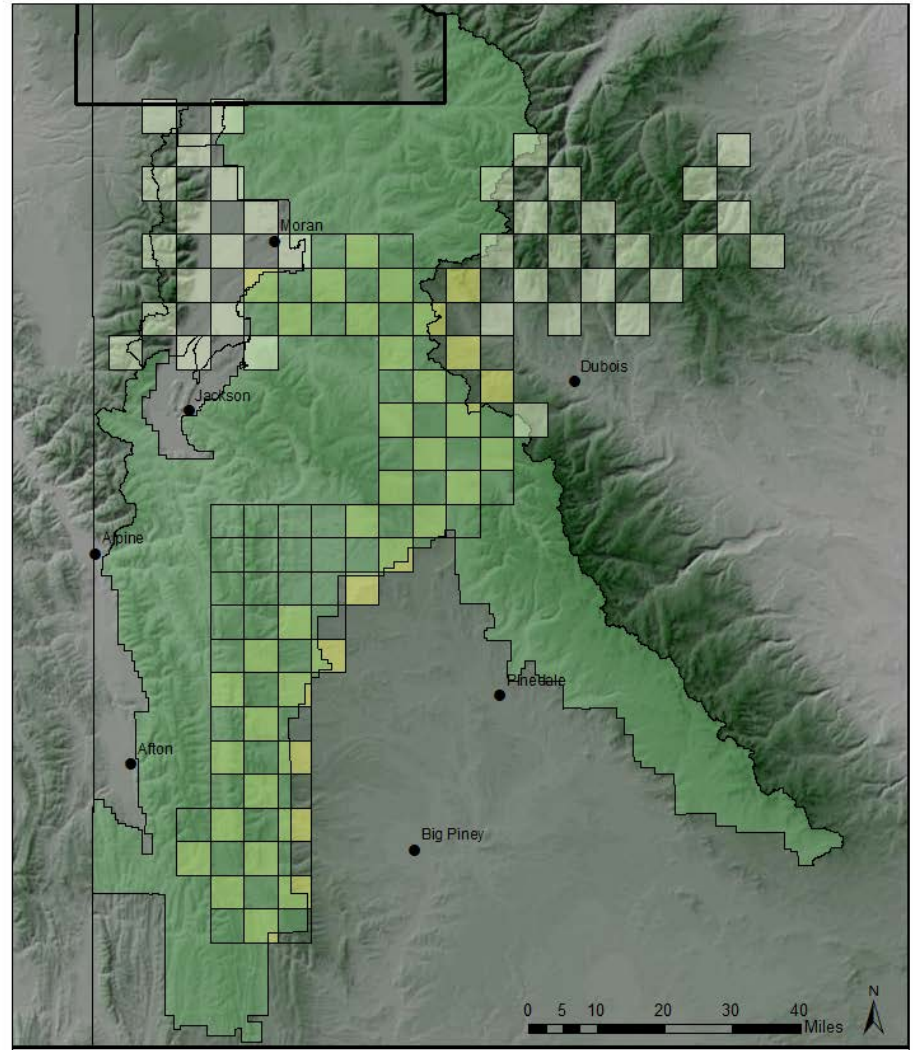
- Wyoming Lynx Locations 1996-2000
- ▲ Wyoming Lynx Locations 2000-2002
- Colorado Lynx Locations 2004-2010
- Bridger-Teton National Forest

Status – Wyoming

- 2010 surveys suggest the distribution of lynx in Wyoming contracted since 1997-2005
- RMRS, in cooperation with WGF, attempted to capture lynx but couldn't locate “natives” only 2 individuals from Colorado

Status – Wyoming

Southern GYA Mesocarnivore Monitoring 2015-2016
BTNF, RMRS, GTNP, SNF



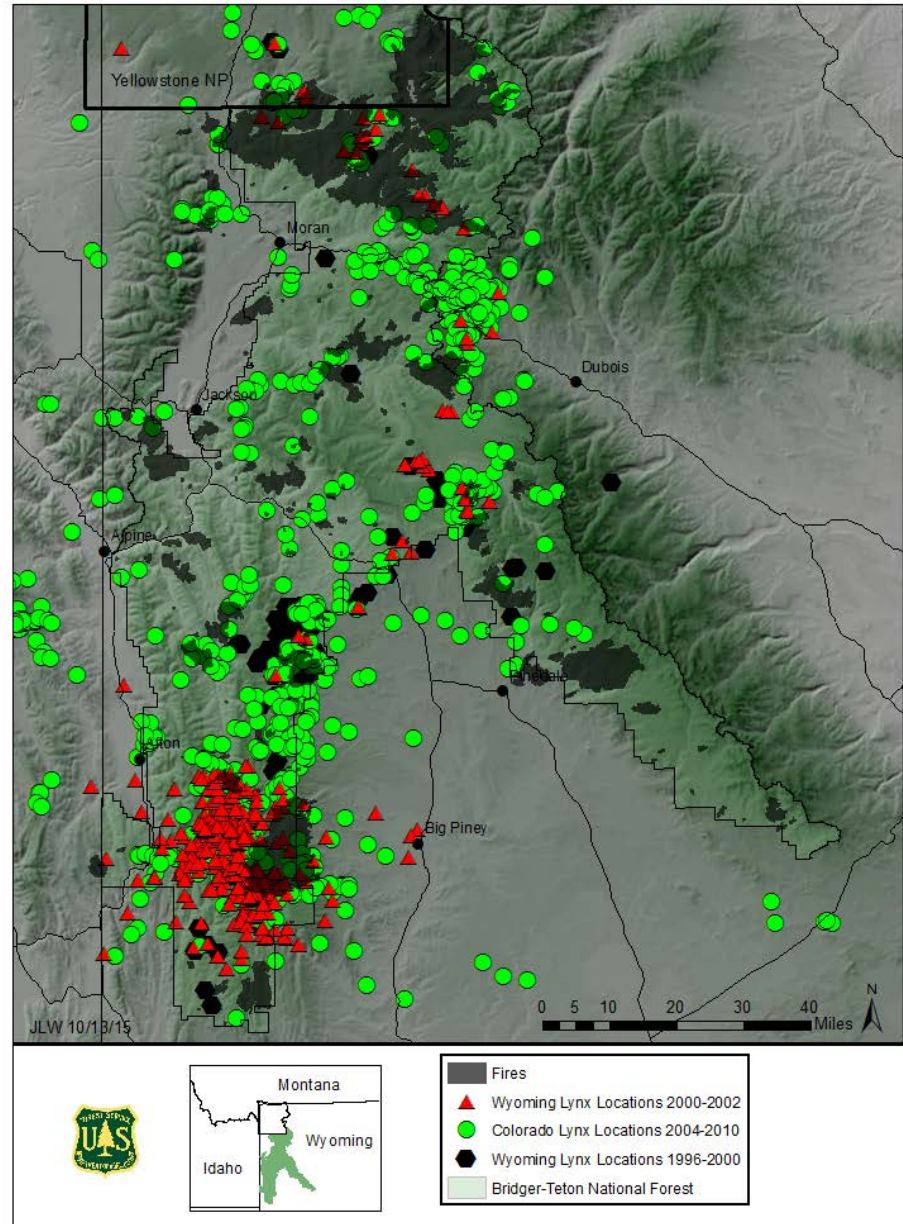
- Lynx Grid extension camera cells
- Bridger-Teton National Forest
- Cells with Cameras/DNA stations

Risk factors – Wyoming

- Fire impacts to Wyoming Range
- Habitat fragmentation of Wyoming Range
- Oil / gas development of lynx habitat in Wyoming Range

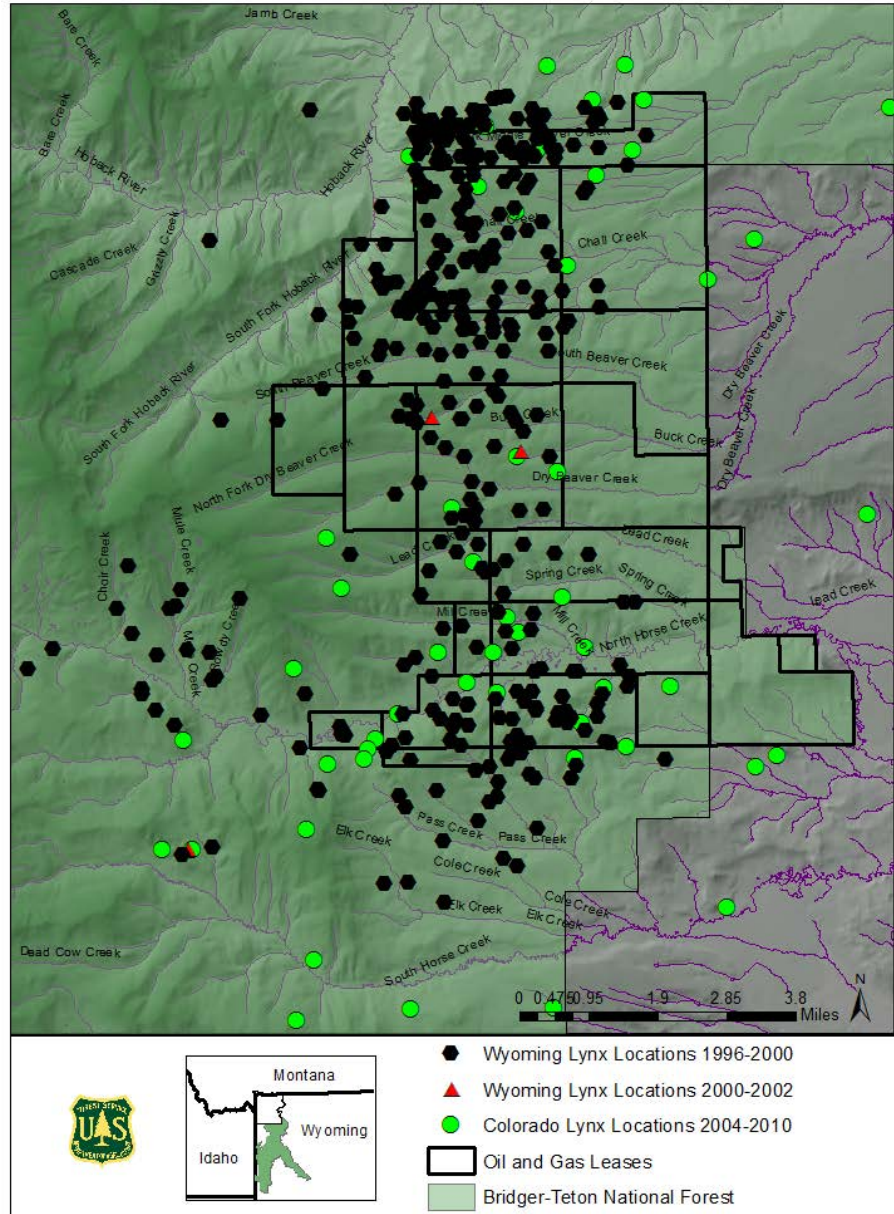
Status – Wyoming

Southern GYA Mesocarnivore Monitoring 2015-2016
BTNF, RMRS, GTNP, SNF



Status – Wyoming

Southern GYA Mesocarnivore Monitoring 2015-2016
BTNF, RMRS, GTNP, SNF



Issues and Conclusions

- Lynx in Montana and Wyoming (may be throughout the continental US) persist as small populations consisting of relatively few individuals
- As such, have heightened risk to environmental and demographic factors

Issues and Conclusions

- Lynx distribution in Montana is similar to 2000, but with probably range contraction out of Garnet Range – cause of contraction unknown
- Small, relatively isolated populations may have persisted for long periods (duration unknown) based on records and genetic sub-structuring – long-lived individuals (average = 8.6 years, many females > 10ys)

Issues and Conclusions

- In Wyoming, lynx had a record of occupancy and distribution from 1997-2008 (??); documented since the turn of the century. Was the GYA a large enough “pool” for persistence?
- Limited data suggest that distribution in Wyoming contracted or the population failed in approximately 2010

Issues and Conclusions

- Vital rates do not suggest cyclicity

How to rectify “waves,” observed vital rates, and fine-scale genetic substructuring?

Issues and Conclusions

- Increased fire intensity, frequency, and spatial extent in northern montane forests is a “the” primary risk factor to lynx habitat in Montana and Wyoming
- Humility is warranted when discounting “small” populations when challenged by environmental change

Current Research

- Remap of lynx habitat in Montana based on a revised RSF based on new forest composition surface from remote sensing and other environmental covariates.
- Determining the trajectory of lynx habitat in Montana relative to fire and forest management – MSU collaboration
- Formally evaluating how lynx respond to silvicultural treatment by a retrospective analysis - management of patch-level mosaics

Current Research

- Evaluating how lynx and hares respond to fire across a continuum of fire age and post-fire silvicultural treatment
- RMRS, in cooperation with the Bridger-Teton National Forest and the National Carnivore program, is conducting a formalized survey of lynx in the GYA incorporating sight-mark recapture via cameras and winter backtracking. Genetics collected using 3 methods – on backtracks, snags on baited trees (at camera stations), and snow-level rub pads.



Thank you

Northern Rockies Lynx Study

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