

# Sierra Nevada red fox in Oregon

some biology and a status update



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# “One of North America’s rarest mammals”

- Washington Post Headline, Jan 2015

- **Biology:** low density, remote subalpine habitat
- **Population trend:** 20<sup>th</sup> century decline
- **Information:** few studies, no baseline



# Outline



- Act I: What is a montane red fox?
- Act II: Population status today in Oregon



*Ongoing or upcoming research*



# Act I: What is a montane red fox?



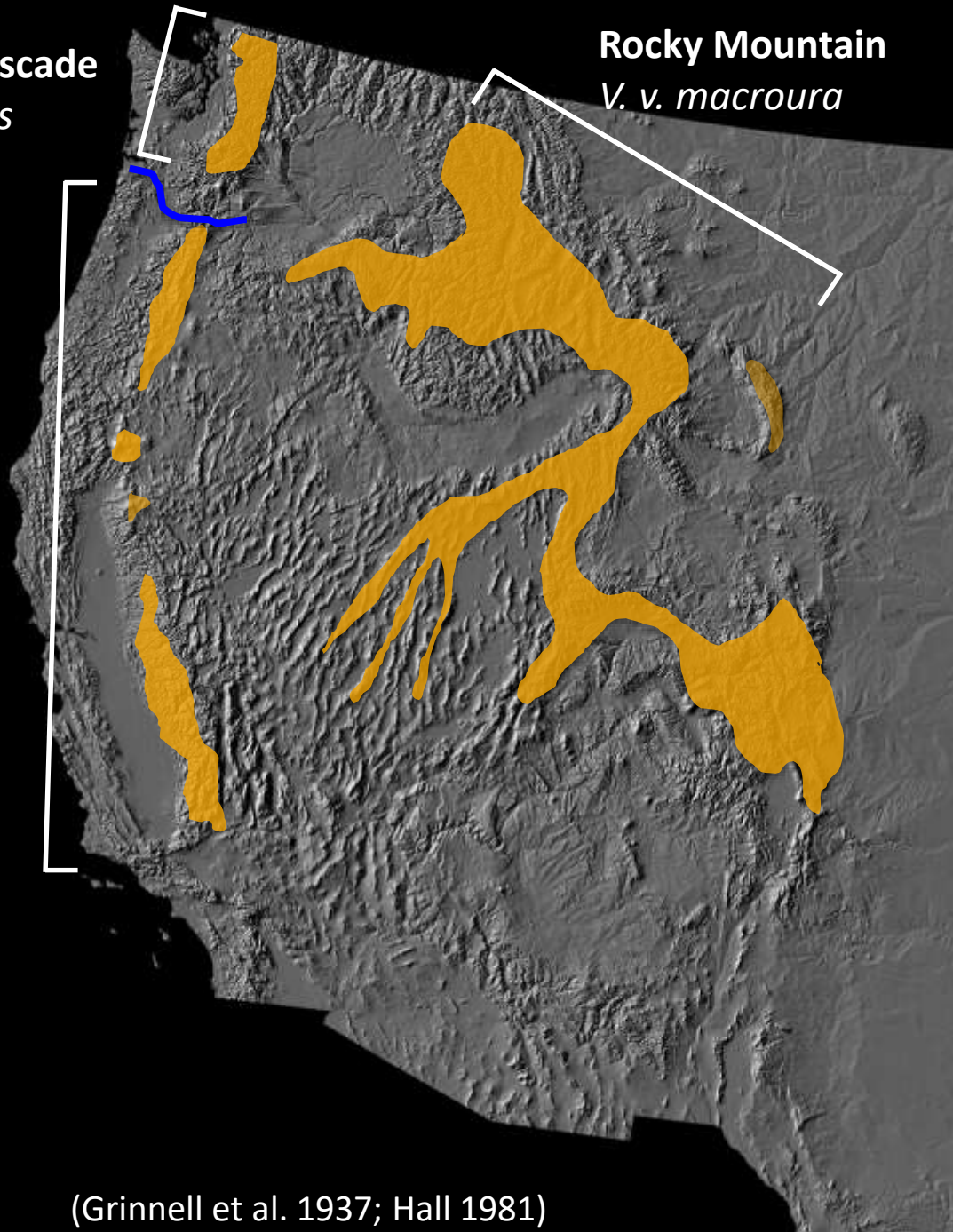
1900s



Washington Cascade  
*V. v. cascadiensis*

Rocky Mountain  
*V. v. macroura*

Sierra Nevada  
*V. v. necator*

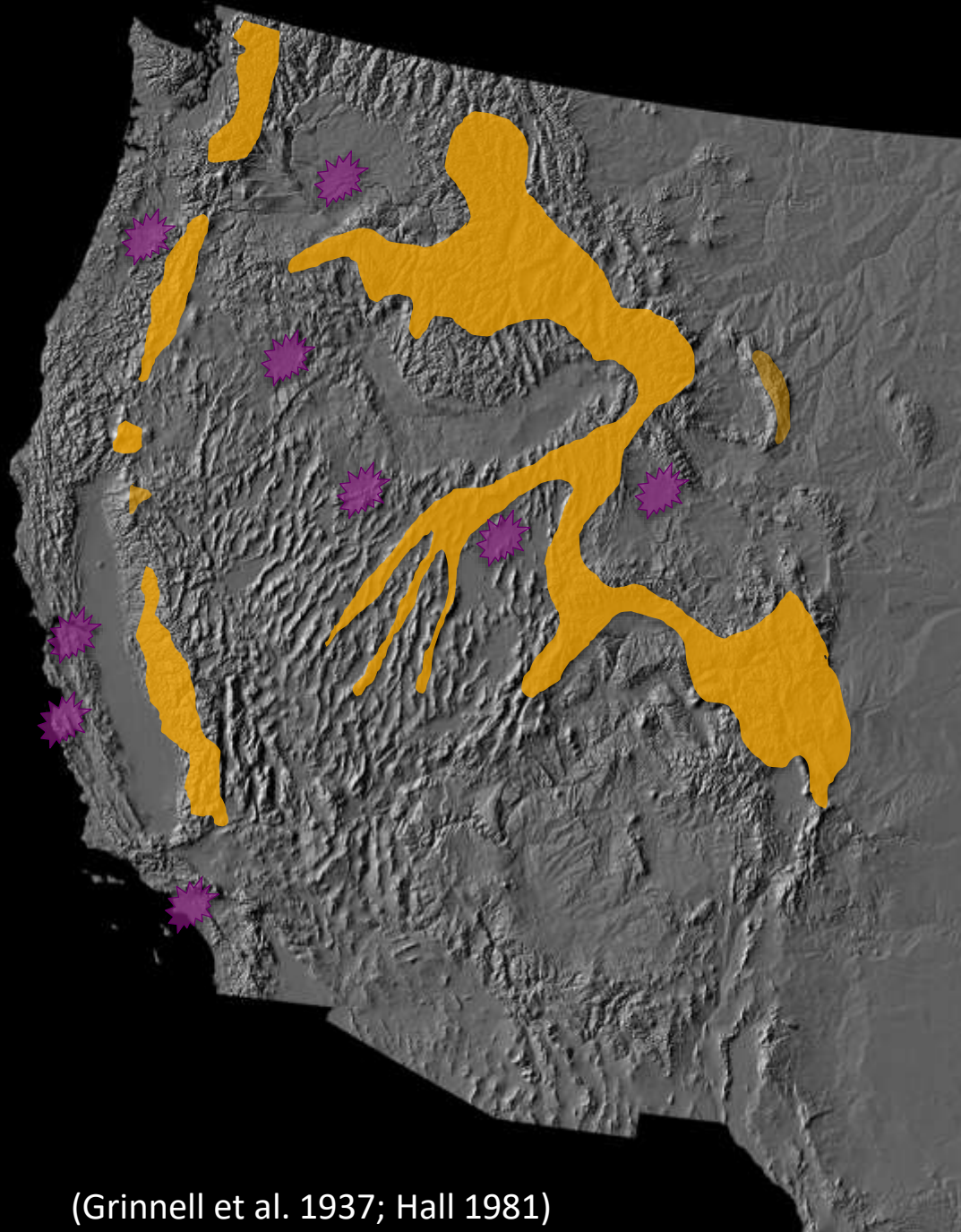
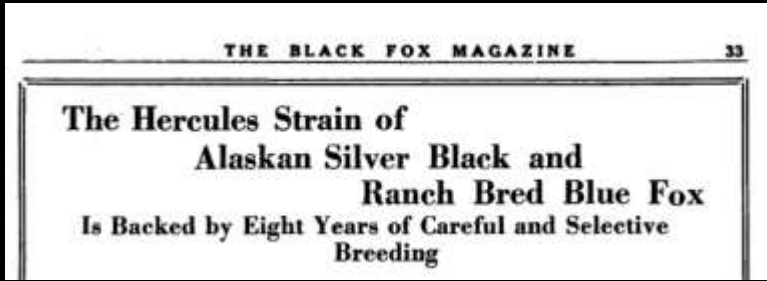


(Grinnell et al. 1937; Hall 1981)



1900s

Fur farm derived populations

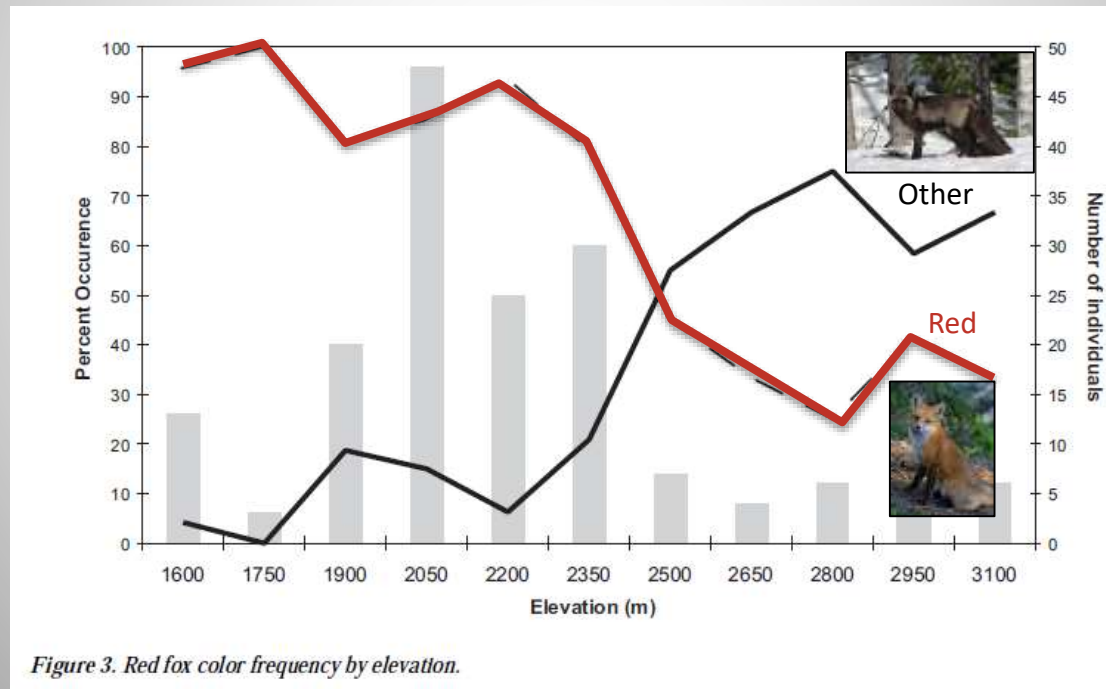


(Grinnell et al. 1937; Hall 1981)

# Montane vs. Lowland

## Local Adaptations?

### Coat Color

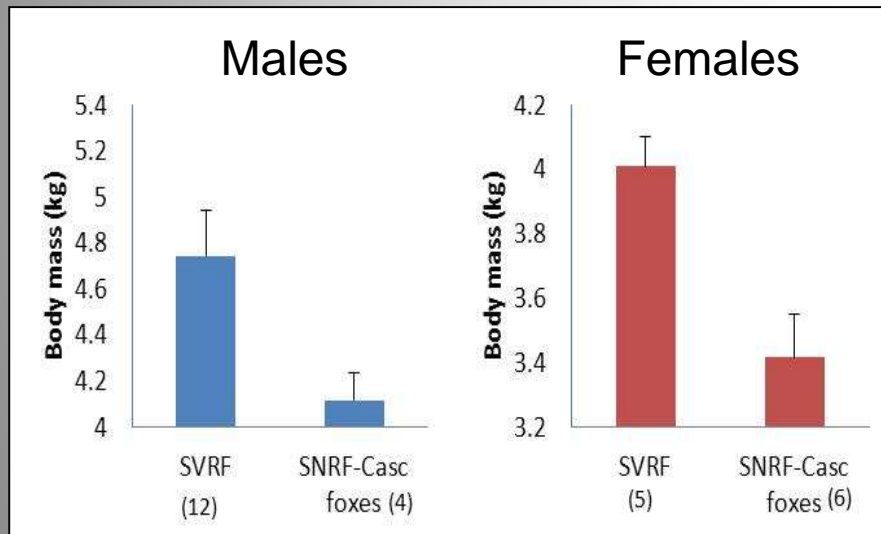


Fuhrmann 2002 Yellowstone Science. 10:8-15.

# Montane vs. Lowland

## Local Adaptations?

Smaller body size



Foot morphology?



Sacramento Valley red fox  
Jan 2011



Sierra Nevada red fox  
Jan 2011

(see Fuhrman 1998)

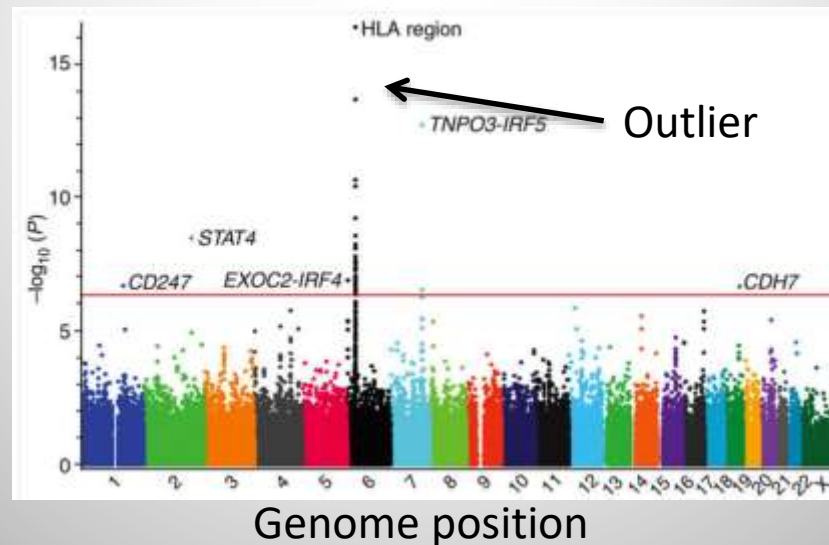


# Montane vs. Lowland

## Local Adaptations?

### Incorporating a genomic approach?

- Look for regions of the genome that differ between groups
- Identify candidate genes
- Test



Sophie Quisquater, UC Davis Phd student, in early stages



# Montane vs. Lowland

## What limits population growth?

### **Lowland** (East, Midwest, California)

- 40-70% annual mortality
- Litters of 5-6 pups, high juvenile survival
- Populations stable or growing

# Montane vs. Lowland

## What limits population growth?

### Montane

- High adult survival
  - 2-4 yrs min lifespan in Son Pass
  - 8 yr female in Lassen
- Low reproductive output
  - 4 females collared in Lassen, no reproduction observed (3-5 yrs)
  - No offspring detected in Sonora Pass among natives (2 yrs)



## What does this mean?

1. Reproduction = key demographic parameter
2. Why? Resource limited? Inbreeding depression?



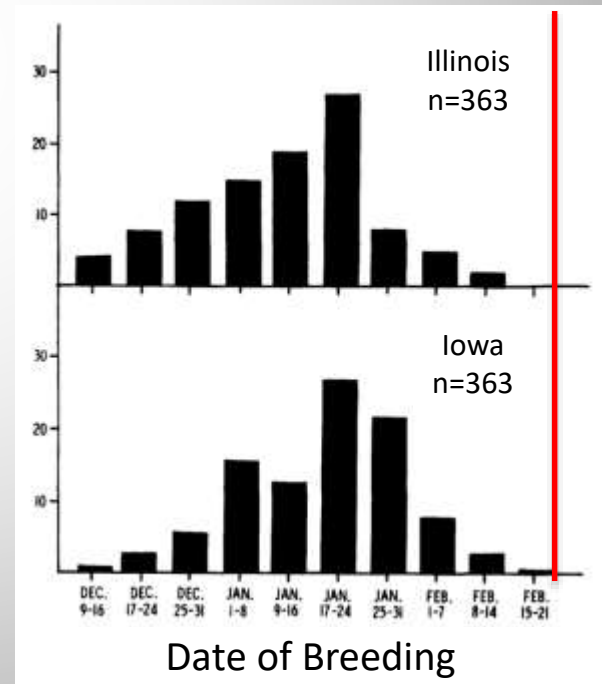
# Montane vs. Lowland

## Timing of Reproduction

- Delayed at higher latitudes... also at higher elevations?
- Important to know for management



March 3<sup>rd</sup>, WA Cascades  
photo from J. Akins

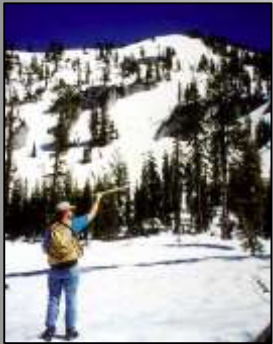


Storm et al. 1976

# Montane vs. Lowland

## Space Use

Very large home ranges

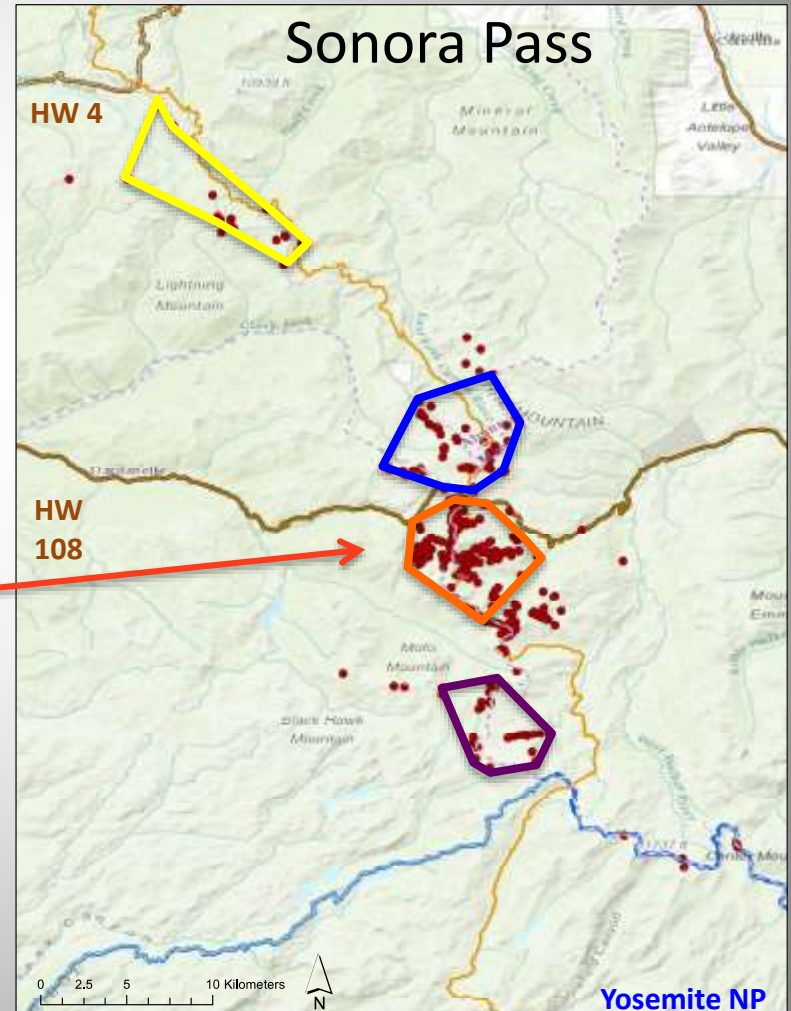


Perrine 2005

Radio Telemetry, Lassen  
(non-breeding) = **23 km<sup>2</sup>**

Genetic scat recaptures = **20 km<sup>2</sup>**

Northwest British Columbia = 16 km<sup>2</sup>  
Lapland = 30-50 km<sup>2</sup>



Quinn and Sacks 2014

# Montane vs. Lowland

## Space Use

Very large home ranges

- Low density
- Difficult to survey
- Have to take care translating presence to abundance





# Deschutes Telemetry Study

ODFW (J. Vaughn)

Wildlife Ecology Institute (T. Hiller)

- GPS collars
- Captured 2 individuals this spring
- Reproduction and denning
- Home range size
- Fine-scaled habitat use



Deschutes County, May 2017



# What is a montane red fox?



- Much smaller
  - other adaptive traits?
- Low reproductive output
  - limiting population growth?
- Large home ranges
  - low density

Resource-limited, highly seasonal environment

...lessons from other populations don't necessarily apply



Photo by Carrie Merson (7/2014) Rocky Mtn red fox (Crested Butte, Colo), 12,500 ft elev





Photo by William Neale (3/2013) Rocky Mtn red fox (Quandary Peak, Colo), 13,100 ft elev



Photo by Patrick Cross, Rocky Mtn red fox (MT), Beartooths 8900-9500 ft elev





Photo by Jocelyn Akins (May 2010) (WA) Cascade red fox (Mt. Rainier NP, WA)





Photo by Keith Aubry (6/23/2011) (WA) Cascade red fox (Mt. Rainier NP)



Photo by Logan Volkmann, (WA) Cascade red fox (Paradise, Mt. Rainier NP)





Photo by Bill Freund (2008) Sierra Nevada red fox (Santiam Pass, OR Cascades, 4800 ft elev)





Photo by anonymous (July 2012) Sierra Nevada red fox (Sparks Lake, OR Cascades, 5,450 ft elev)





Photo courtesy of Laurie Turner (8/14/2013) Sierra Nevada red fox (Mt. Bachelor, OR Cascades, 5500 ft elev)





Photo by D. Baxter 2007 Sierra Nevada red fox (Latopie Lake, Sonora Pass, ~10,400 ft elev)



2014-06-27 6:42:06 AM M 2/3

○ 50°F



Photo by C. Quinn June 2014, Sierra Nevada red fox (McKay Drainage, SN ~10,000 ft elev)

2015-05-14 1:23:49 PM M 3/3

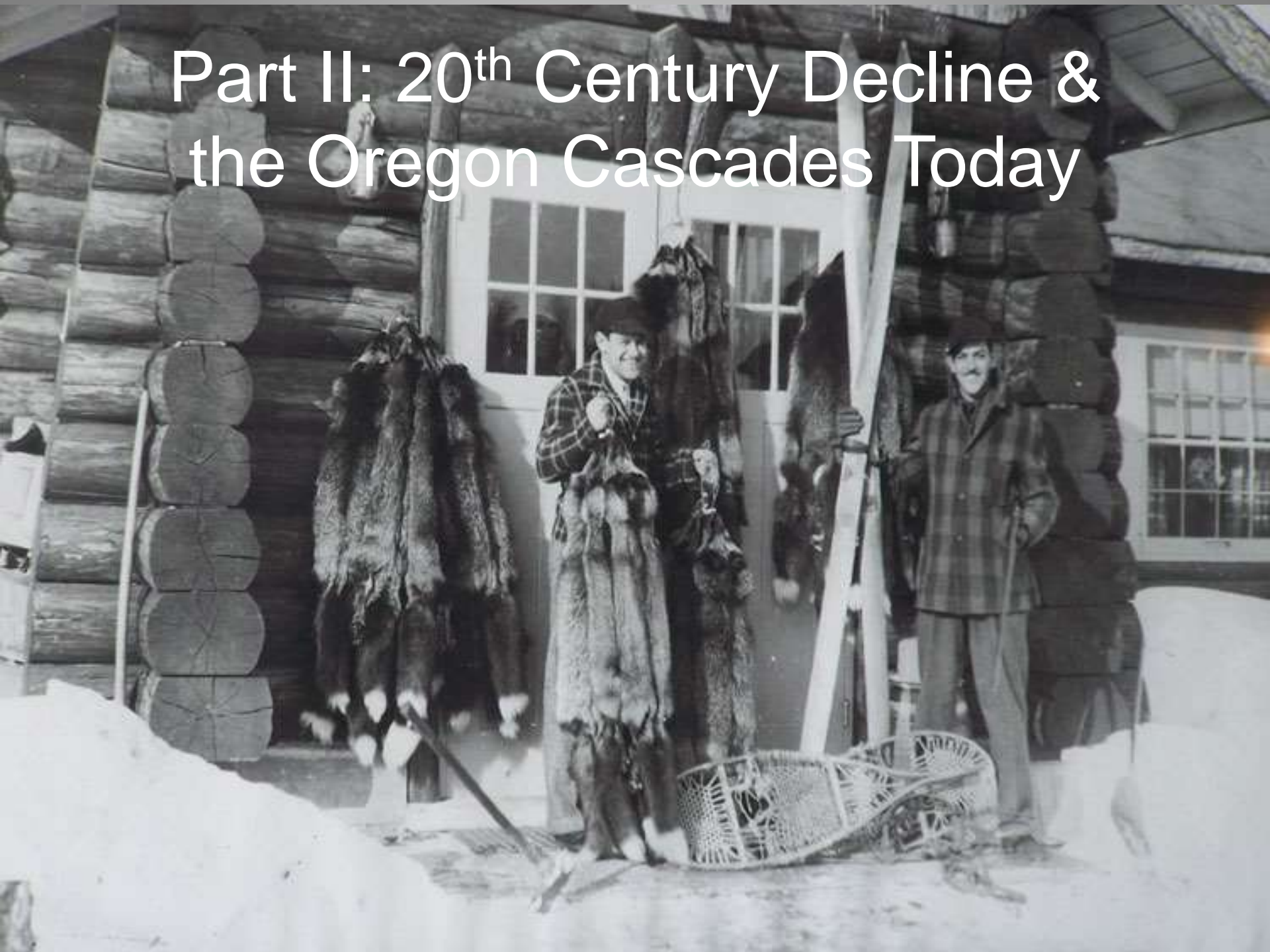
35°F



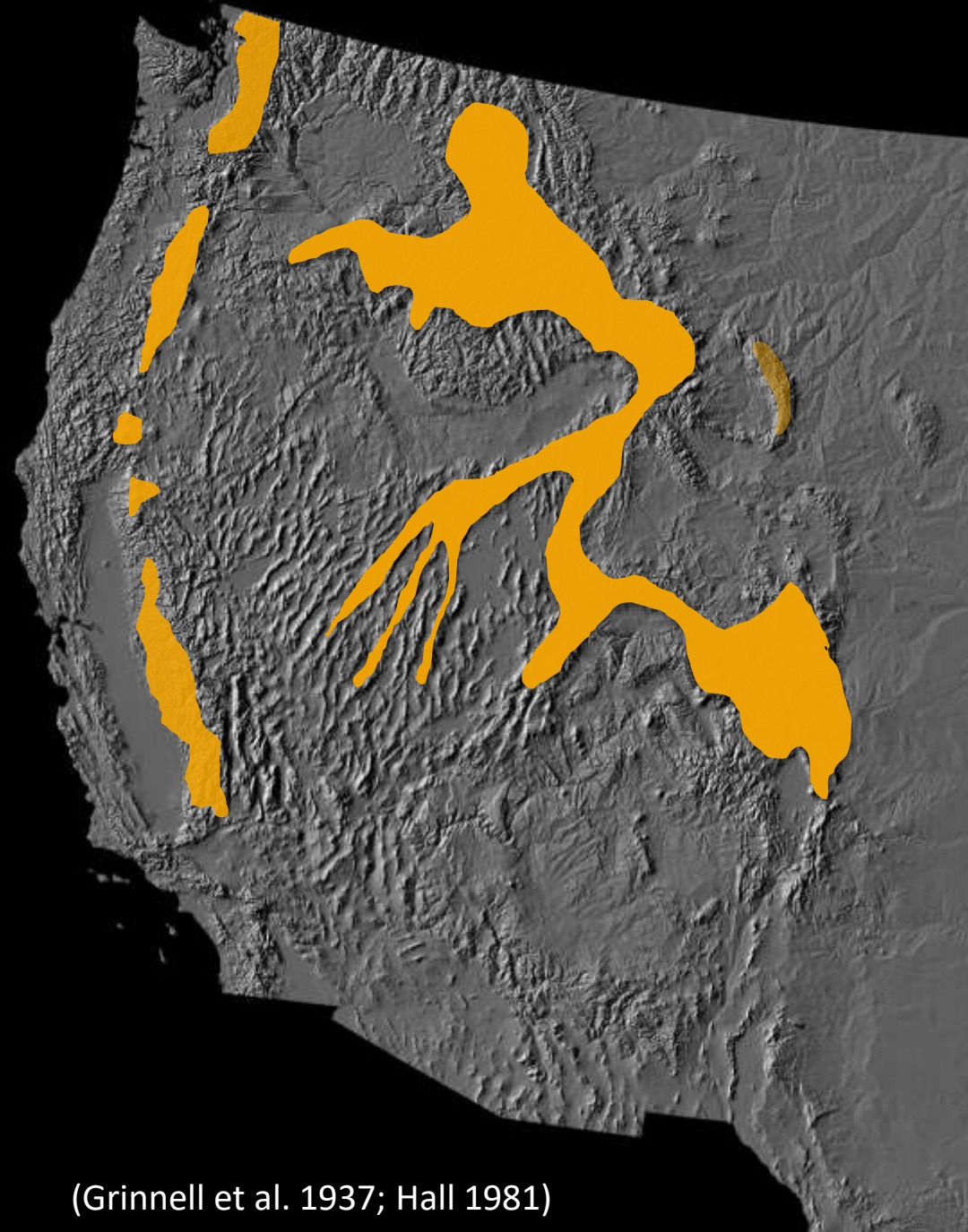
Photo by J. Power (Reconyx) May 2014, Sierra Nevada red fox (Arnot Peak, ~10,000 ft elev)



# Part II: 20<sup>th</sup> Century Decline & the Oregon Cascades Today



Early 1900s

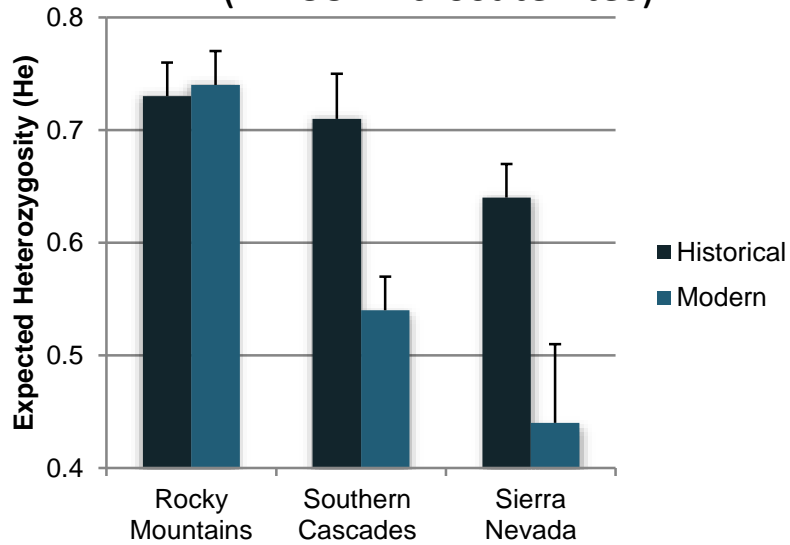


(Grinnell et al. 1937; Hall 1981)

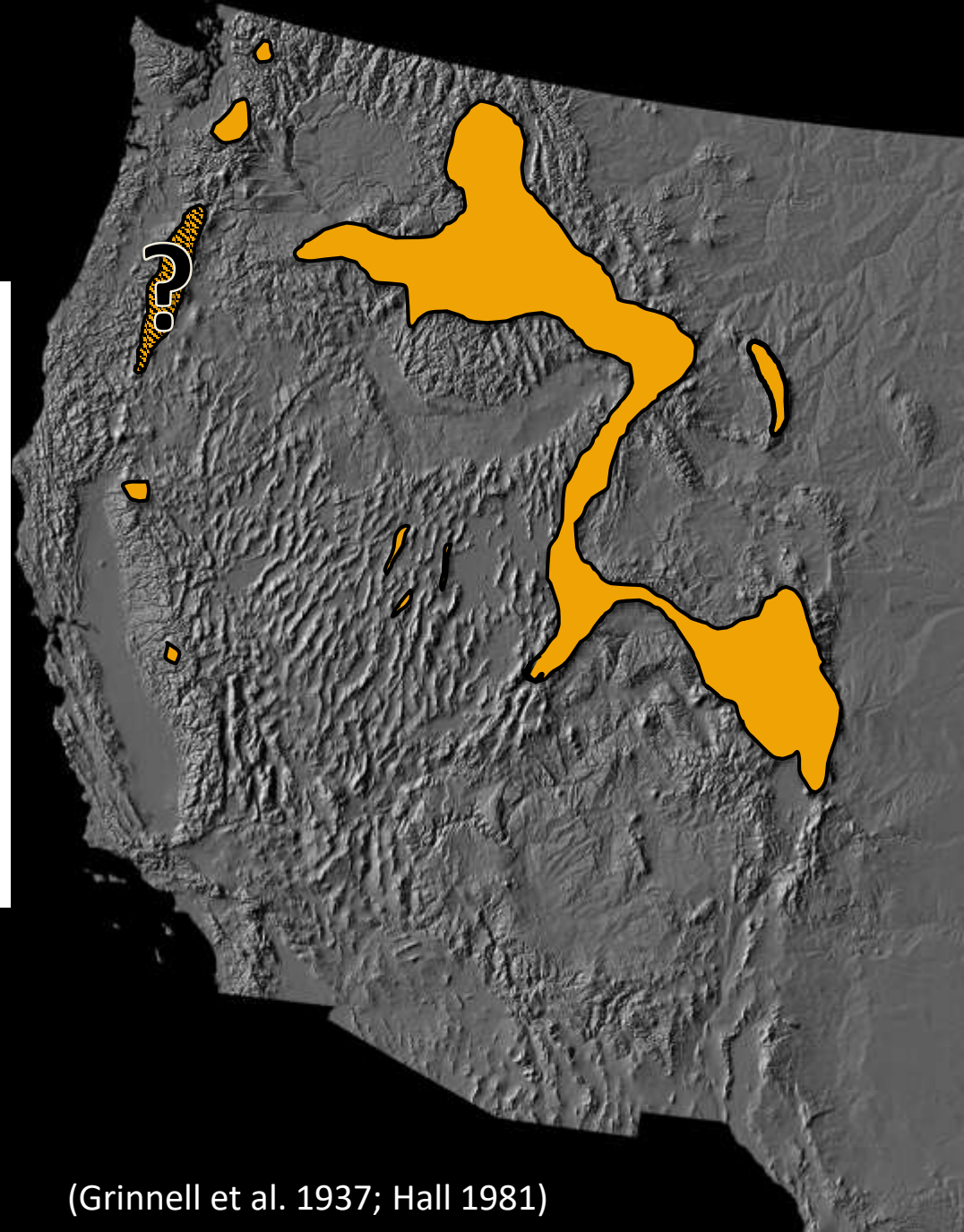


# Today

Nuclear DNA  
(14-33 microsatellites)

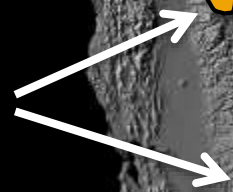


Sacks et al. 2010

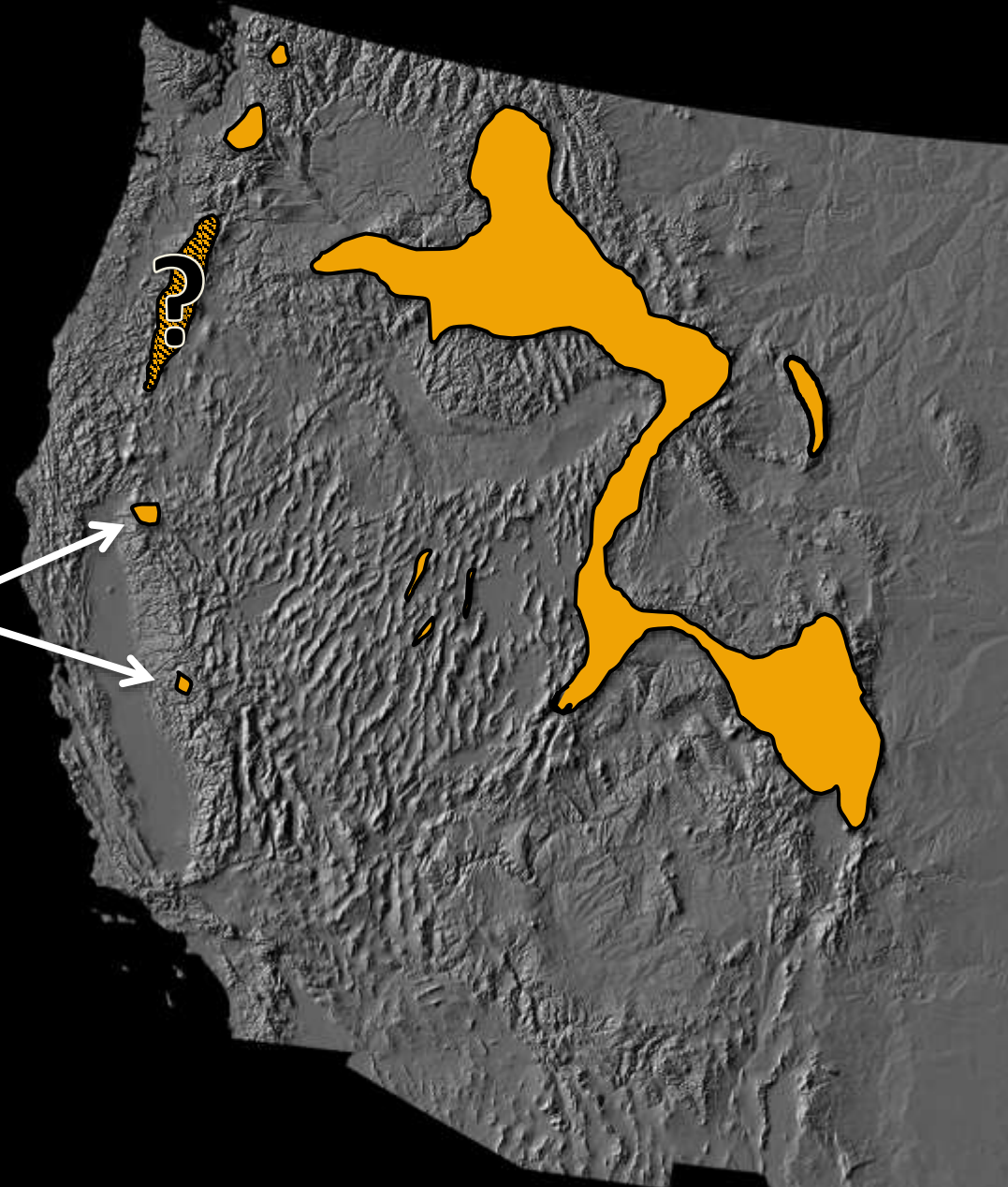


(Grinnell et al. 1937; Hall 1981)

< 50  
individuals



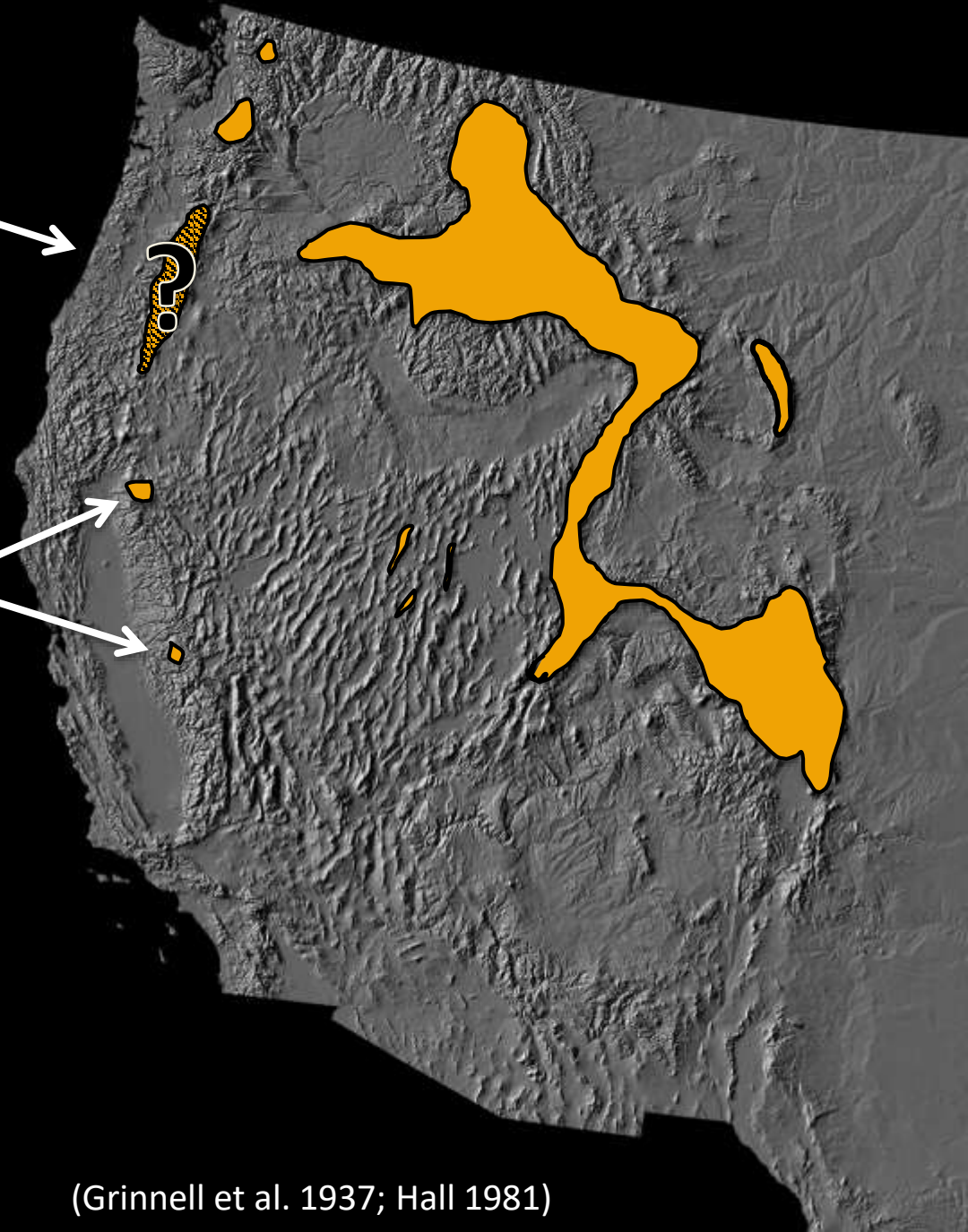
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What is the population status in Oregon?

< 50  
individuals



(Grinnell et al. 1937; Hall 1981)

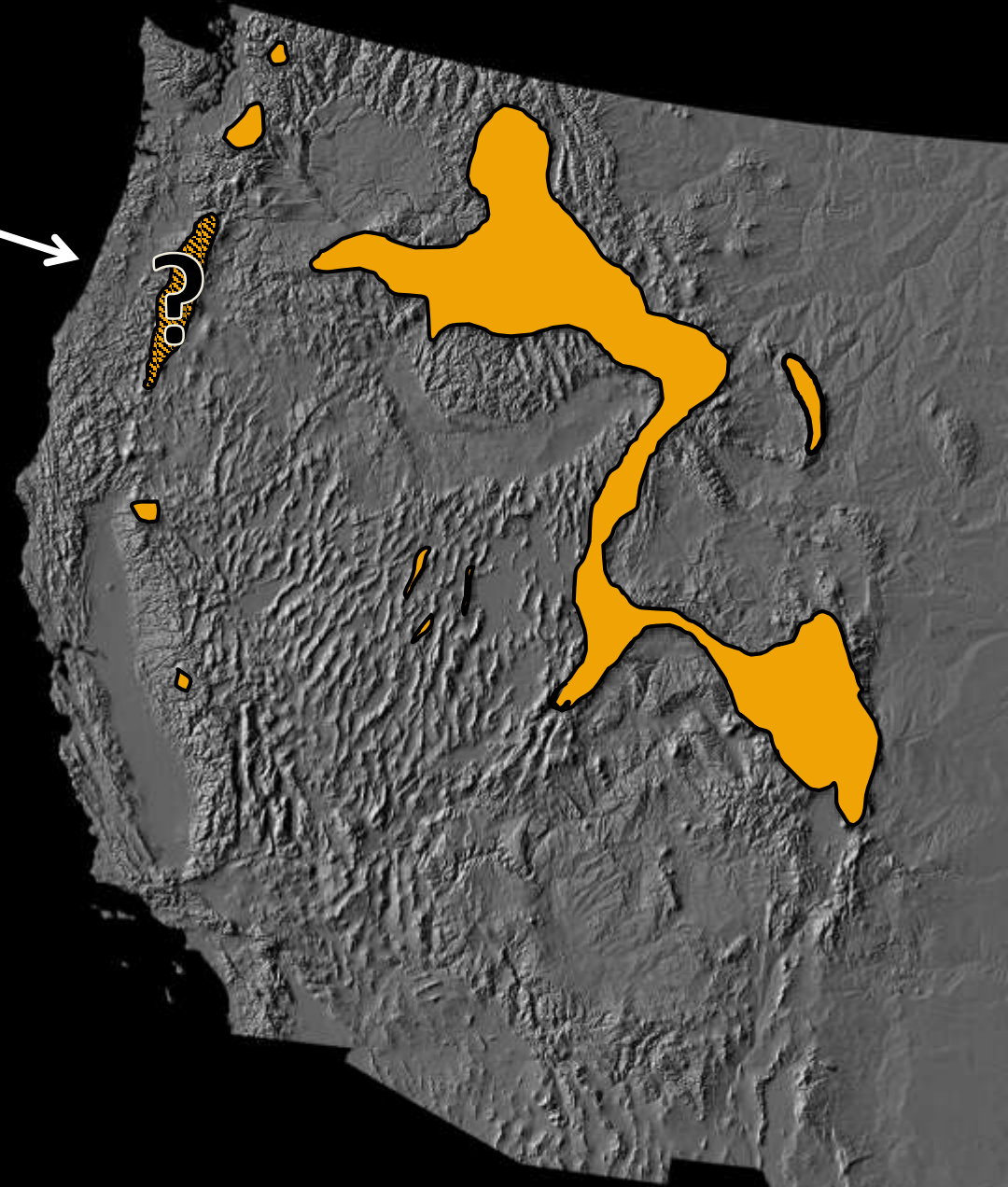
What is the population status in Oregon?



? Historical baseline



Bailey 1936



(Grinnell et al. 1937; Hall 1981)

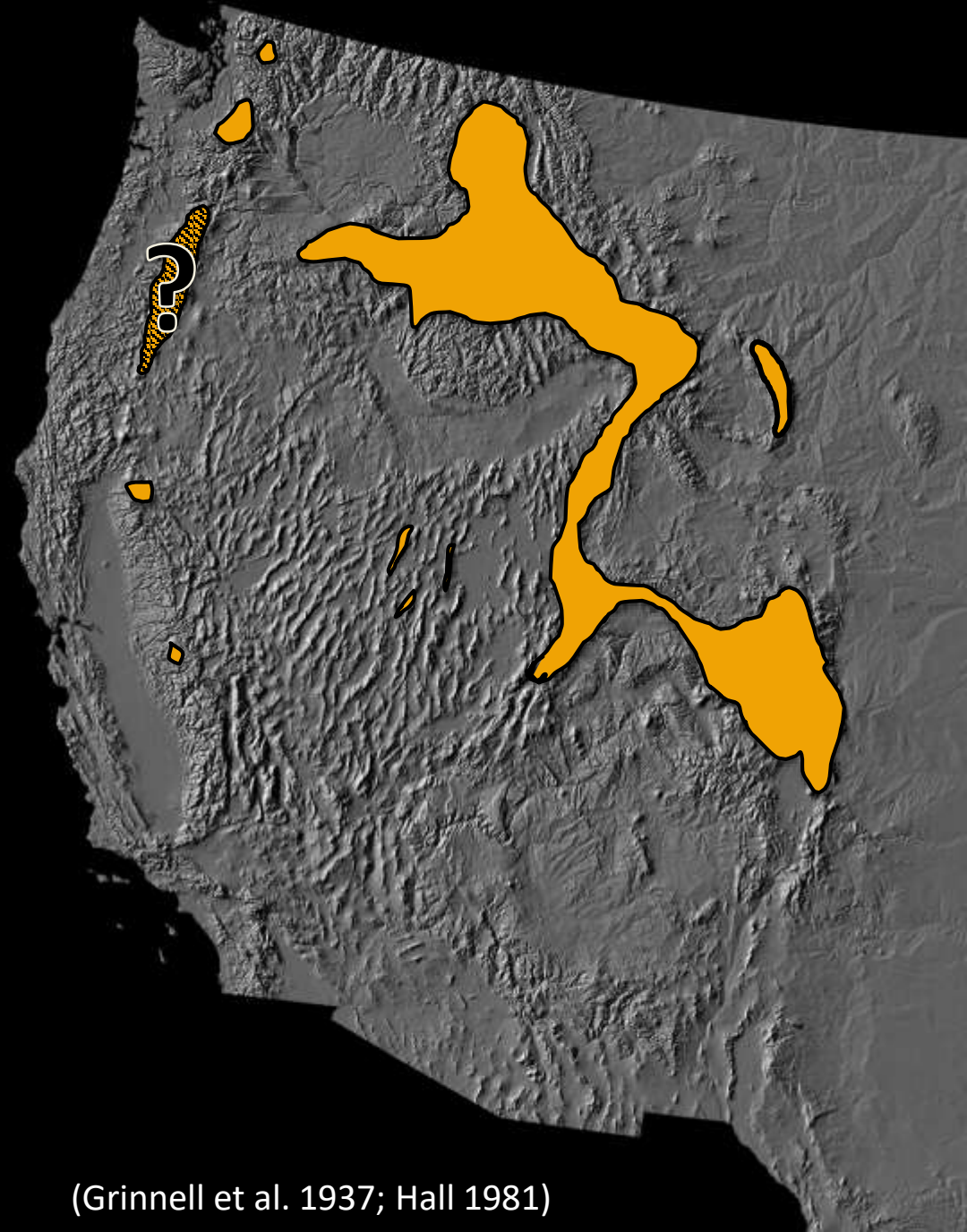


# What is the population status in Oregon?

## ? Historical baseline

“Usually... absent from the densely timbered or brushy areas west of the Cascades, as well as from the arid sagebrush valleys east of the range... Open grassy parks and meadows afford their favorite hunting grounds”

--Bailey 1936



(Grinnell et al. 1937; Hall 1981)

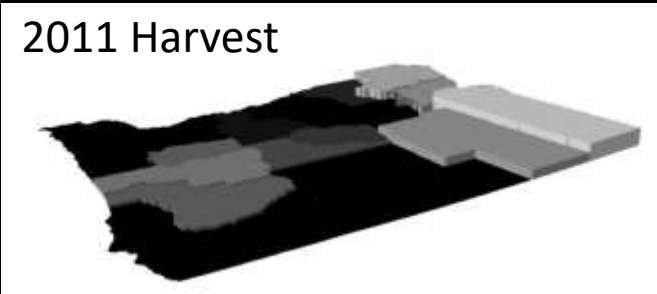


What is the population status in Oregon?

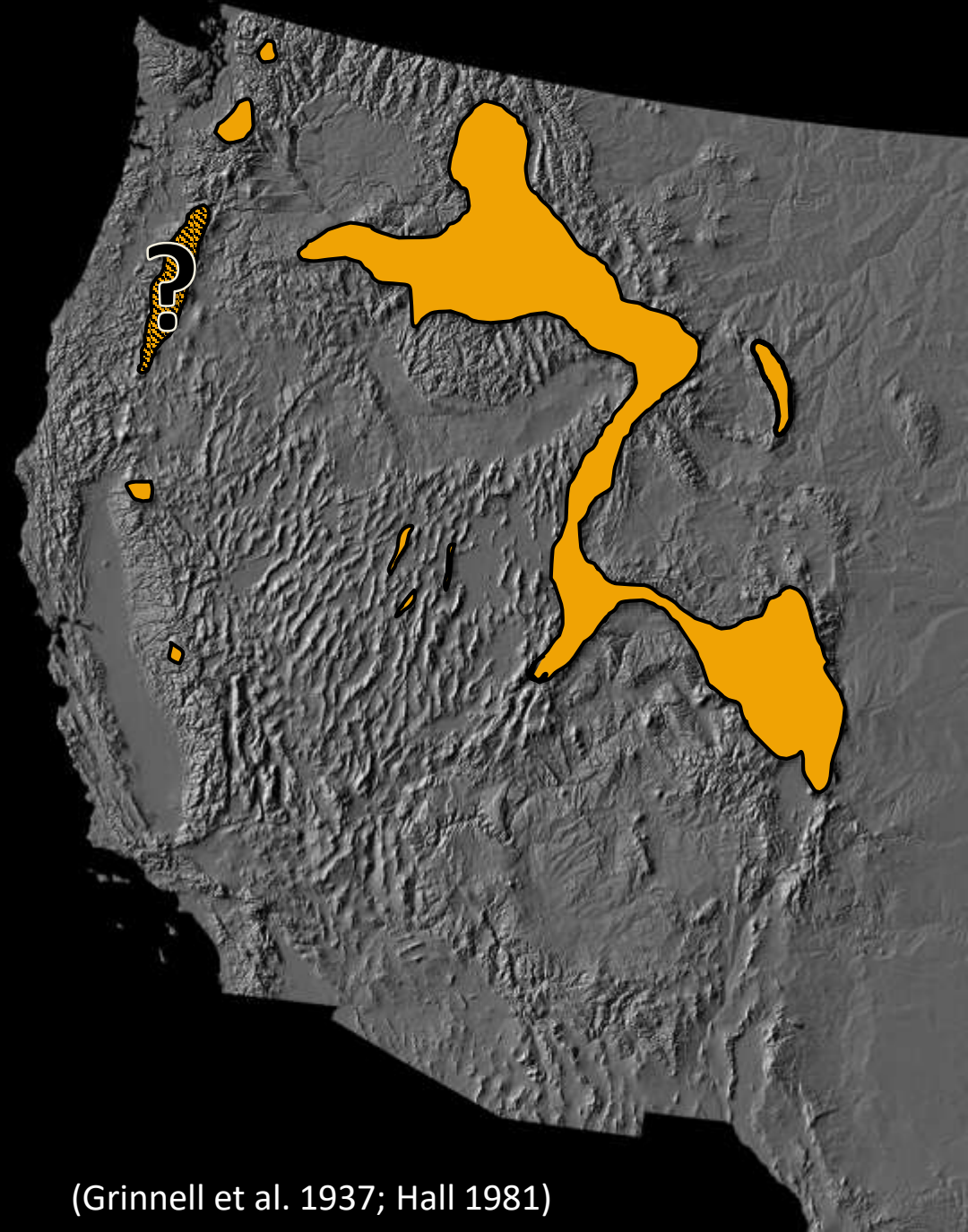
? Historical baseline

? Trapping records

2011 Harvest



ODFW Furbearer Report 2011



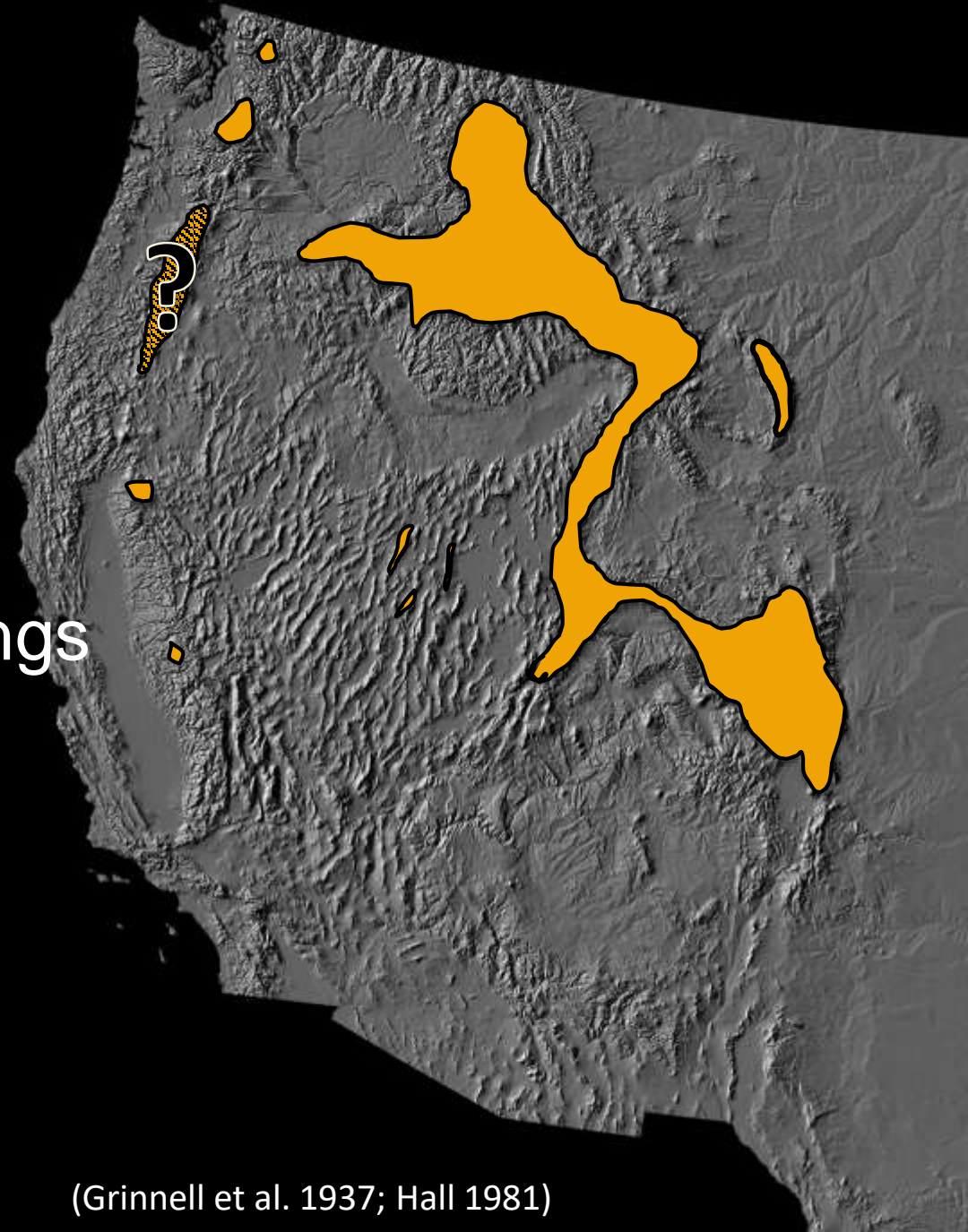
(Grinnell et al. 1937; Hall 1981)

What is the population status in Oregon?

? Historical baseline

? Trapping records

? Opportunistic sightings



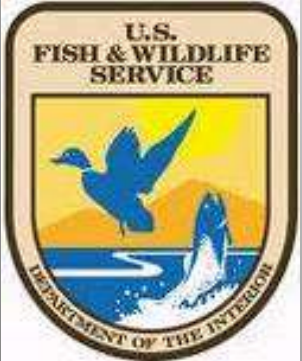
(Grinnell et al. 1937; Hall 1981)





# Widespread, collaborative effort to collect genetic samples & photos

2010 - 2016







# Questions

1. Where do we find SNRF?
  - Broad-scale distribution
  - Fine-scale habitat associations
2. Connectivity of detections?
3. Effective population size and genetic diversity?
4. Genetic integrity and relationship to other fox populations?



# Questions

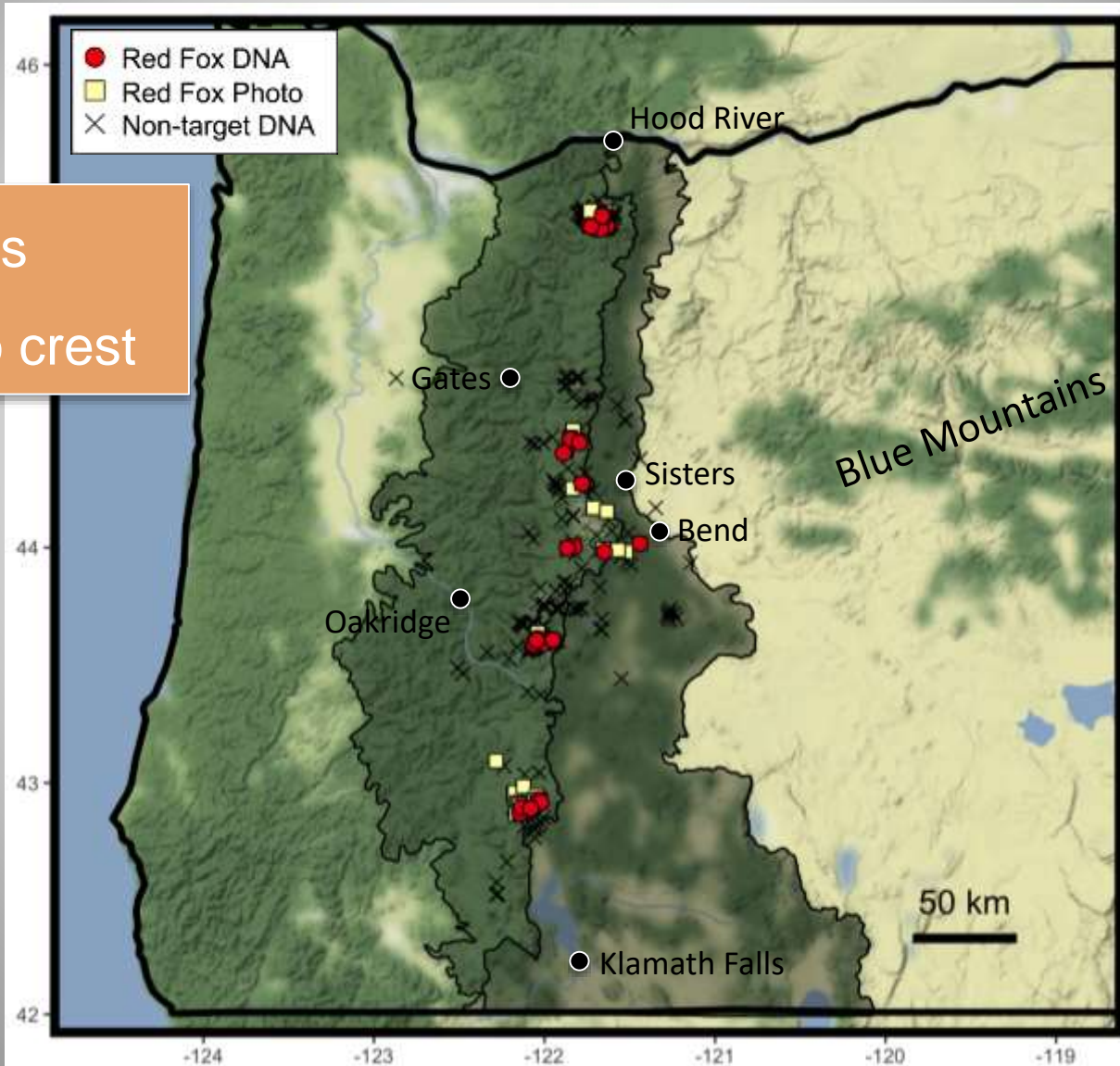
1. Where do we find SNRF?
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# 1. Where?

2010–2016

- 78 genetic
- 37 camera

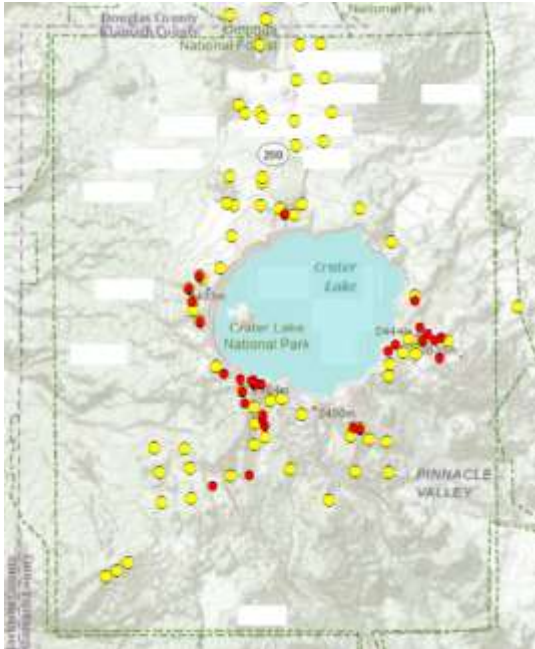
- 4 regions
- Close to crest





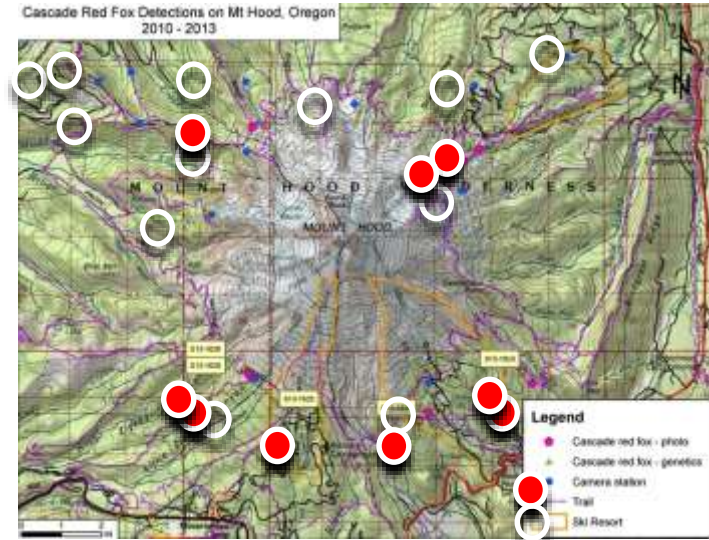
# 1. Where?

## Crater Lake

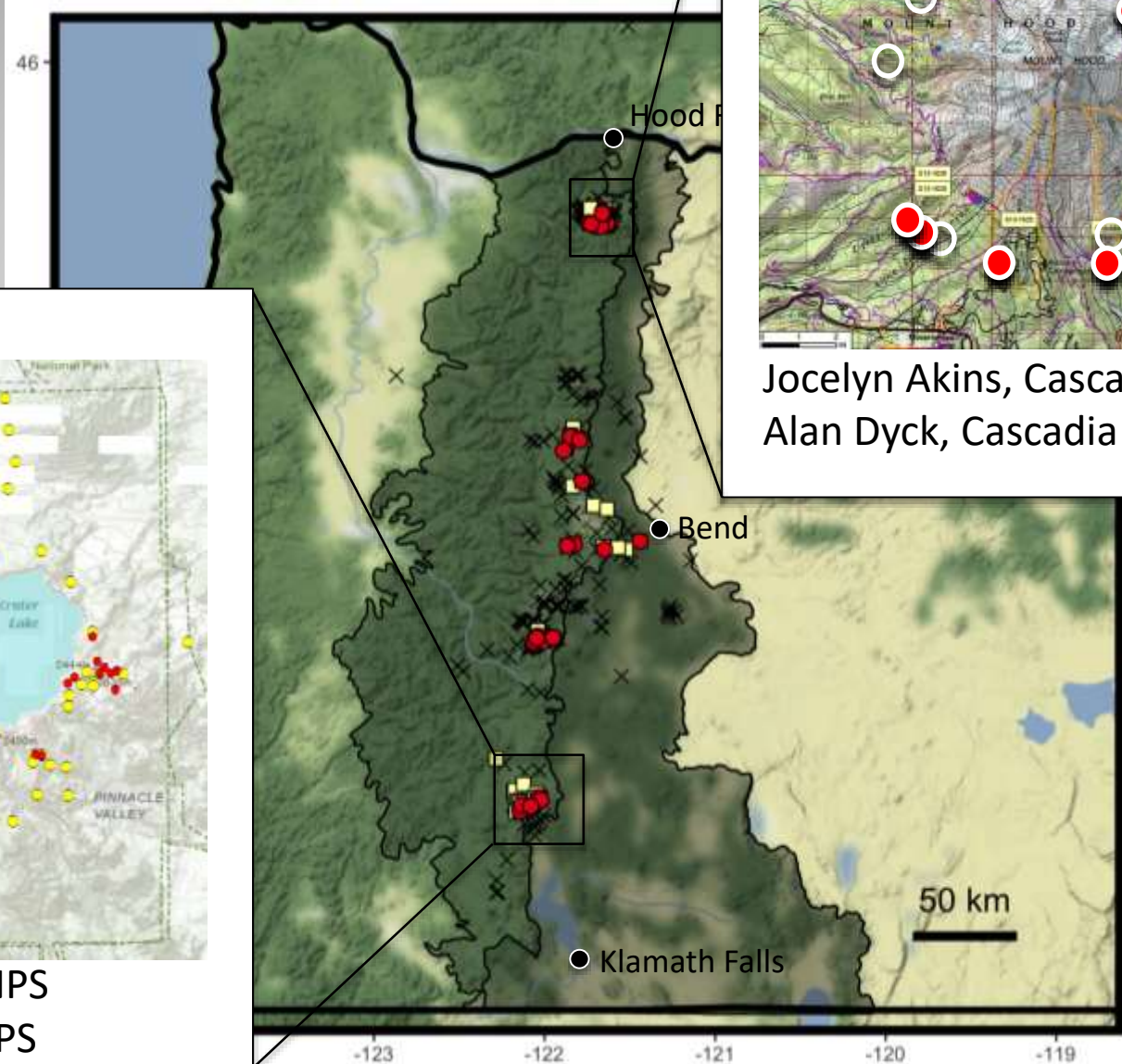


Sean Mohren, NPS  
Maria Immel, NPS

## Mount Hood

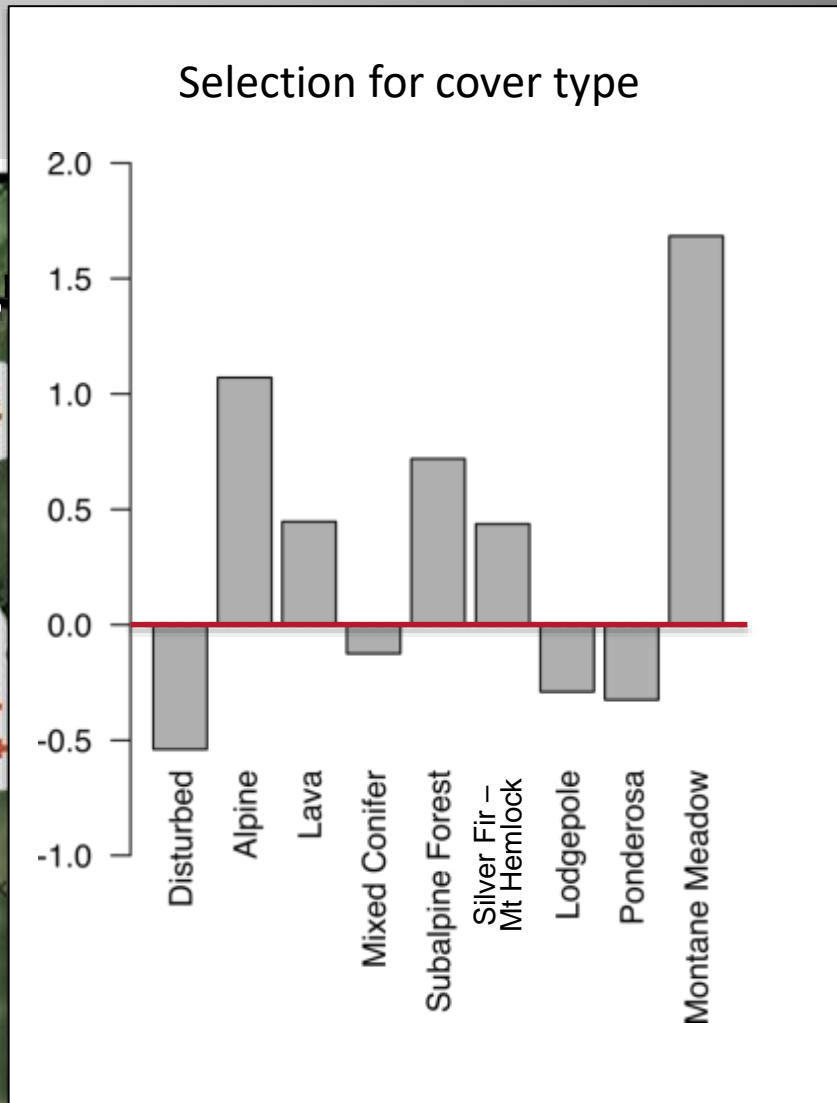
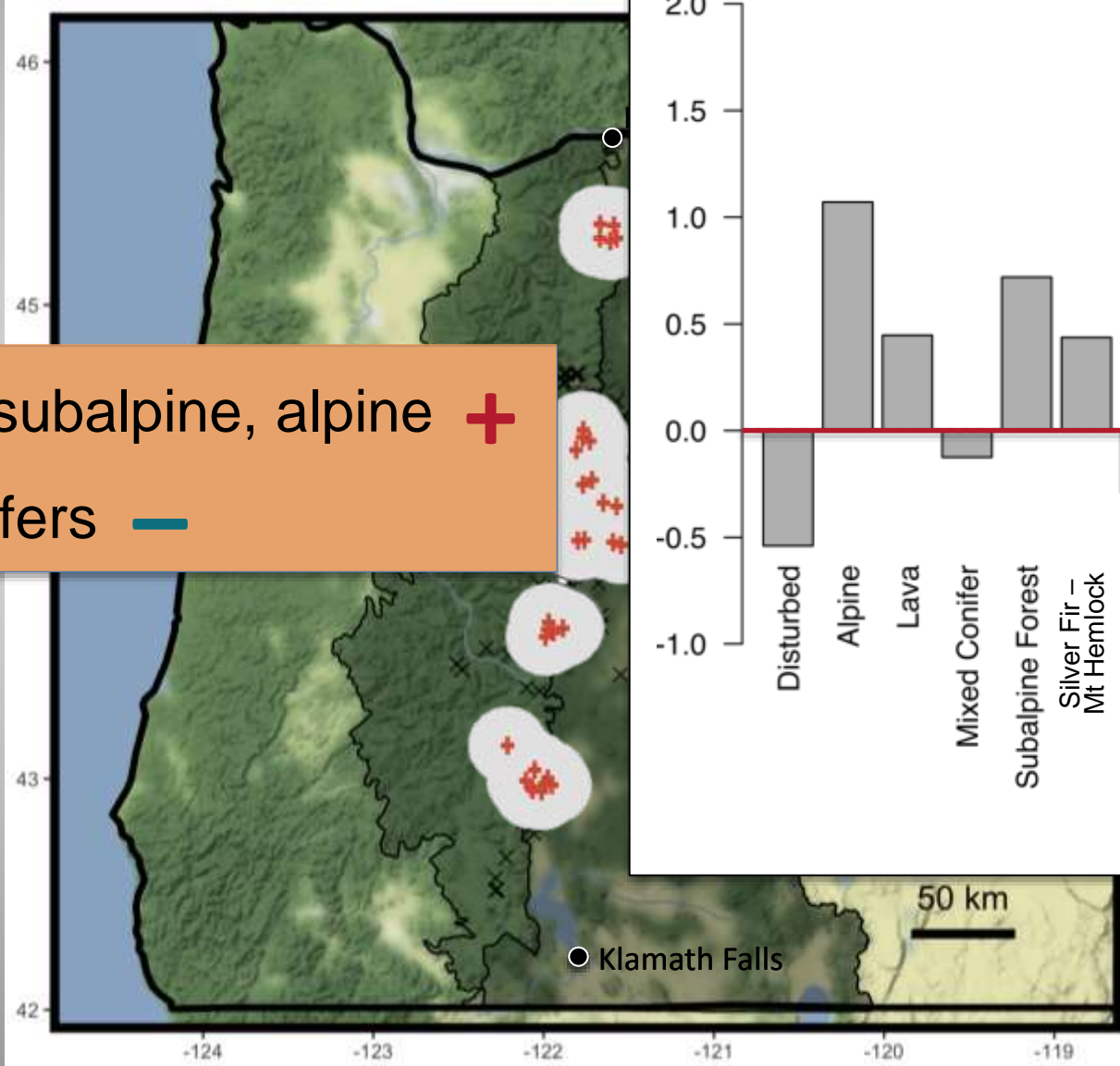


Jocelyn Akins, Cascade Carnivore  
Alan Dyck, Cascadia Wild



# 1. Where?

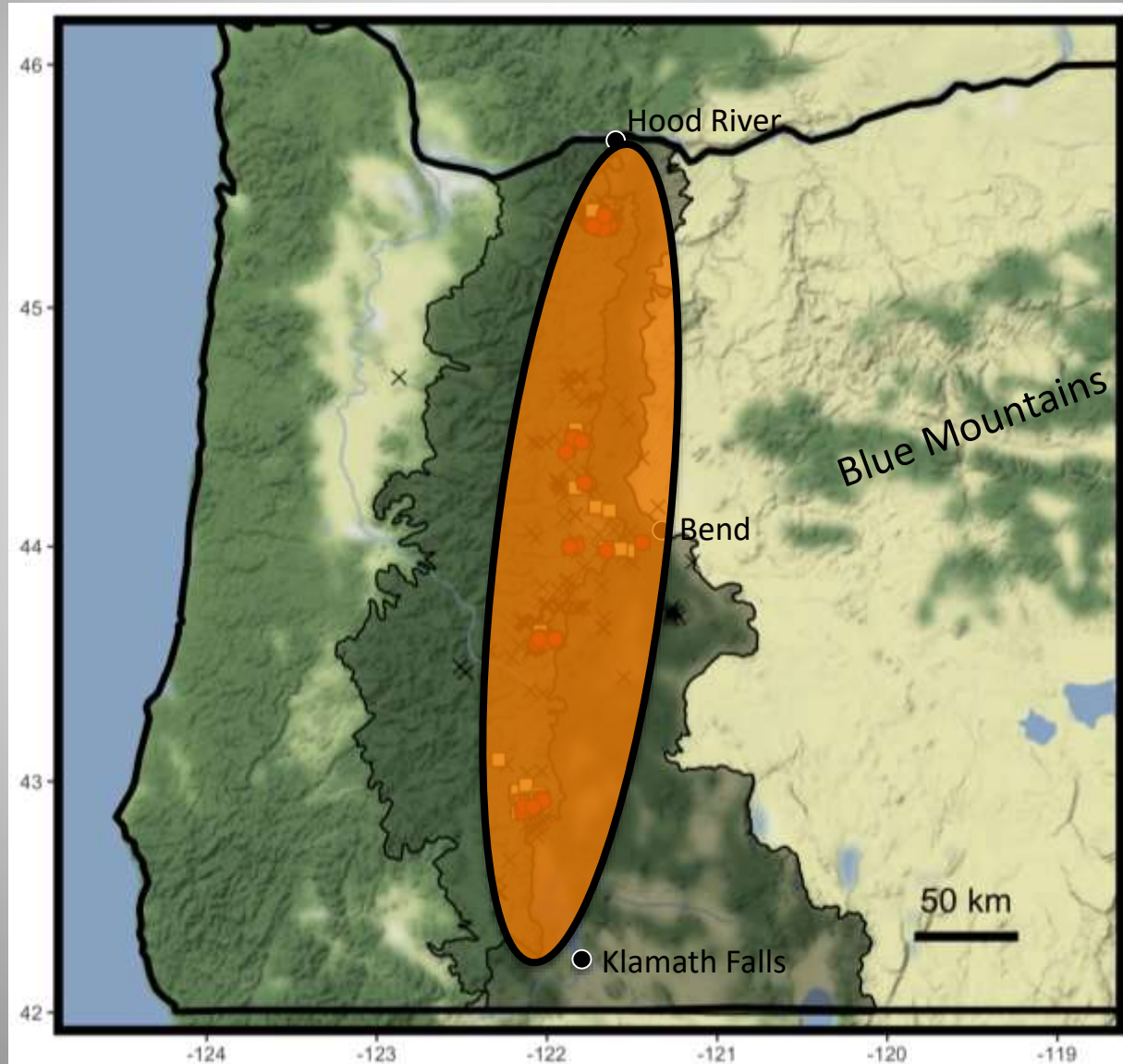
Meadows, subalpine, alpine +  
Dense conifers —





## 2. How connected?

One large population...

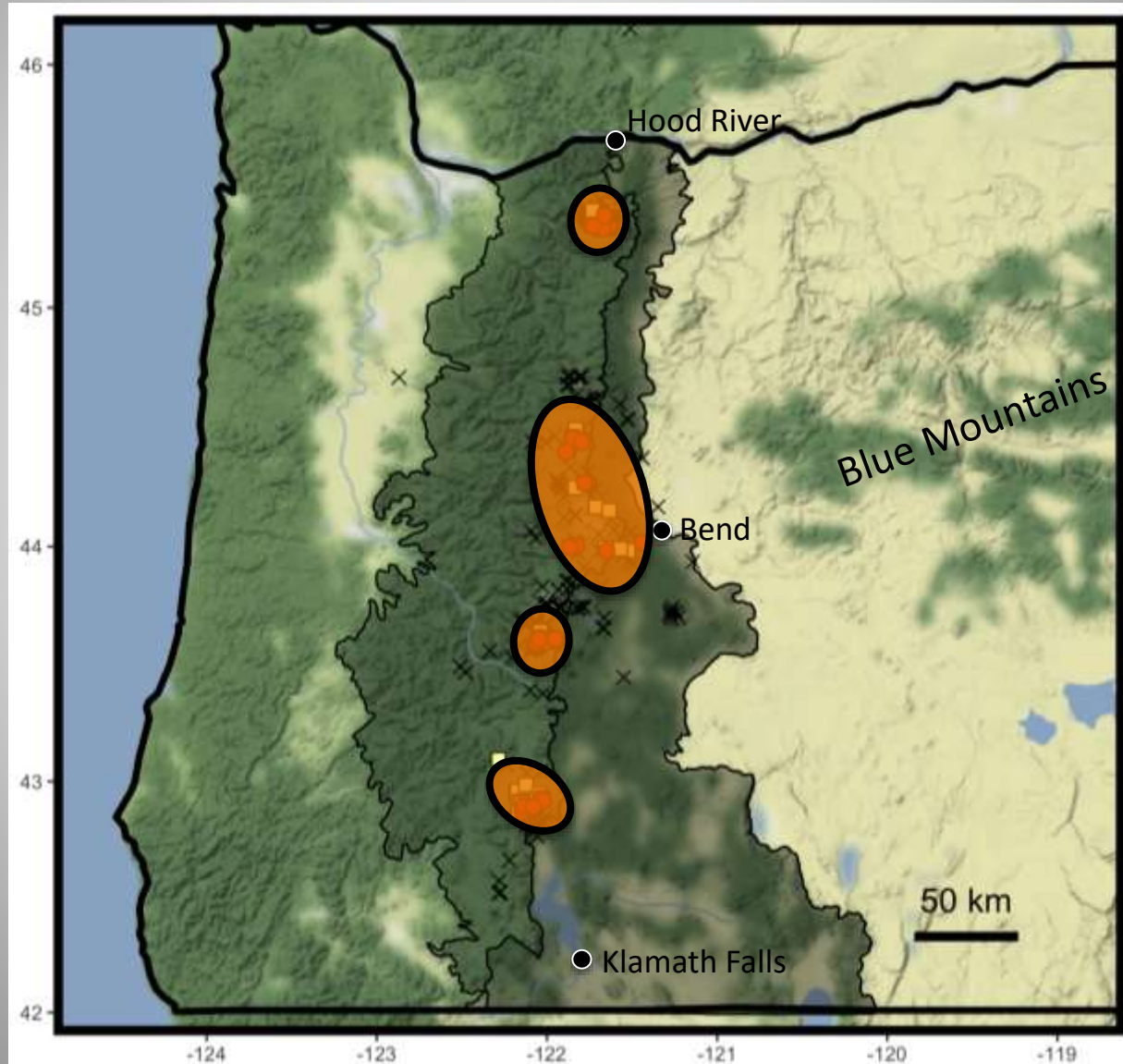




## 2. How connected?

One large population...

or several small...



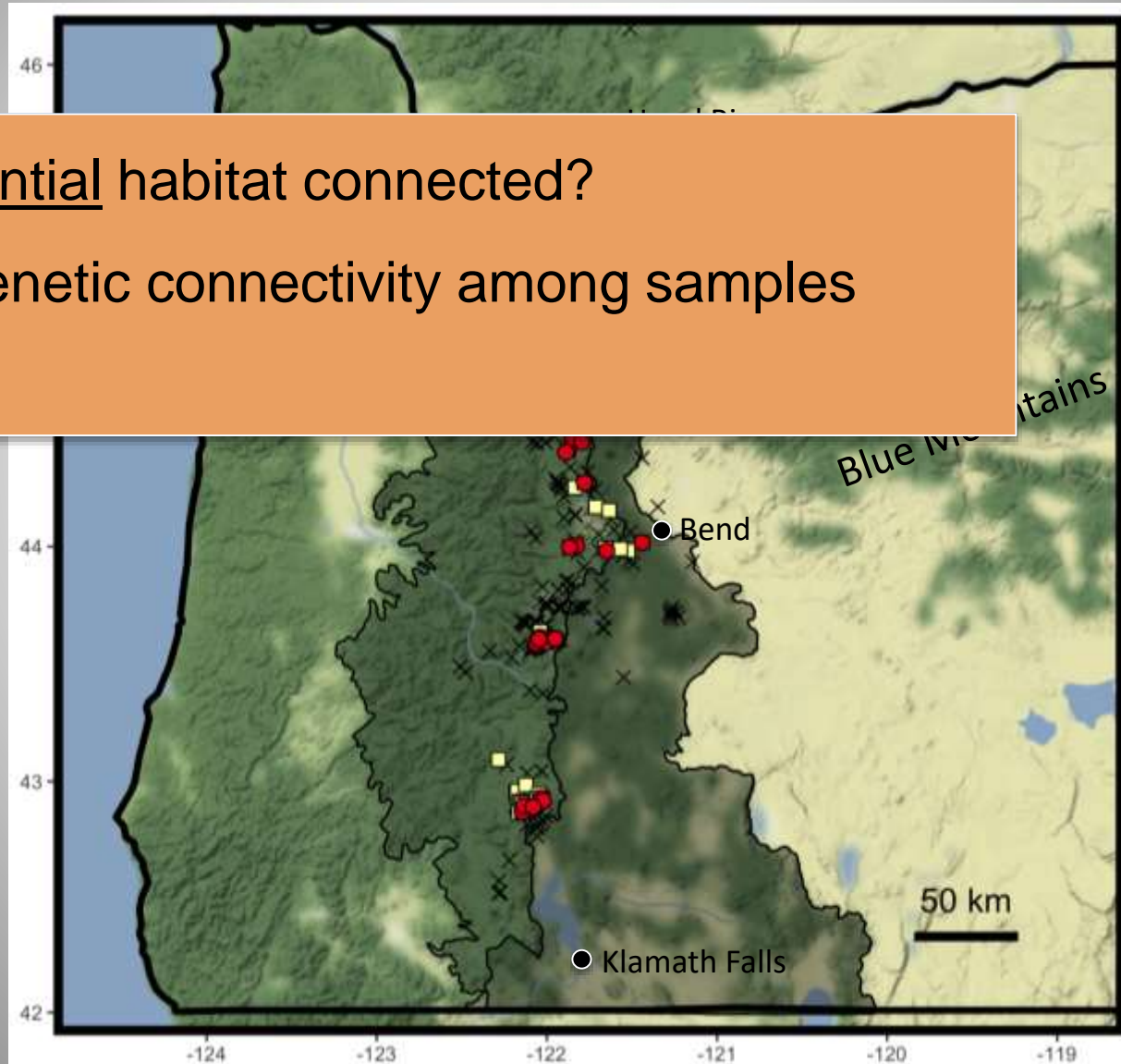
## 2. How connected?

One large population...

or several small...

1. Is potential habitat connected?

2. Test genetic connectivity among samples





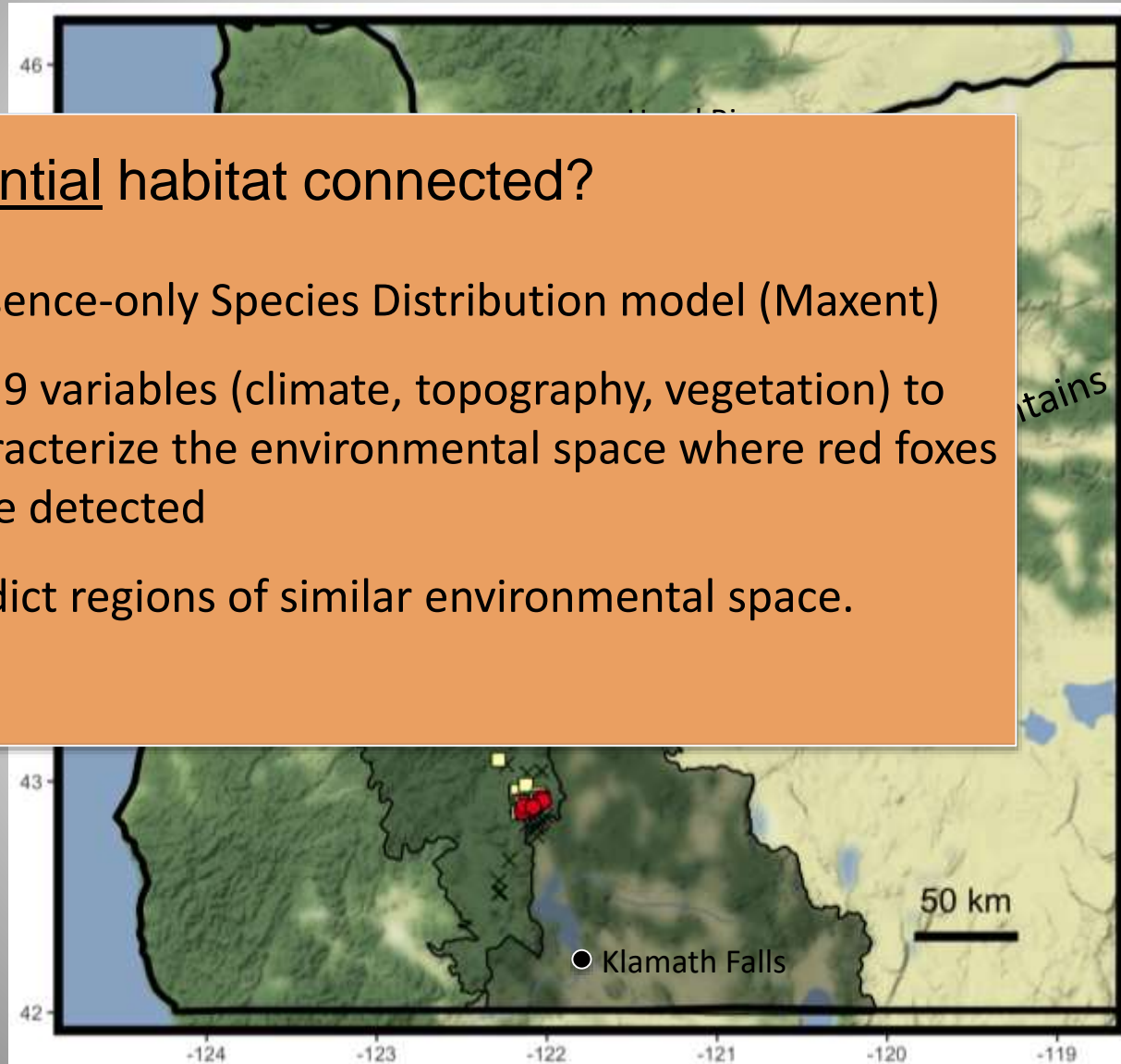
## 2. How connected?

One large population...

or several small...

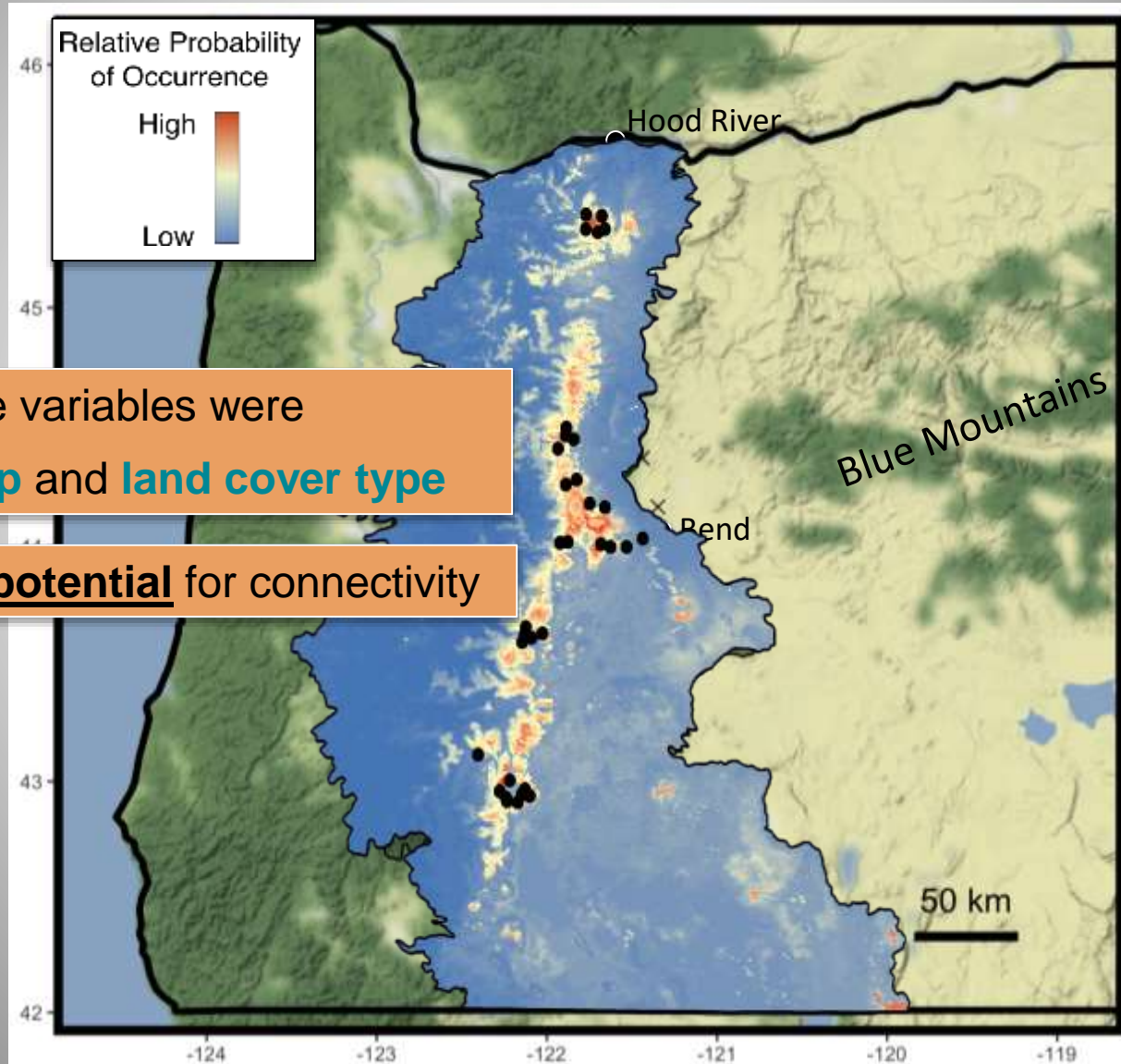
### 1. Is potential habitat connected?

- Presence-only Species Distribution model (Maxent)
- Use 9 variables (climate, topography, vegetation) to characterize the environmental space where red foxes were detected
- Predict regions of similar environmental space.



# How connected?

## Maxent Species Distribution Model

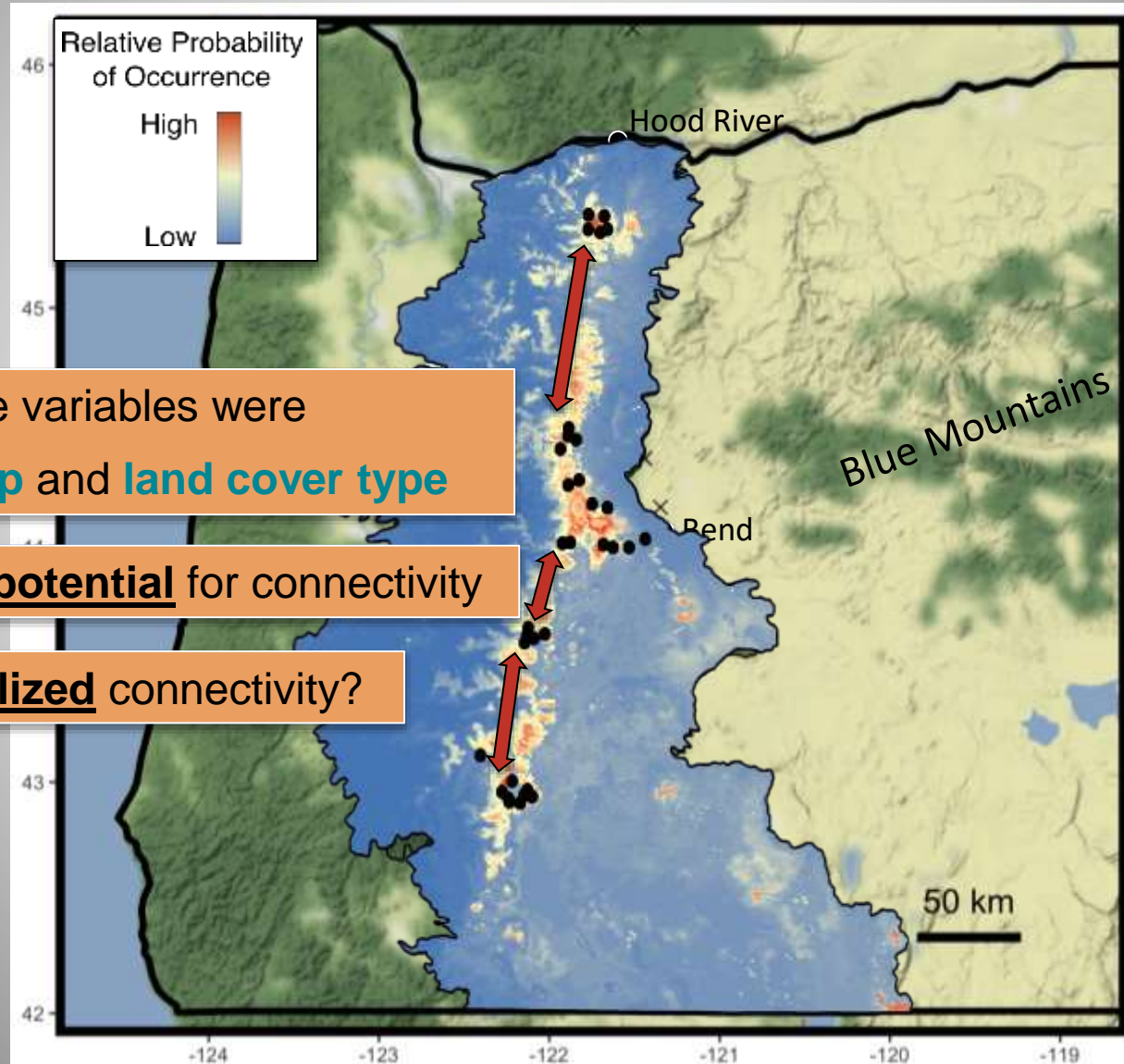


Most informative variables were **min winter temp** and **land cover type**

Relatively high **potential** for connectivity

# How connected?

## Maxent Species Distribution Model



Most informative variables were **min winter temp** and **land cover type**

Relatively high **potential** for connectivity

What about **realized** connectivity?



## Where?

- 4 detection regions
- Close to the crest – min winter temp and cover class most important predictors
- Meadows, subalpine, alpine +
- Dense coniferous forest —

## How connected?

- Largely continuous potential habitat



# Work in Progress

- Add more genetic samples within Cascades
  - Processing 2017 summer samples right now
  - Target new areas predicted by model but not well sampled
- Add genetic samples from outside the Cascades
  - Introgression from nonnative red fox?
  - Gene flow with Blue Mountains?



# Genetic characteristics of foxes in Northeastern Oregon

PI Greg Green

- Are red foxes in Blue Mountains nonnative fur farm or native Rocky Mt. subspecies?
  - Mitochondria predominantly native
  - Nuclear analyses in progress
- Connectivity between Cascades and Blue Mts?





# Conclusions

A photograph of a wolf walking through a snowy forest. The wolf is in the foreground, facing right. In the background, there are several tree trunks, one of which has a black collar or band around it. The ground is covered in snow, and the lighting suggests a bright day.

- 5-10 years ago almost no information on fox in Oregon.
  - Biology
  - Distribution and population status
- Today a fox renaissance!
  - telemetry, cameras, genetics, diet

# Acknowledgements

Contributors: J. Akins (**Cascade Carnivore Project**), J. Doerr , C. Ferland, & R. Seitz (**Willamette National Forest**), L. Turner & M. Gregg (**Deschutes National Forest**), S. Colyer, J. VonKienast, & D. Clayton (**Rogue River-Siskiyou National Forest**), A. Dyck (**Mt. Hood National Forest**), J. Chapman (**Region 6 US Forest Service**), K. Moriarty (**Pacific Northwest Research Station, USFS**), J. Nelson (**High Desert Museum**), S. Mohren & M. Immel (**Crater Lake National Park**), C. Heath, L. Erickson (**Oregon Department of Fish and Wildlife**), D. Gumtow-Farrior, C. Gumtow-Farrior (Oregon State University-Cascades), G. Green, P. Alden, T. Hiller, and J. MacFadden.

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Mammalian Ecology and Conservation Unit



# Questions?

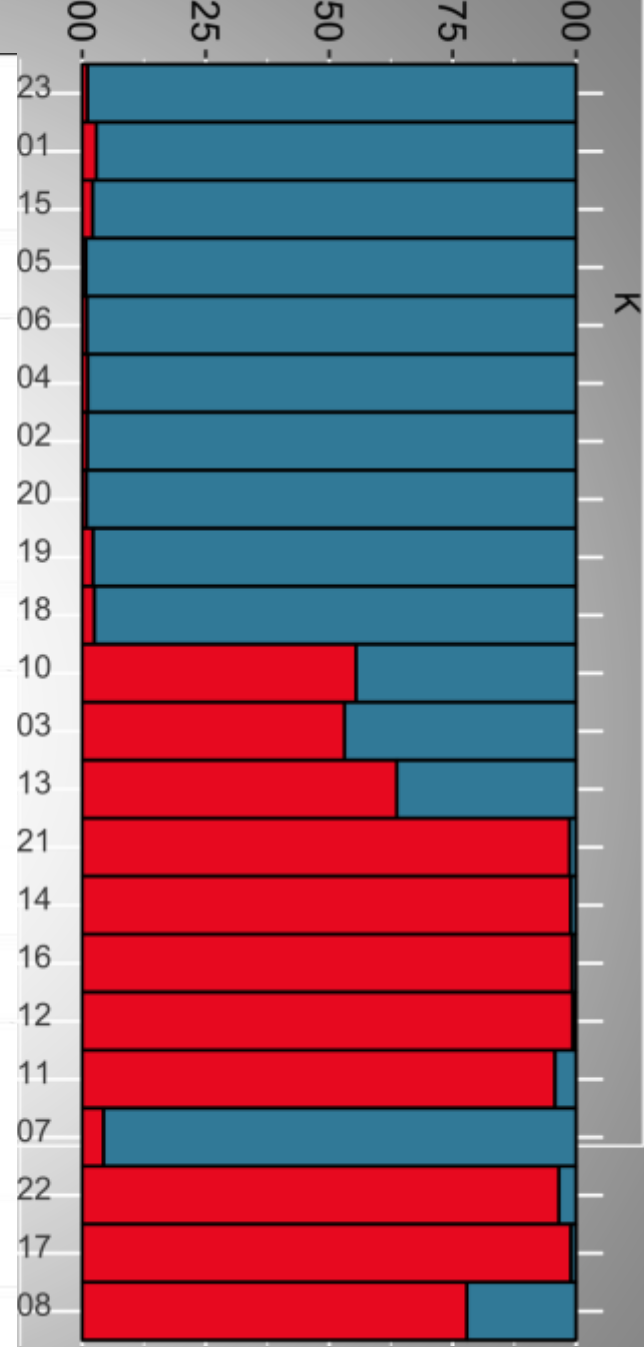
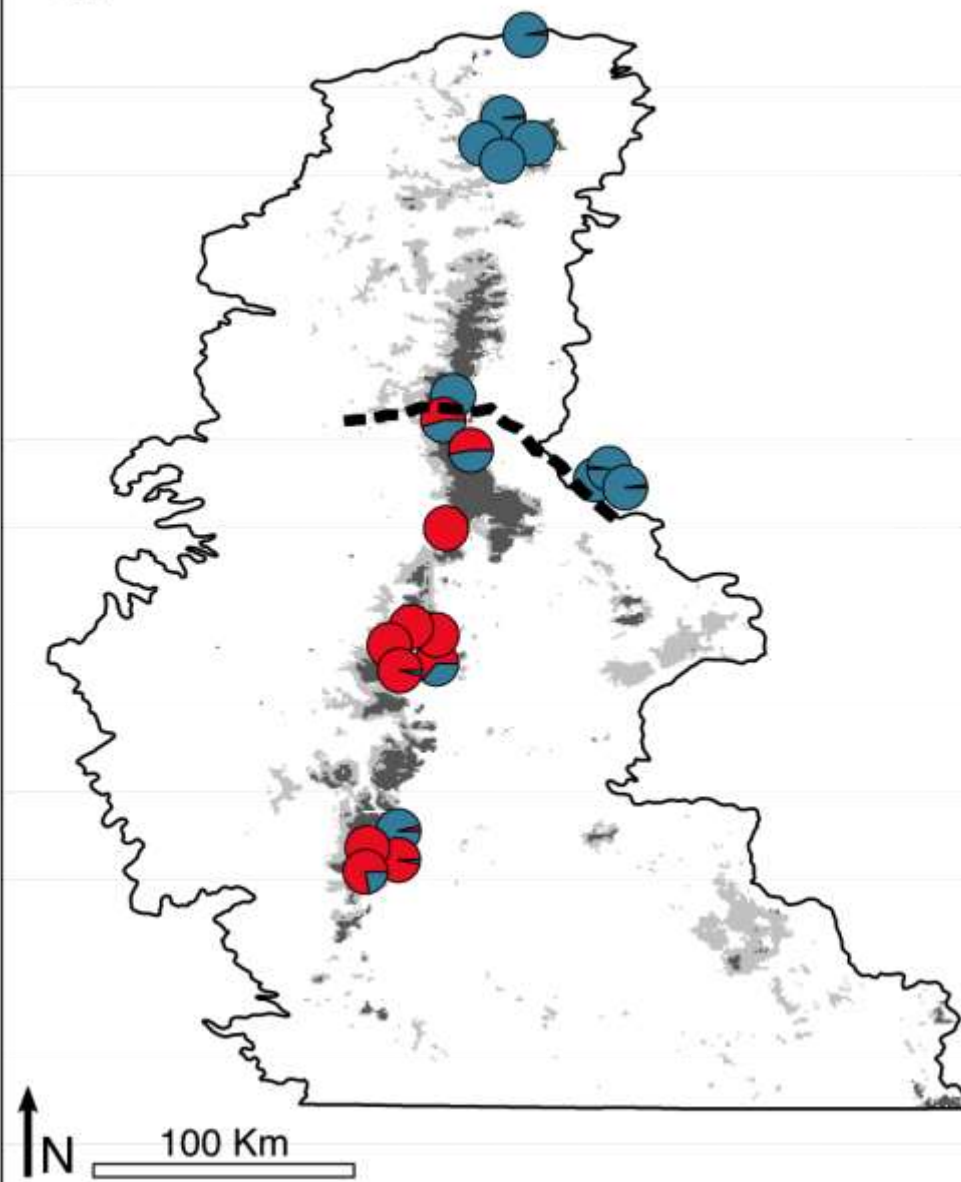


Photo by J. Power

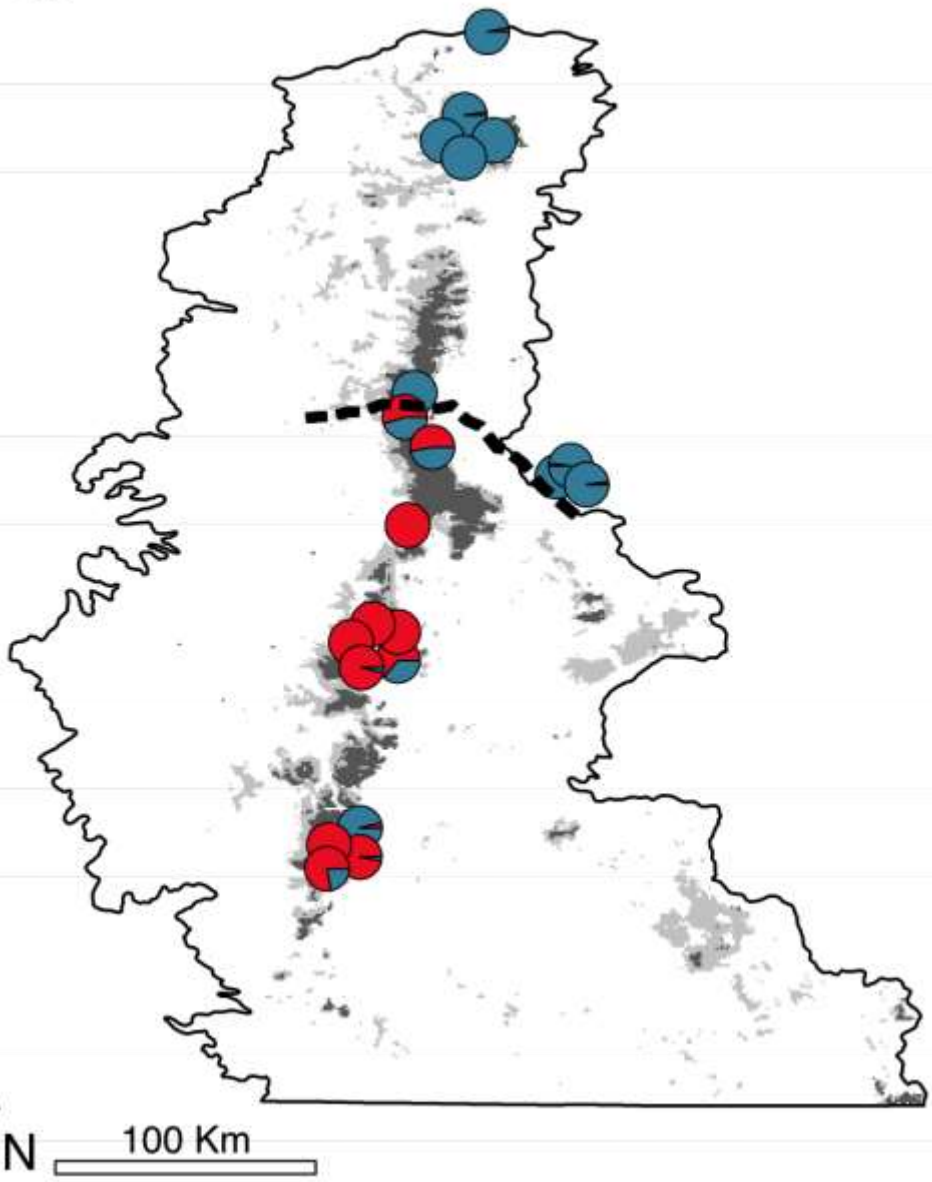
[cbquinn@ucdavis.edu](mailto:cbquinn@ucdavis.edu)



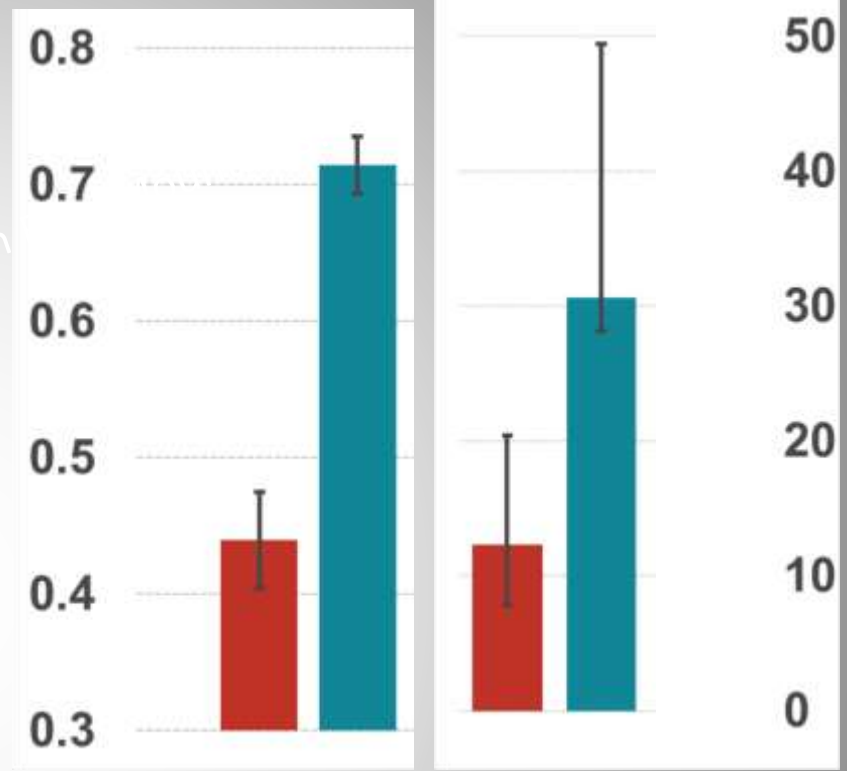
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a.



### Measures of genetic diversity



Heterozygosity

Ne