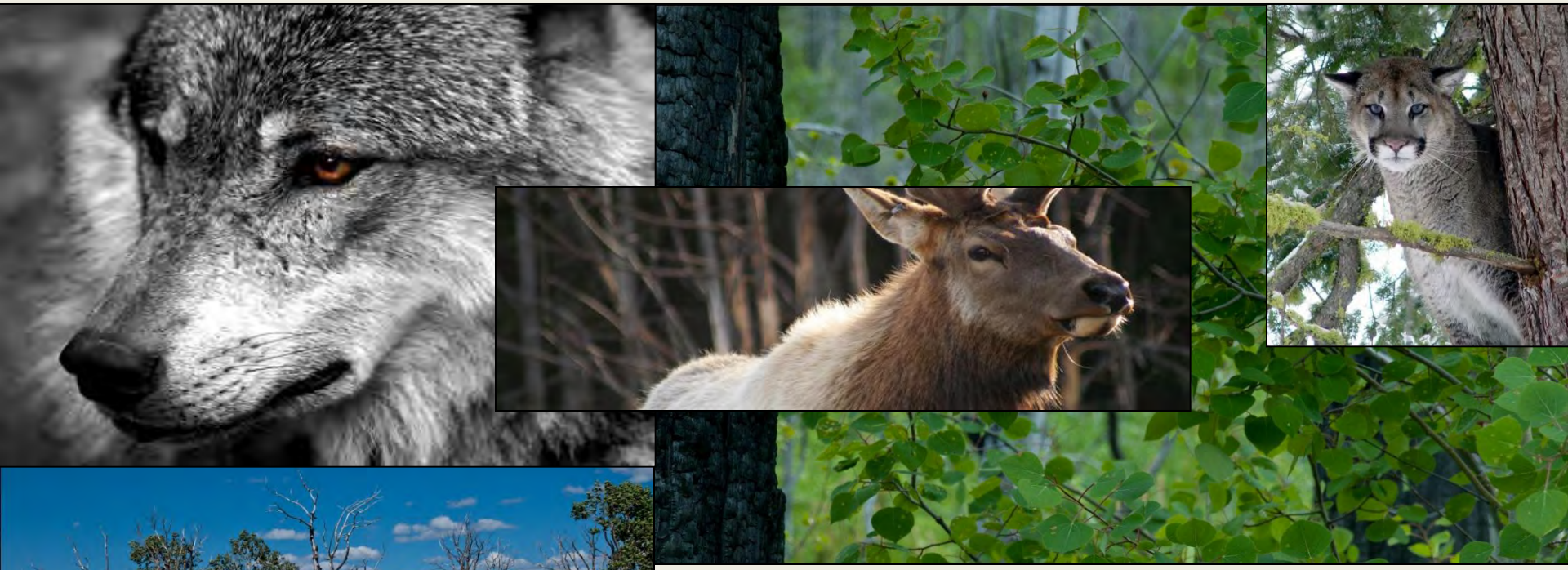
How predators influence communities: Fire, wolves, elk and aspen trophic cascades, case studies from the Rocky Mountains



Cristina Eisenberg
David E. Hibbs
Oregon State University

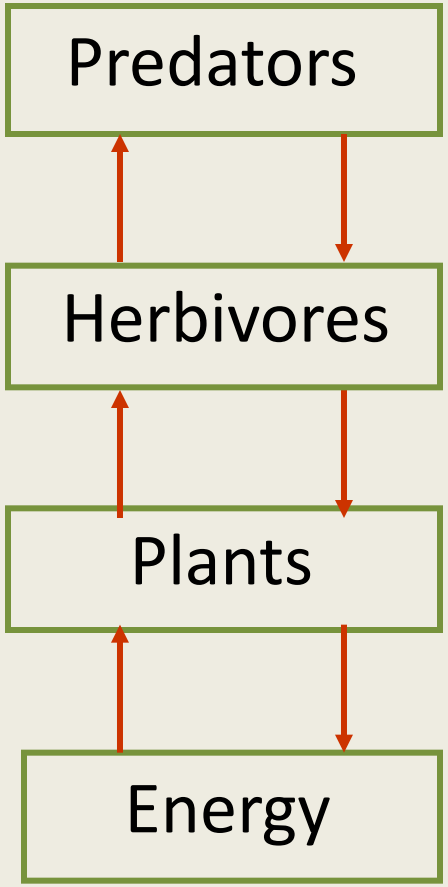
ESA
97th Annual Meeting
Portland, OR
August 8, 2012

Overview

- Food web theory: Top-down and bottom-up effects
- Glacier National Park, Montana: Context dependence of trophic cascades
- High Lonesome Ranch, Colorado: Restoring ecological resilience on the Colorado Plateau

Food Web Theory: Trophic Cascades

Energy from sunlight and disturbance controls plant growth, and this influences herbivore and predator abundance.



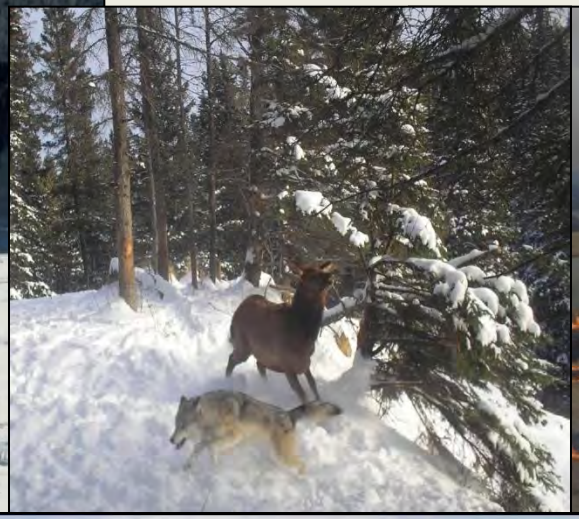
Predators control herbivore numbers and this influences herbivory and energy cycling—a trophic cascade.

Community structure is shaped from the bottom-up and from the top-down

Hairston et al. 1960; Murdoch 1966; Polis 1994

Will wolves have an effect on ecological communities?

If so, how might context influence wolf effects?



Trophic Cascades: A Conceptual Model

Aspen → Elk → Wolves

Elk → Aspen

Wolves → Elk

Macro-Environment → Aspen

Disturbance → Aspen

Elton 1927; Leopold 1943; Menge 1995; Power 1991; Ripple and Beschta 2007

Lavigne 1995

Complexity of Food Webs in a Large Mammal System

Cristina Eisenberg and David E. Hibbs

To examine the relative influence of top-down and bottom-up factors and the context-dependence of these relationships in a wolf→elk→aspen tri-trophic system

Three ecologically similar valleys:

All have similar climate, soils, and plant communities.

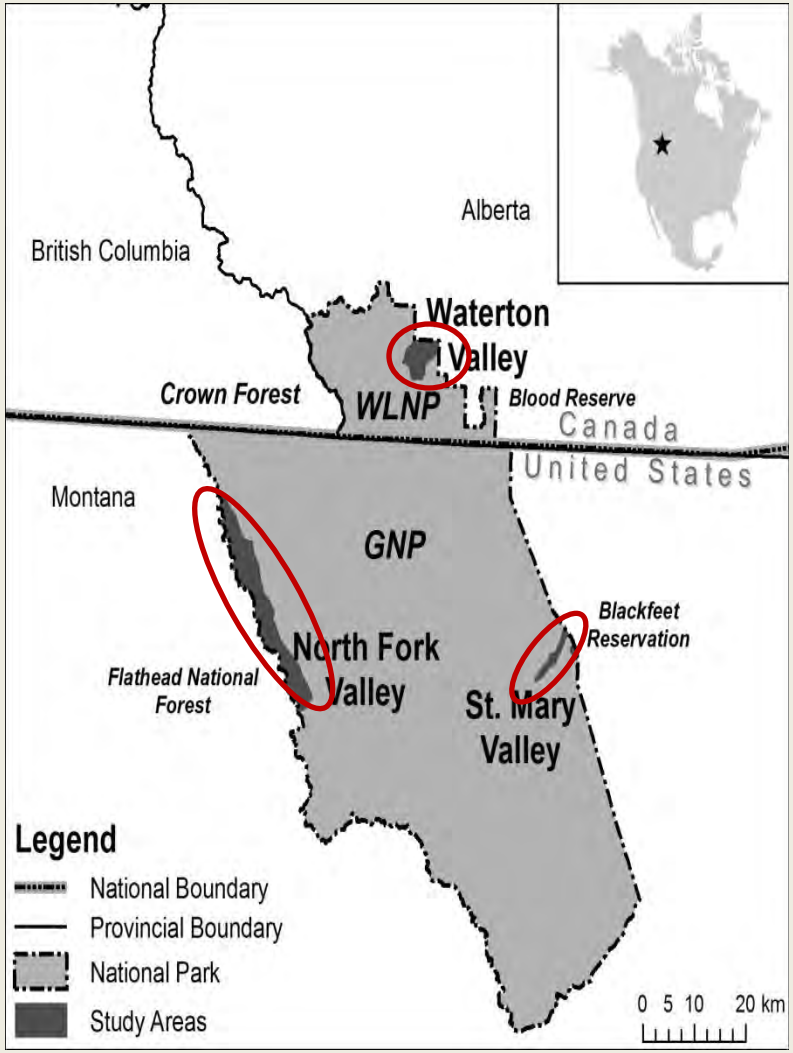
Foothills-parkland ecoregion, characterized by grasslands with patches of aspen.

All are elk winter range.

Saint Mary Valley
Low wolf population
Unburned sites only

Waterton Valley
Moderate wolf population
Unburned sites only

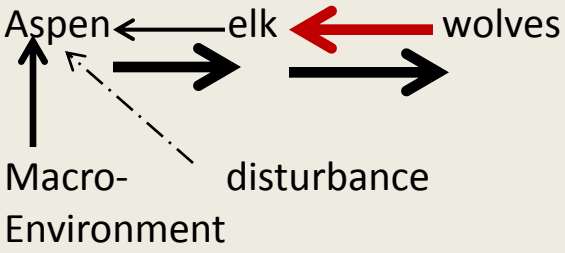
North Fork Valley
High wolf population
Burned and unburned sites



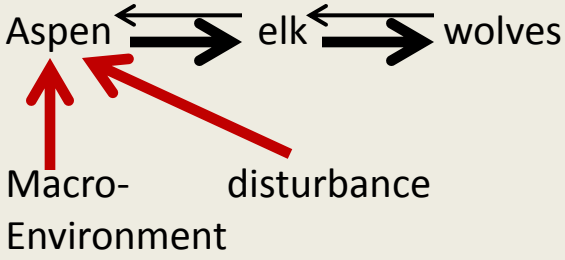
Study Site

All elk winter range in Waterton Lakes National Park, AB, and Glacier National Park, MT, where livestock herbivory is not present

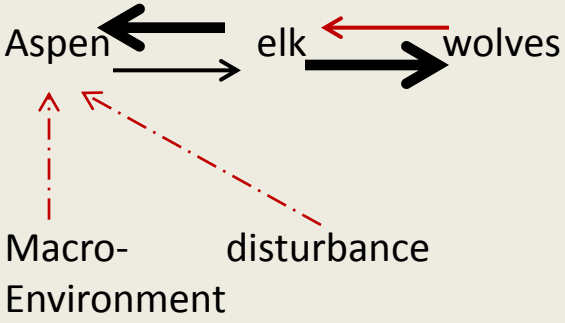
Conceptual Model: Three Cases



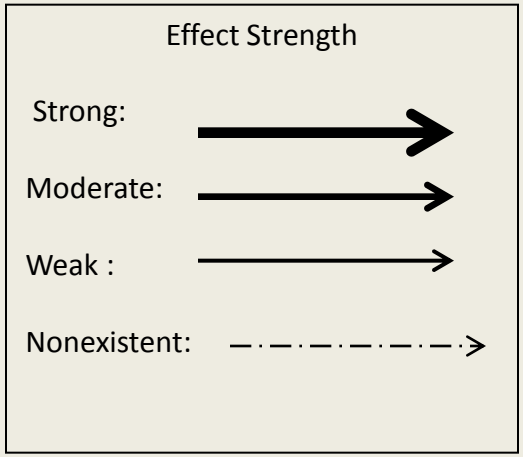
Top-Down Effects



Bottom-up Effects

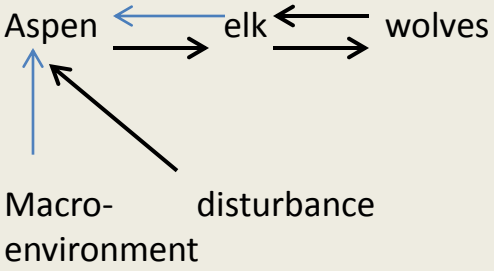


Trophic Trickles

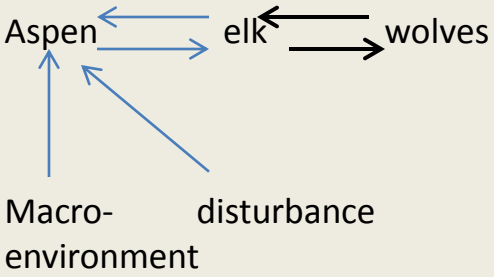


Overview of Data Types and Analysis Tools

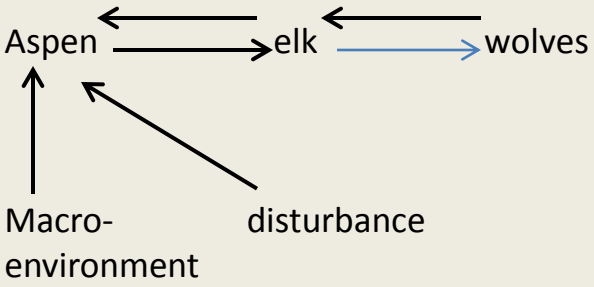
Elk Resource Selection
Pellet Transects



Elk and Wolf Interactions
Focal Animal Observations



Trophic Cascades
Aspen Demography



Analysis Tools:
Information theoretic approach (AIC); Model-fitting (GLM); ANOVA

Methods: Pellet Transects

Objective: To measure the relationship between predation risk perceived by elk and elk resource selection in winter range.

transects 50 × 2 m^2

Saint Mary *n*=741

Waterton *n*=2079

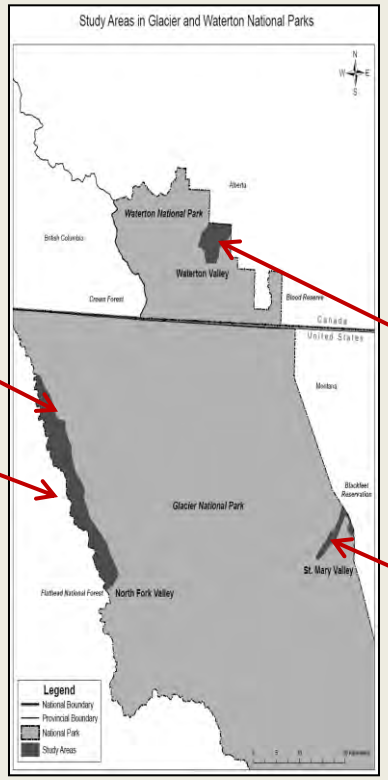
North Fork *n*=1820

Data:
ungulate pellet piles
large carnivore scats

Elk Density

North Fork:
9 elk km^2
high wolf
population

North Fork (fire):
8 elk km^2
high wolf population



4-10/km^2 = high elk density
YNP, post wolf recovery elk densities = 6-13/km^2 in 2000.

White et al. 2003; White et al. 2012

Waterton:
24 elk km^2
moderate wolf population

Saint Mary:
21 elk km^2
low wolf population

Methods: Focal Animal Observations

Objective: to examine the relationship between predation risk perceived by elk, as evidenced by elk vigilance behavior, and the context for this relationship.

Focal sampling:

Observing a single individual continuously for a specified period of time

3-20 minutes in length

Measured time spent head up, scanning, vs. head down, eating

Stratified evenly by social class:

bull, spike bull, cow, cow with calf

North Fork *n*=166

Waterton *n*=321

Saint Mary *n*=217

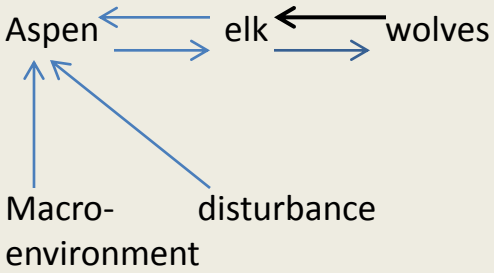
Methods: Analysis, General Linear Mixed Model (GLM)

Objective: to examine the relationship between predation risk perceived by elk, as evidenced by elk vigilance behavior, and the context for this relationship.

General Linear Model to describe the mean proportion of elk vigilance

Vigilance = Forest + Group + Road + Social + Impediments
+ Group Impediments

Forest	distance to forest edge
Group	group size
Road	distance to road,
Social	social class (adult bull, spike bull, adult cow, adult cow with calf)
Impediments	risk, 1(low), 2 (moderate), 3 (high)



Results: GLM

Valley	Variable	Effect	*p*-value
Saint Mary		No significant effects	
Waterton	Group	-	<0.00001
	Impediments	+	0.0005
North Fork	Group	+	0.03
	Social Class	Bull>others	0.02
	Group × Impediments	+/-	0.03

Methods: Aspen Demography

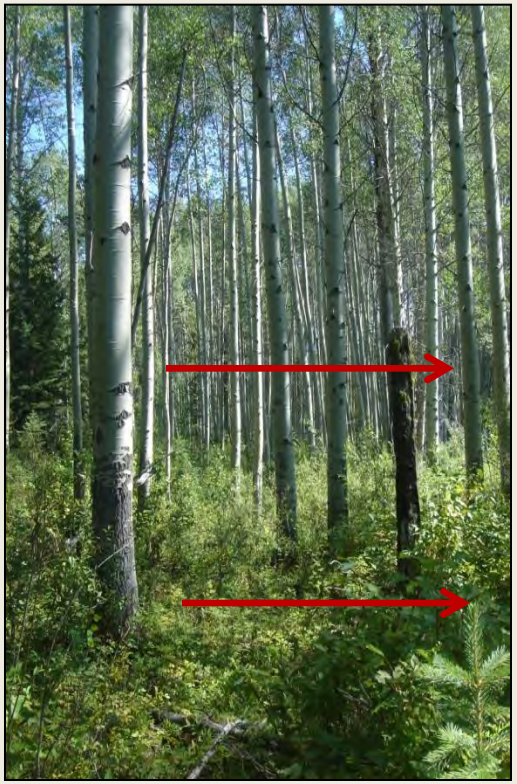
Response variable: **browse**

Top-down effects:

- **Browse by stand size**
- **Browse by plot position**

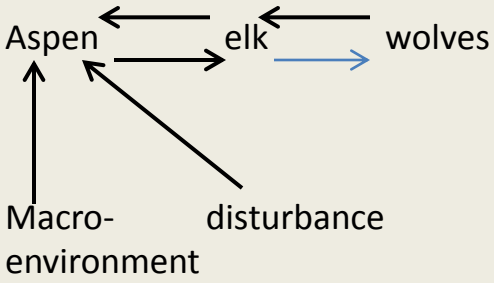
Bottom-up effects:

- **Moisture**
- **Fire**
- **Heat load**
  - slope
  - folded aspect
  - latitude



2.5 m

1m

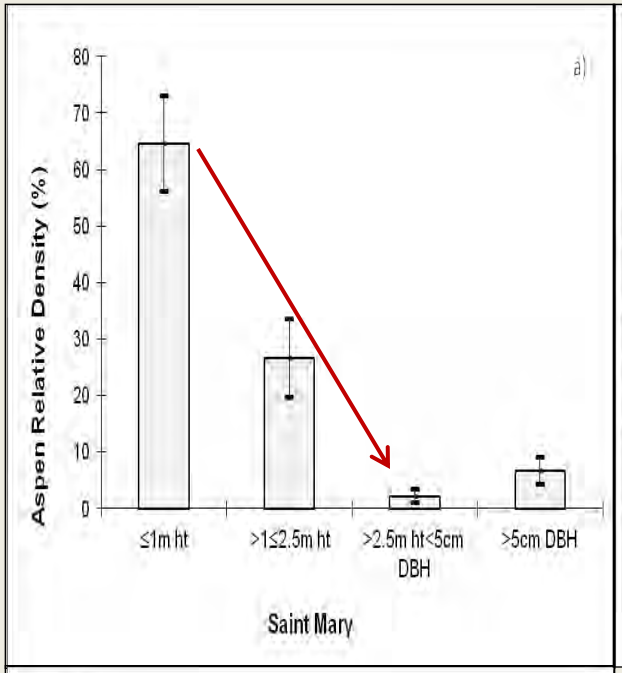


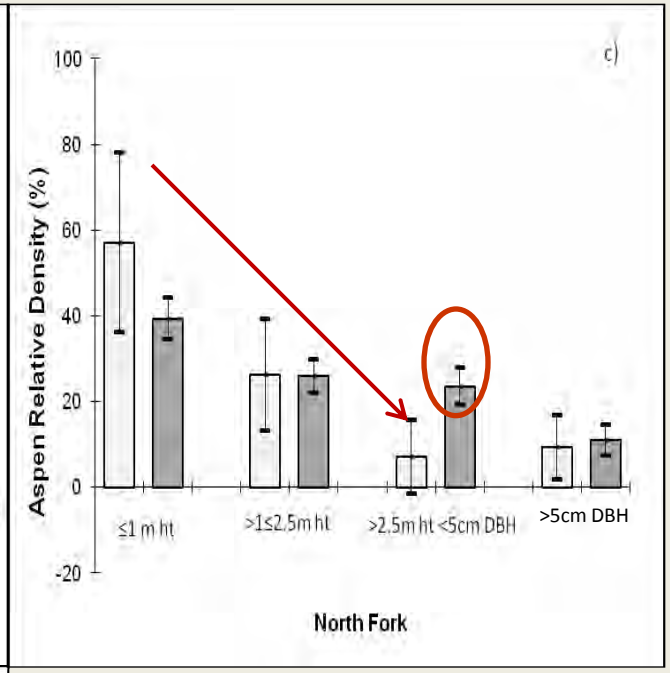
North Fork, No fire, wolf den

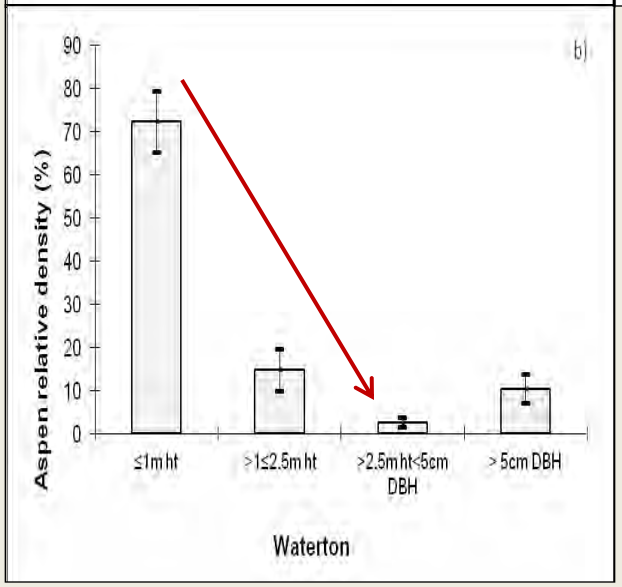
North Fork, fire, wolf den

Romme et al. 1995; McCune and Keon 2002; Ripple and Beschta 2007; Halofsky and Ripple 2008

Results: Aspen Demography



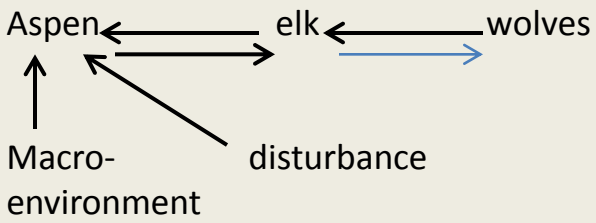




Aspen density by size class in three Valleys.

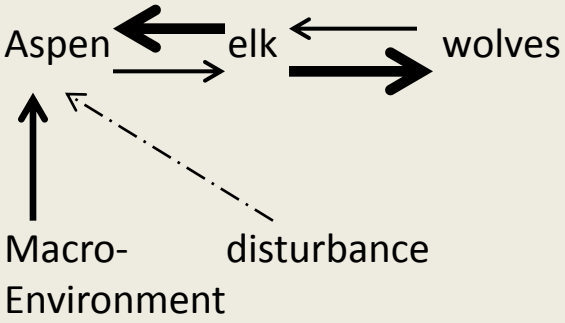
Light gray histogram bars represent aspen stands with no fire.

Dark gray histogram bars represent North Fork aspen stands with fire.

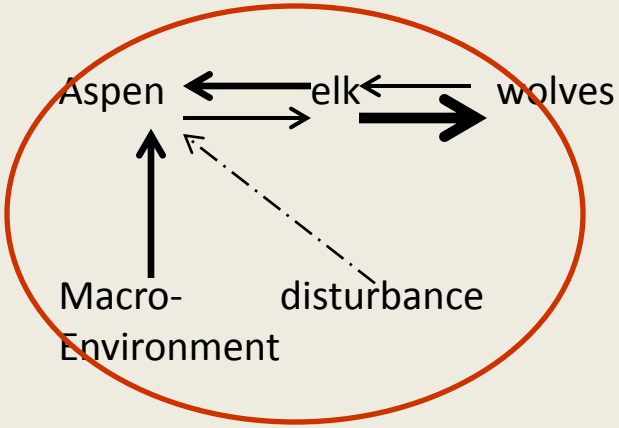


Error bars represent 95% confidence intervals.

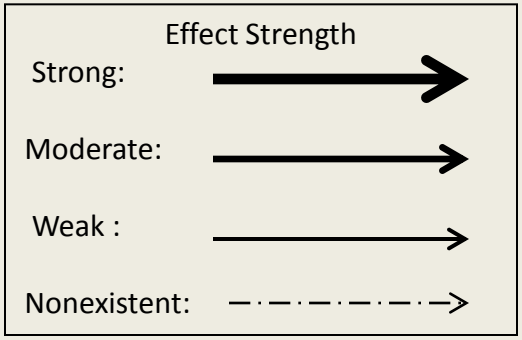
Synthesis: Conceptual Models



Saint Mary

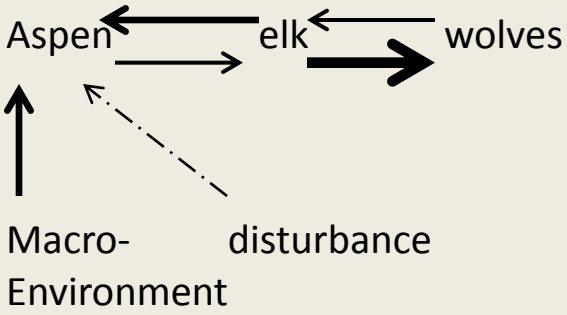


North Fork

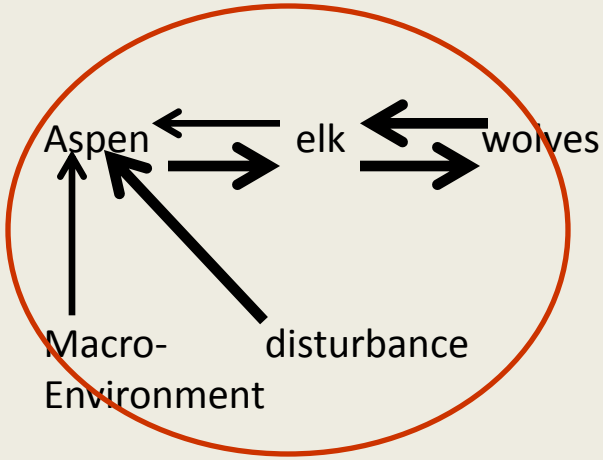


How quantified:
Aspen = recruitment
Elk = herbivory
Wolves = wolf density

A trophic trickle?



Waterton

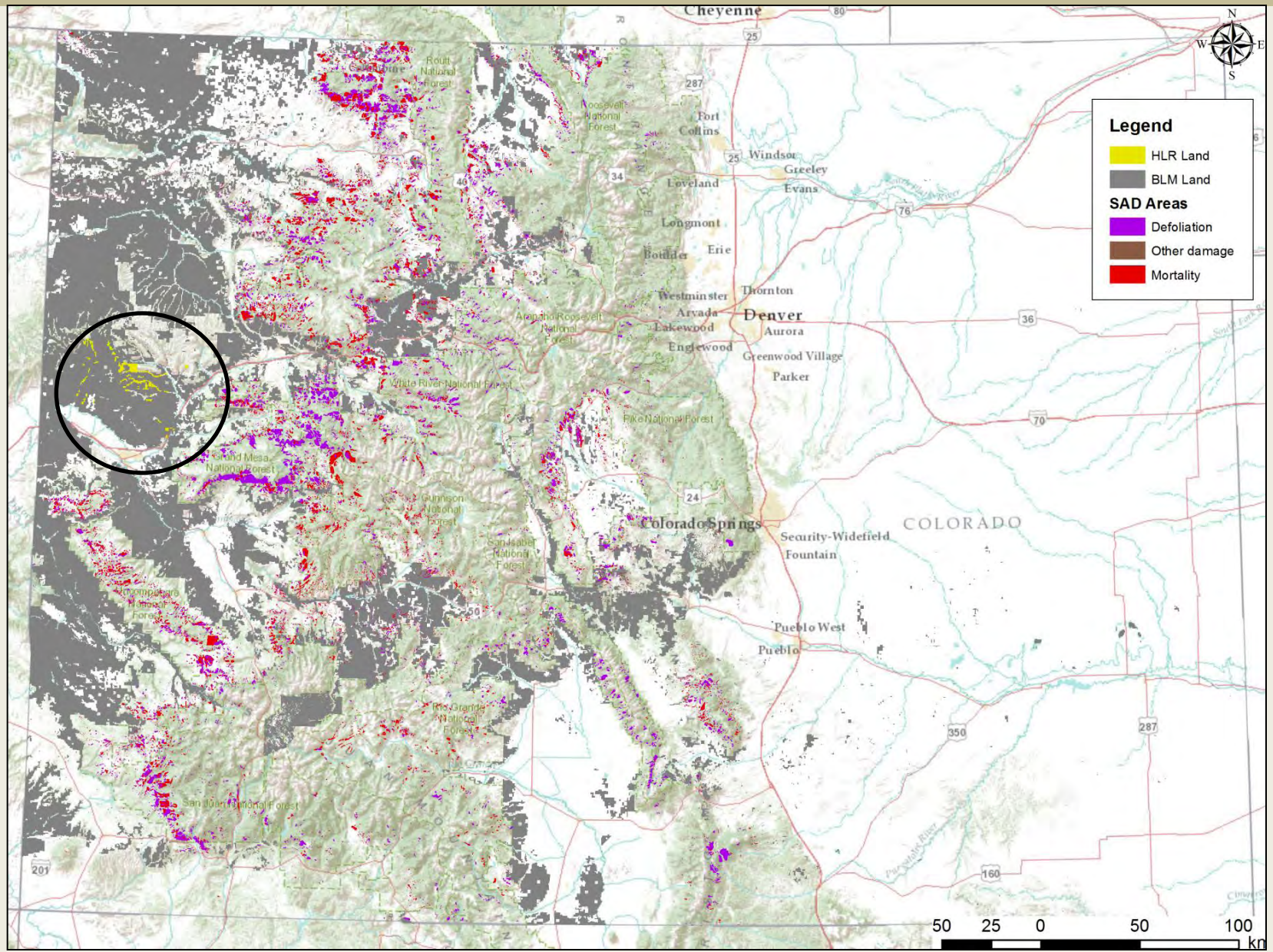


North Fork (Fire)

Colorado Plateau: HLR Aspen Trophic Cascades Research and Ecological Restoration Program

Colorado with BLM, USFS, and HLR Land

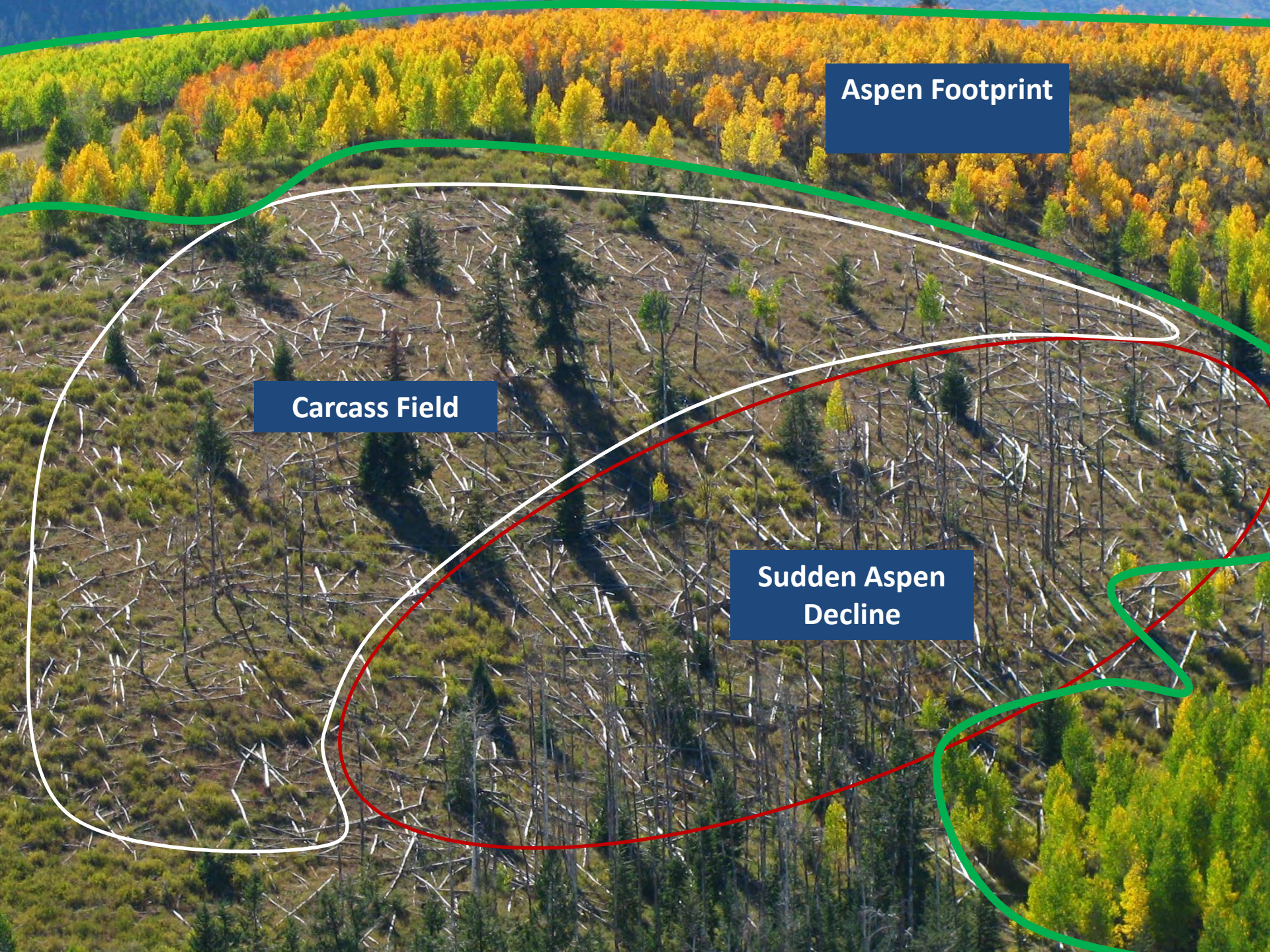
(SAD, Defoliation, and Damage data only on USFS land)



Wolf Dispersal to the Colorado Plateau

Aspen Restoration Strategy

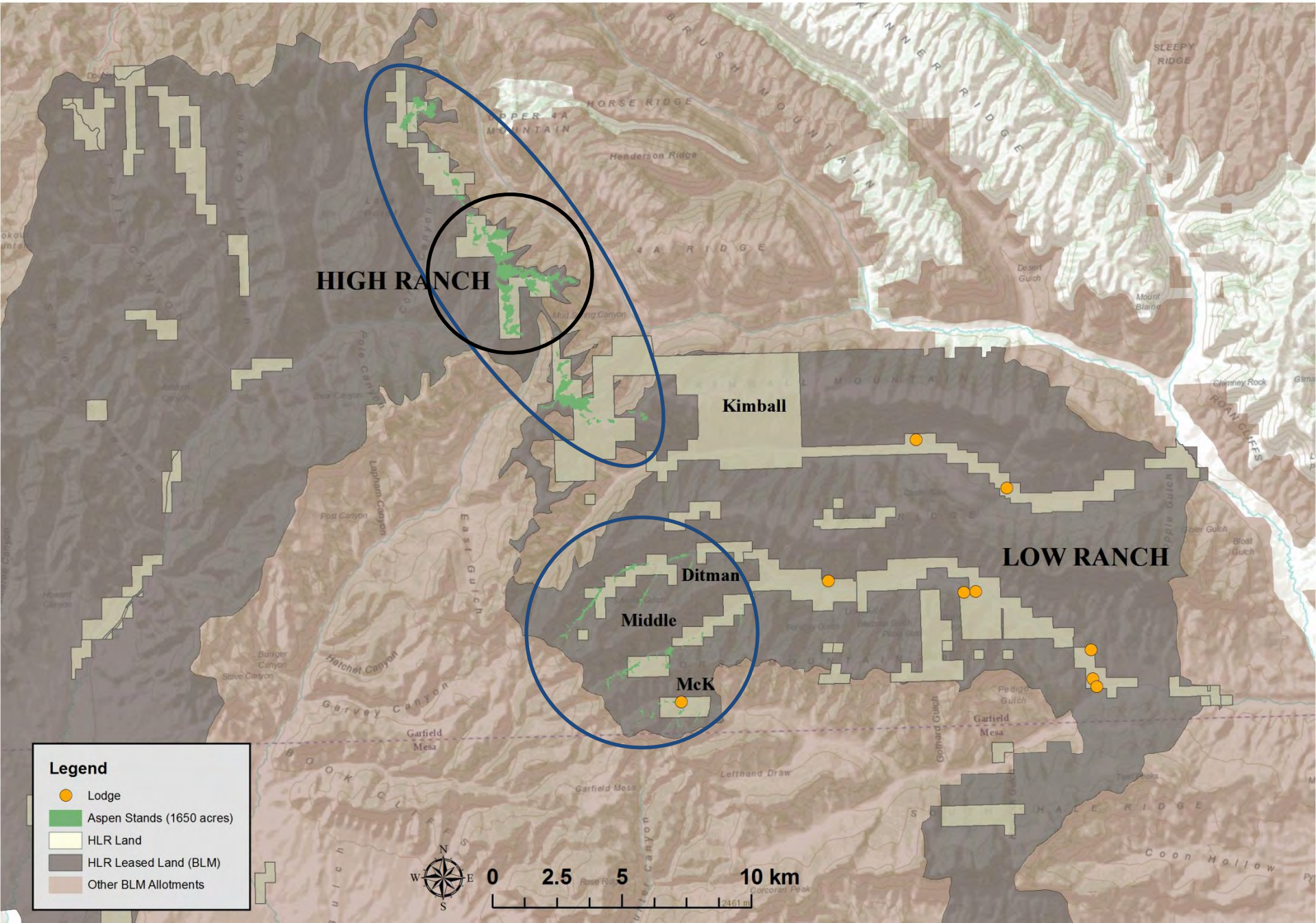
- Identify stands in crisis (% decline)
- Identify areas to maintain connectivity
- Test options (coppicing, exclosures, fire)
- Restore multi-trophic processes, e.g., predation
- Evaluate effects of cattle herbivory


Aspen Footprint
Carcass Field
Sudden Aspen Decline

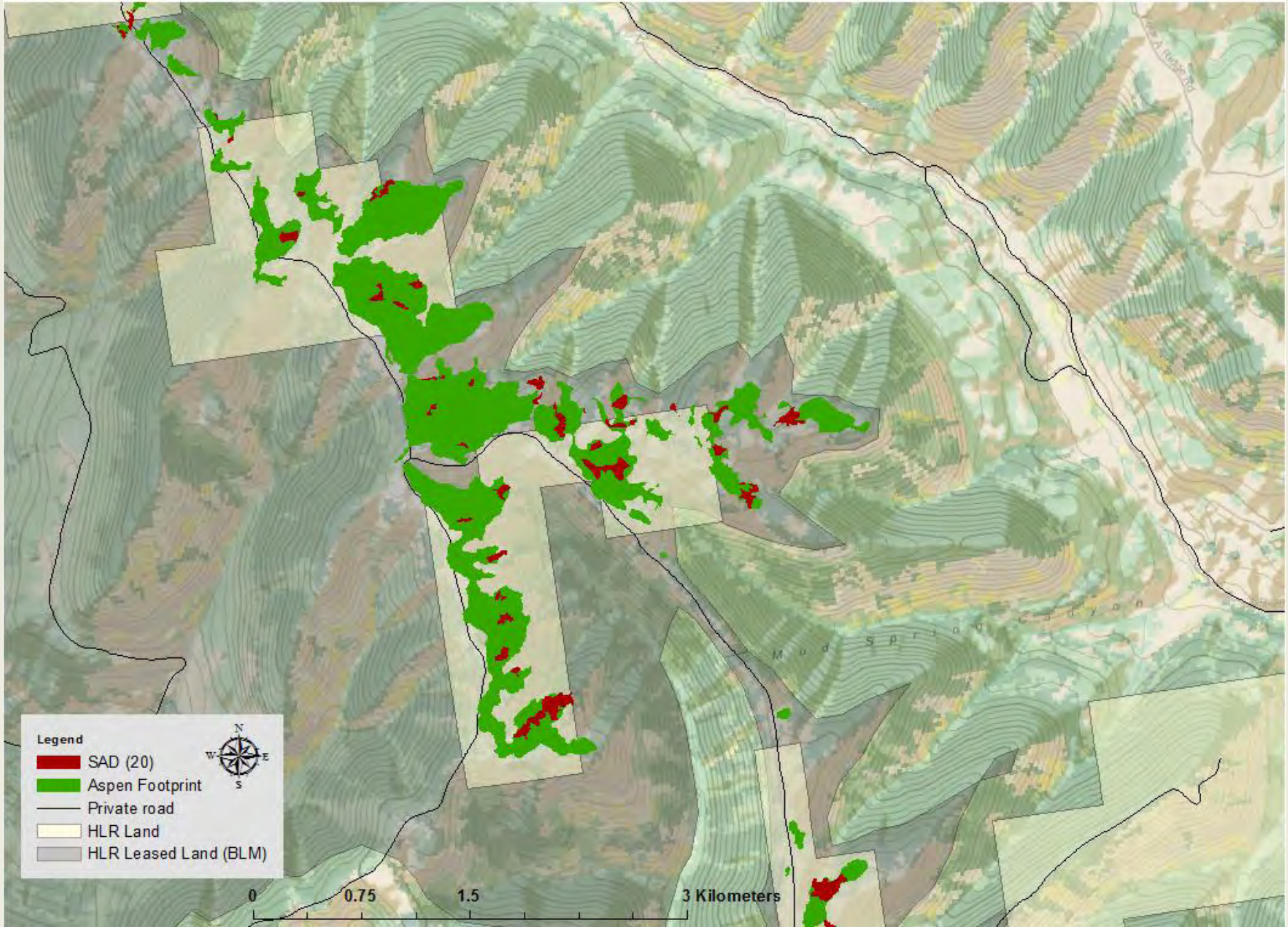
HLR Aspen Treatments

Location	Treatment # 1	Treatment # 2	Treatment #3	No Treatment
High Ranch (2 replicates)	Exclosure	Clear-cut Coppicing + jackstraw (CWD)	Clear-cut Coppicing + slash pile fence	Control
Low Ranch (2 replicates)	Exclosure	Clear-cut Coppicing + jackstraw (CWD)	Clear-cut Coppicing + slash pile fence	Control

High Lonesome Ranch



HLR & BLM Land - High Ranch Aspen Stand Boundaries



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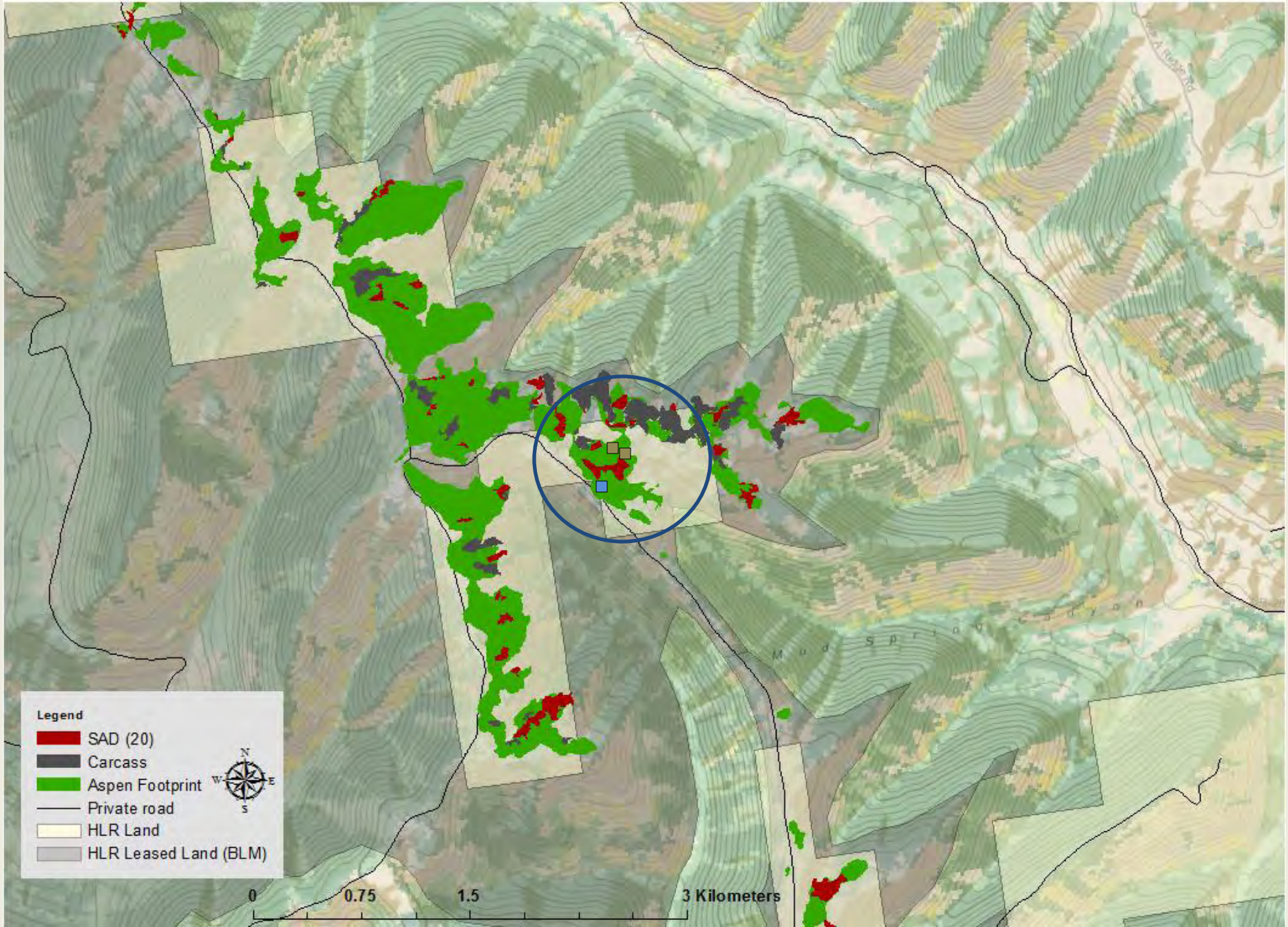

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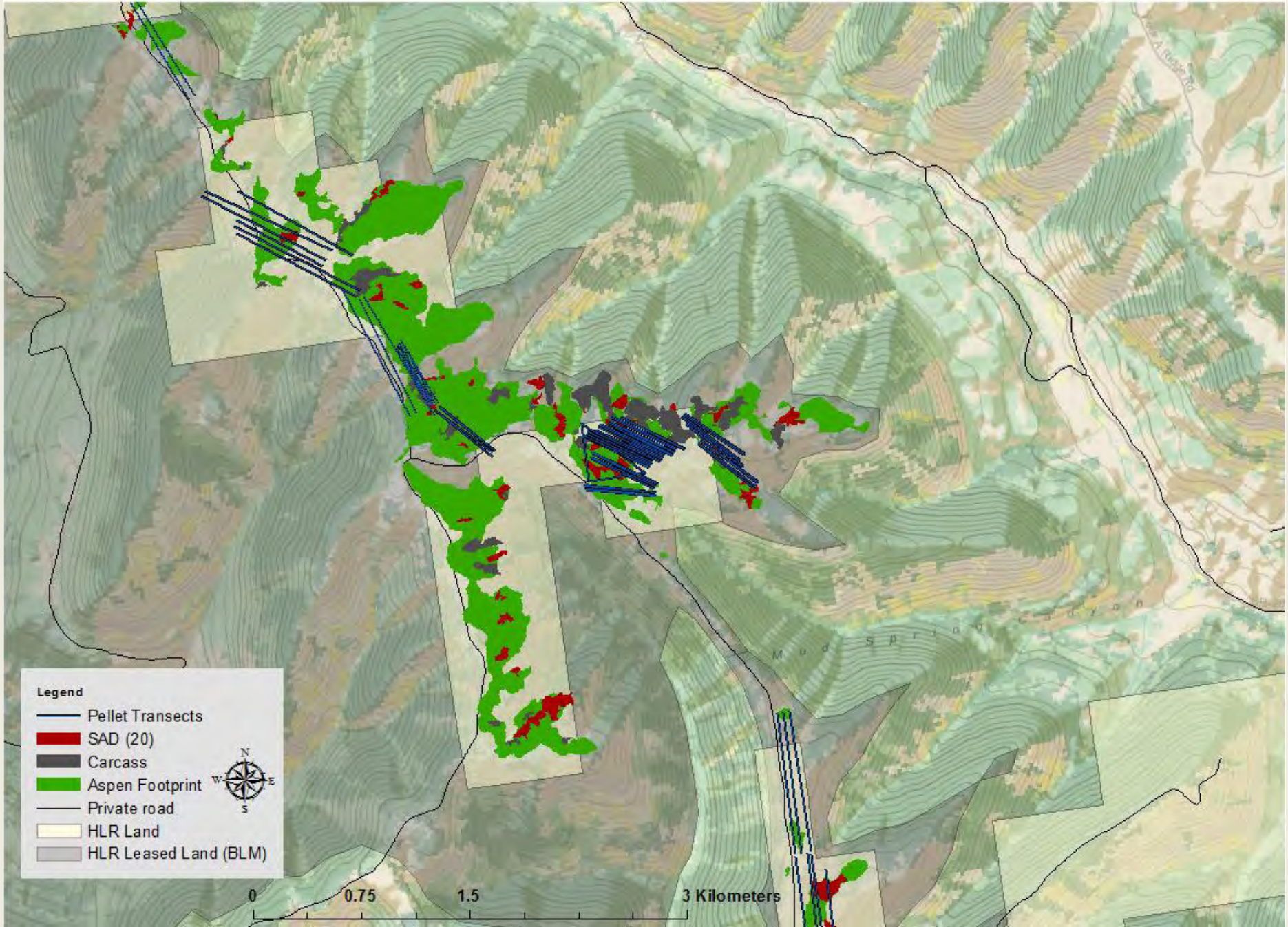
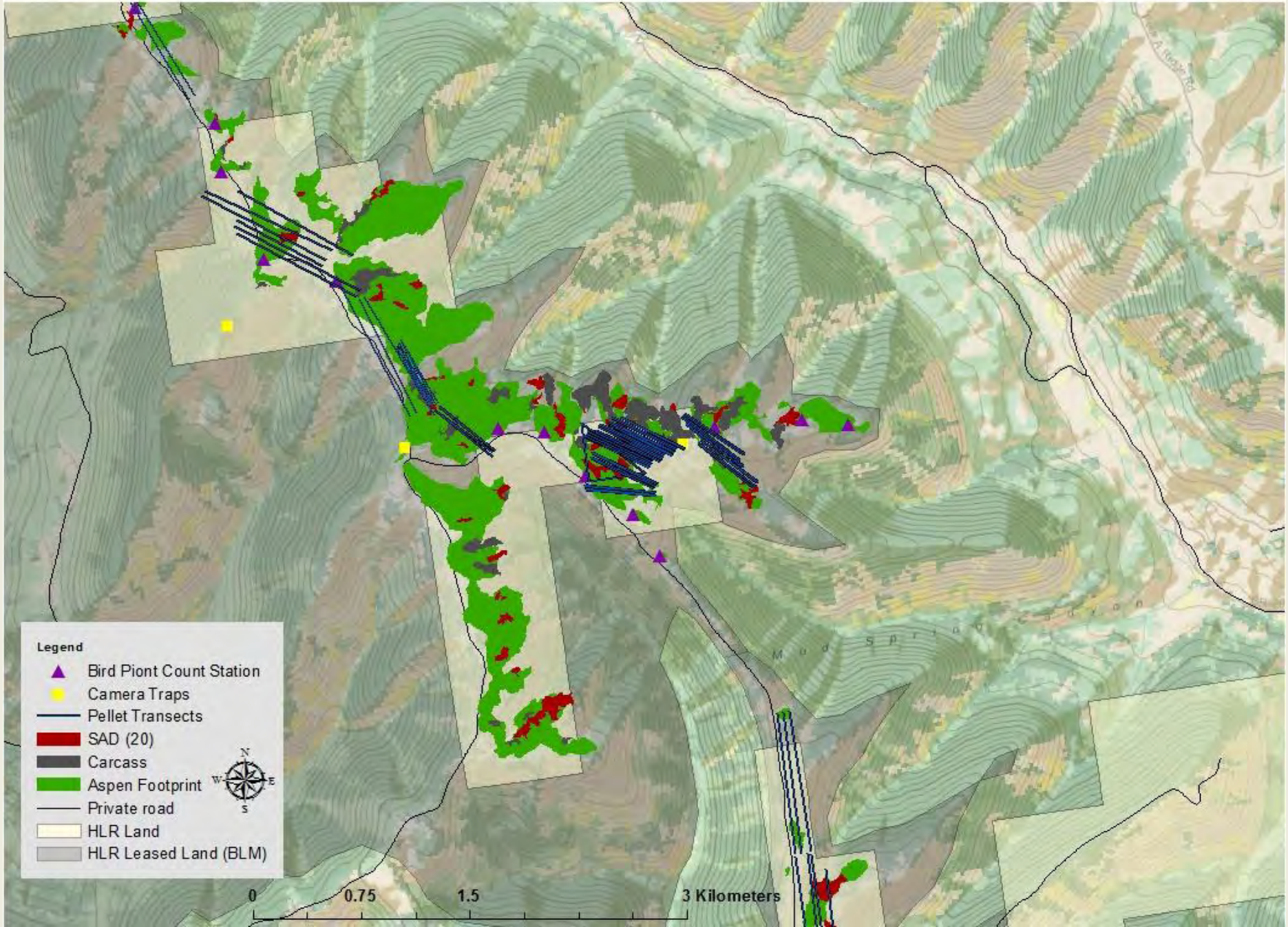
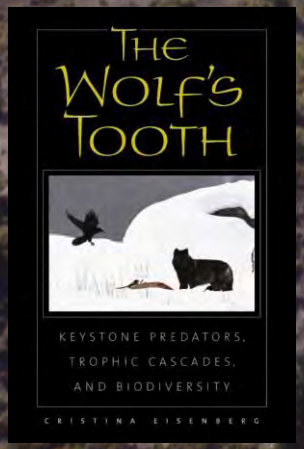


HLR & BLM Land - High Ranch Aspen Stand Boundaries



Questions?



ISLANDPRESS

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www.thehighlonesomeranch.com