Where to Look for Invasive Plants Following Prescribed Fire in Black Hills NPS Units

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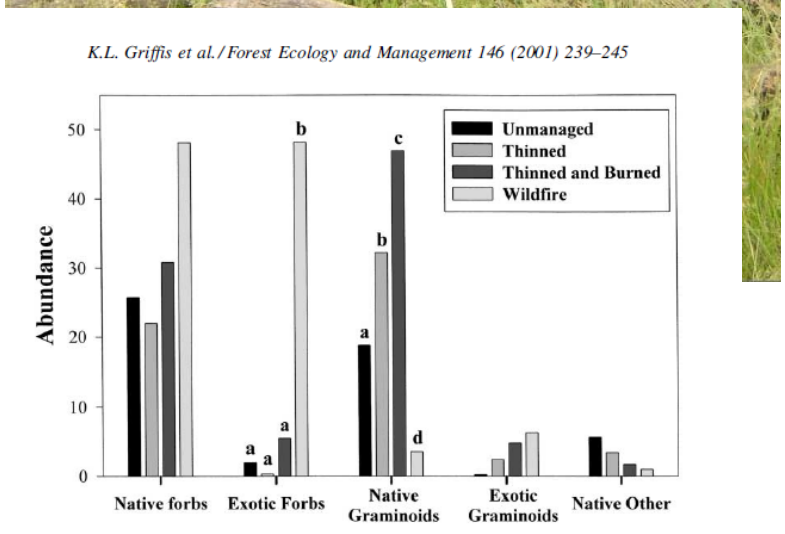
Rapid City, SD

U.S. Department of the Interior

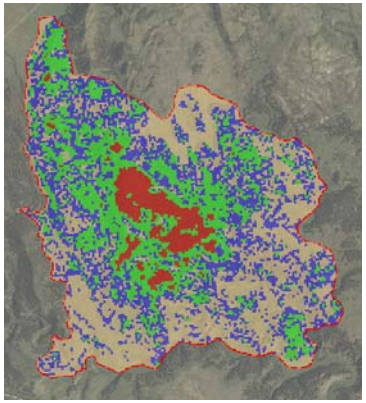
Context

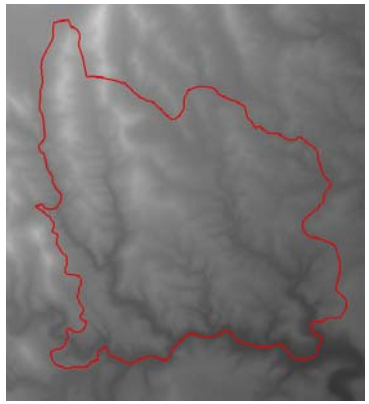
- Prescribed fire is an important part of natural resources management in the Black Hills.
- Parks are concerned about invasive plants following prescribed fire.

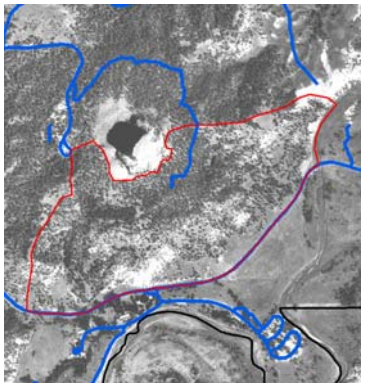


Questions

- How does prescribed fire in BH ponderosa pine forest affect the abundance of target invasive plant species in NPS units?
- Are there any environmental and/or fire characteristics that can be used to predict where these target invasives will be most abundant before and after fire?







Design

- three parks
  - Devils Tower National Monument (DETO)
  - Jewel Cave National Monument (JECA)
  - Wind Cave National Park (WICA)
- four burn units
  - Belle Fourche (DETO): 96 ha
  - Lithograph (JECA): 78 ha
  - Centennial (WICA) 159 ha
  - American Elk (WICA) 1152 ha

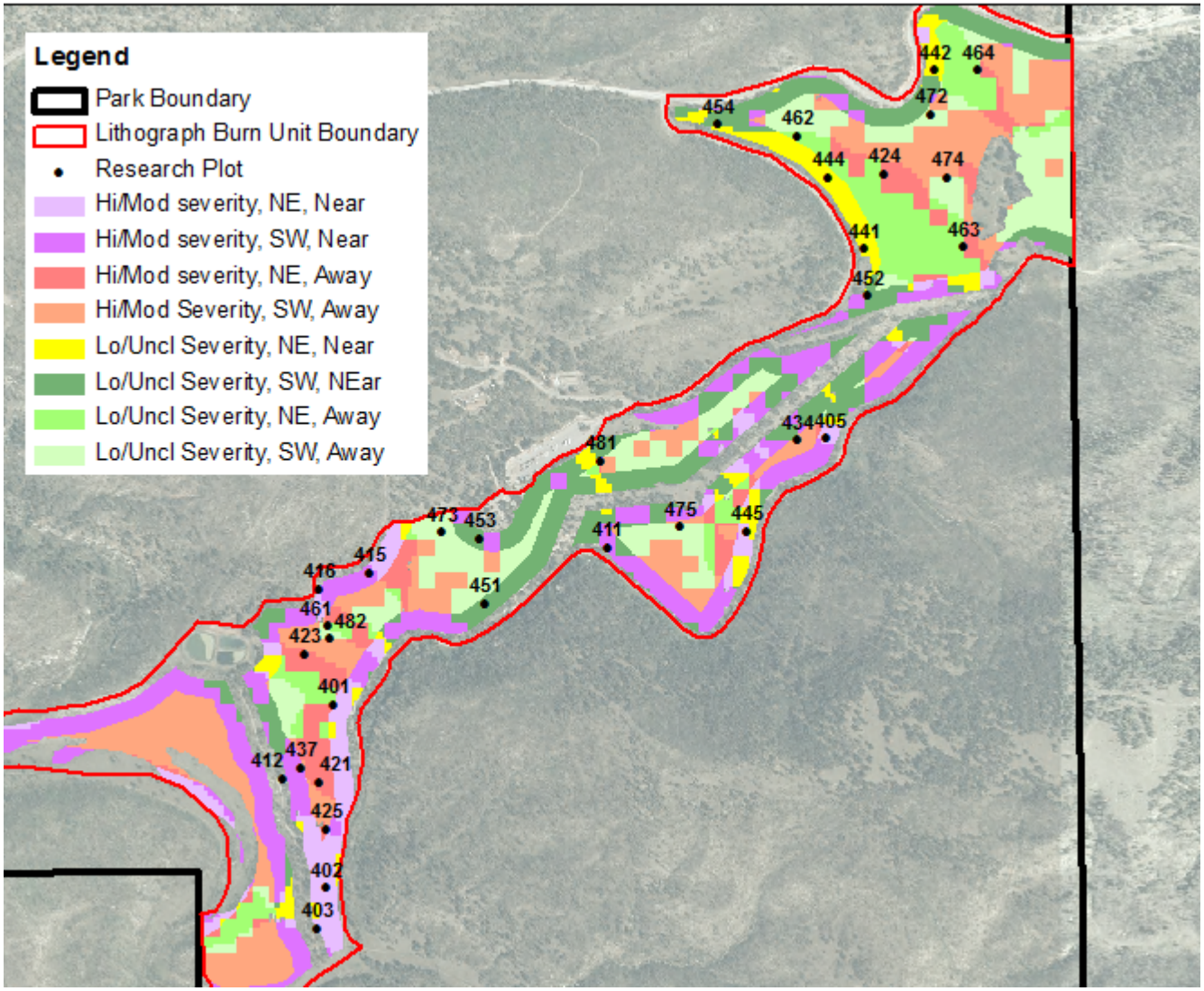
Design

- random sample locations stratified within each burn unit

Stratification Criterion	Burn Unit(s)
Vegetation type (usu. canopy density)	Belle Fourche, Centennial, American Elk
Slope aspect (NE vs. SW)	All
Soil	
clay vs. loam	Belle Fourche
slopes & ridges vs. valleys & terraces	Centennial, American Elk
Proximity to road (> vs. ≤ 50 m)	All
Jasper Fire Severity	Lithograph

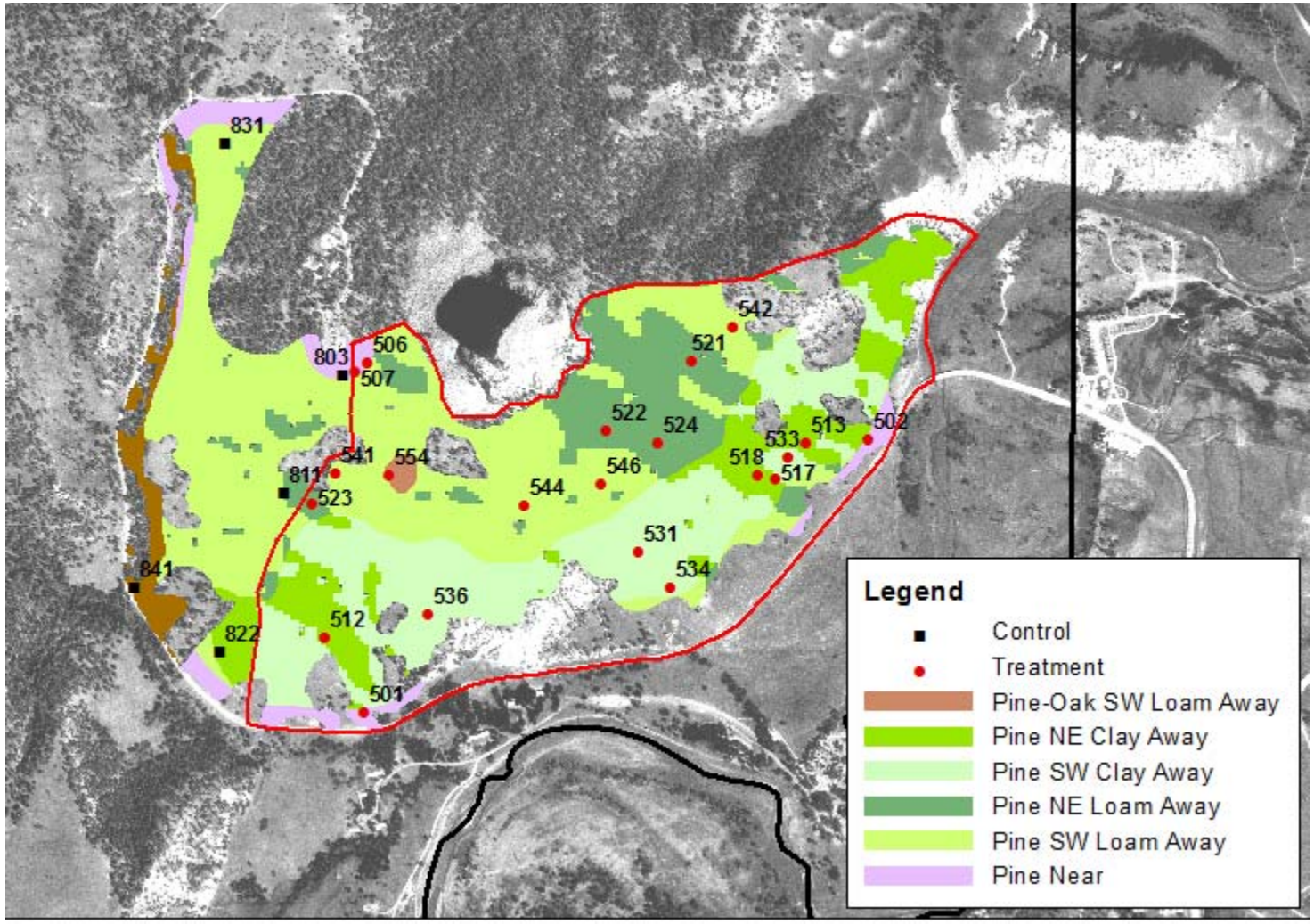
- goal of stratification is not to characterize abundance by factorial combination of all factors, but to get as wide a spread of conditions among plots

Design – Lithograph



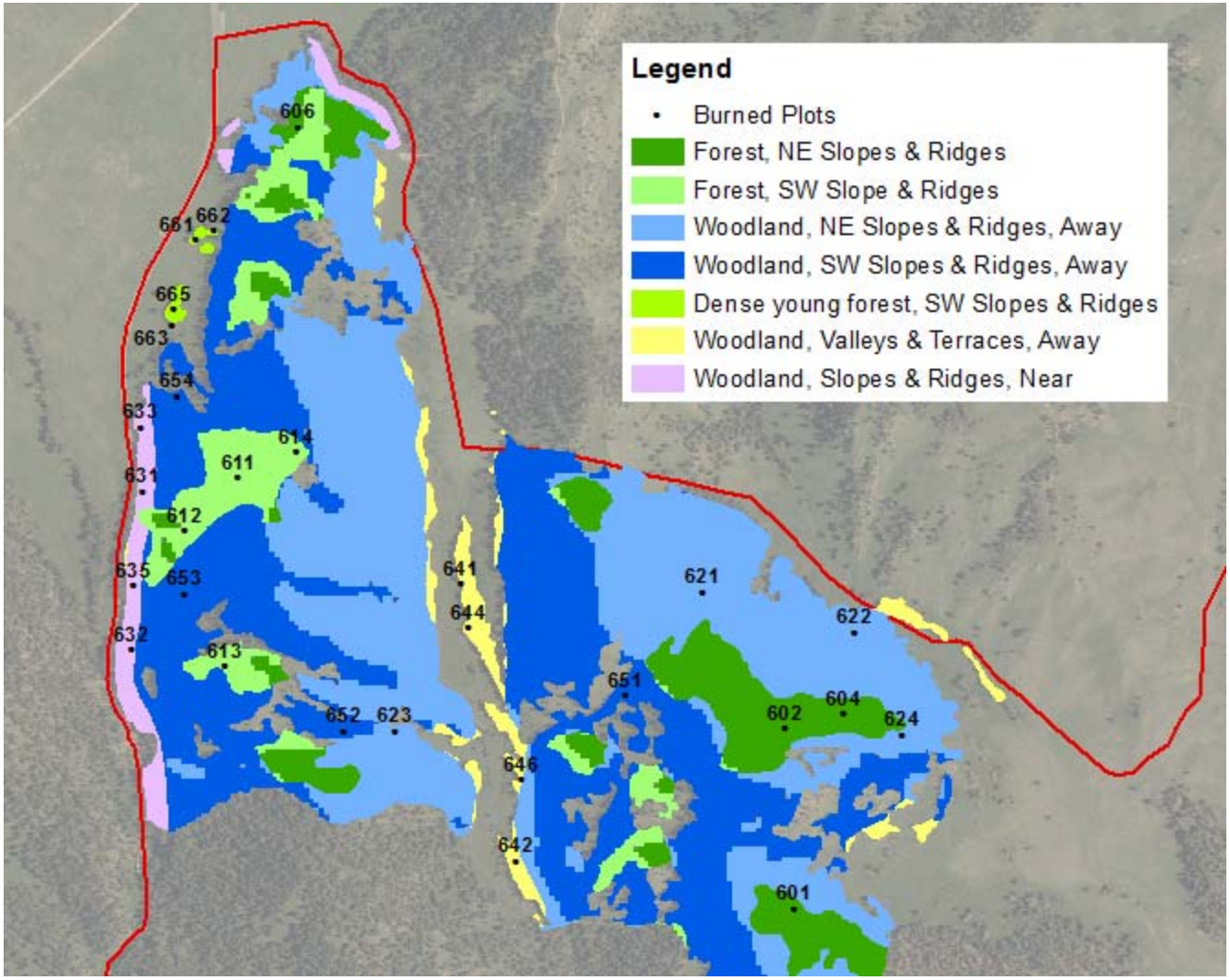
8 strata, 31 treatment plots, 1 control plot*

Design – Belle Fourche



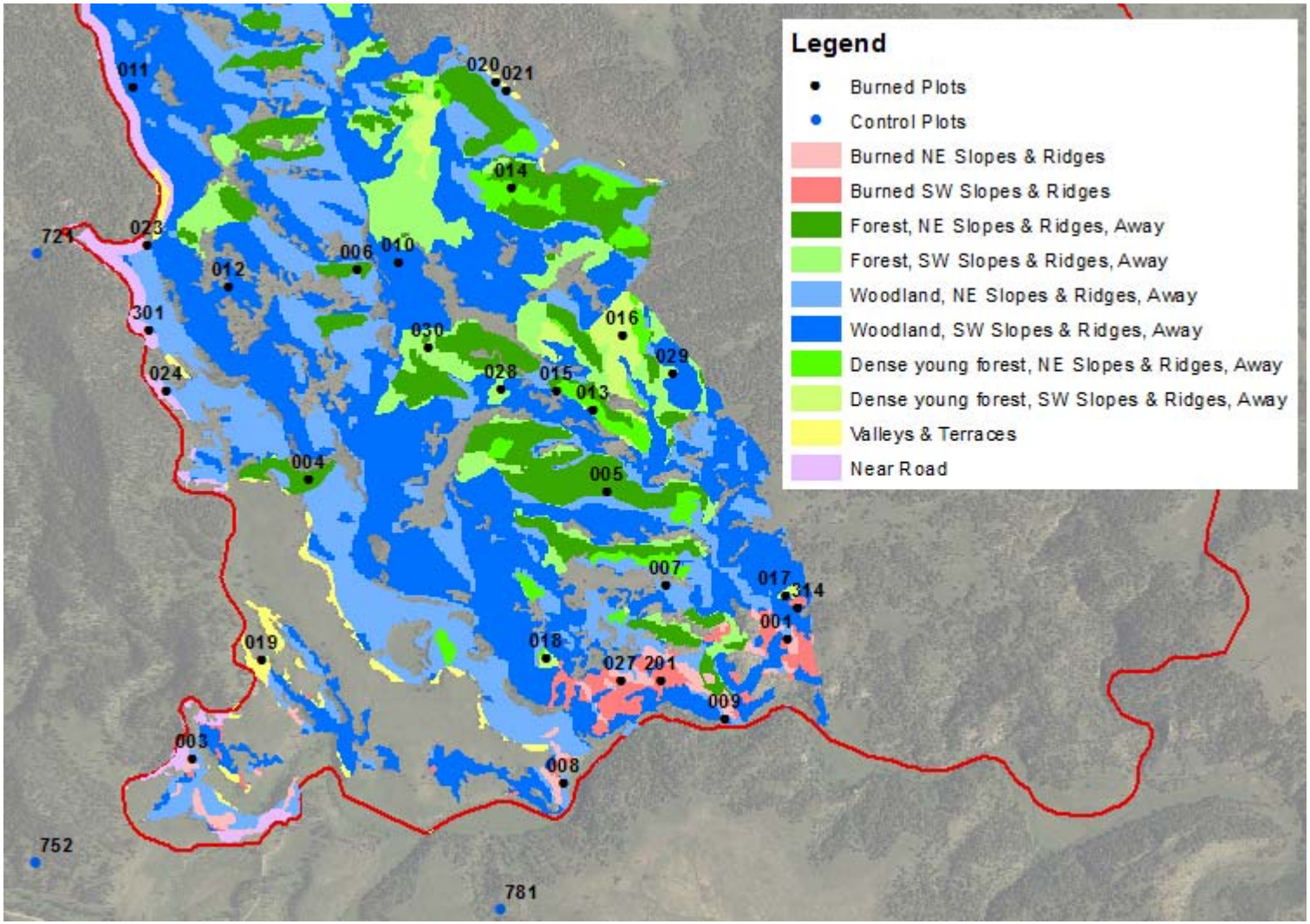
6 strata, 21 treatment plots, 5 control plots

Design – Centennial



7 strata, 28 treatment plots, 6 control plots#

Design – American Elk



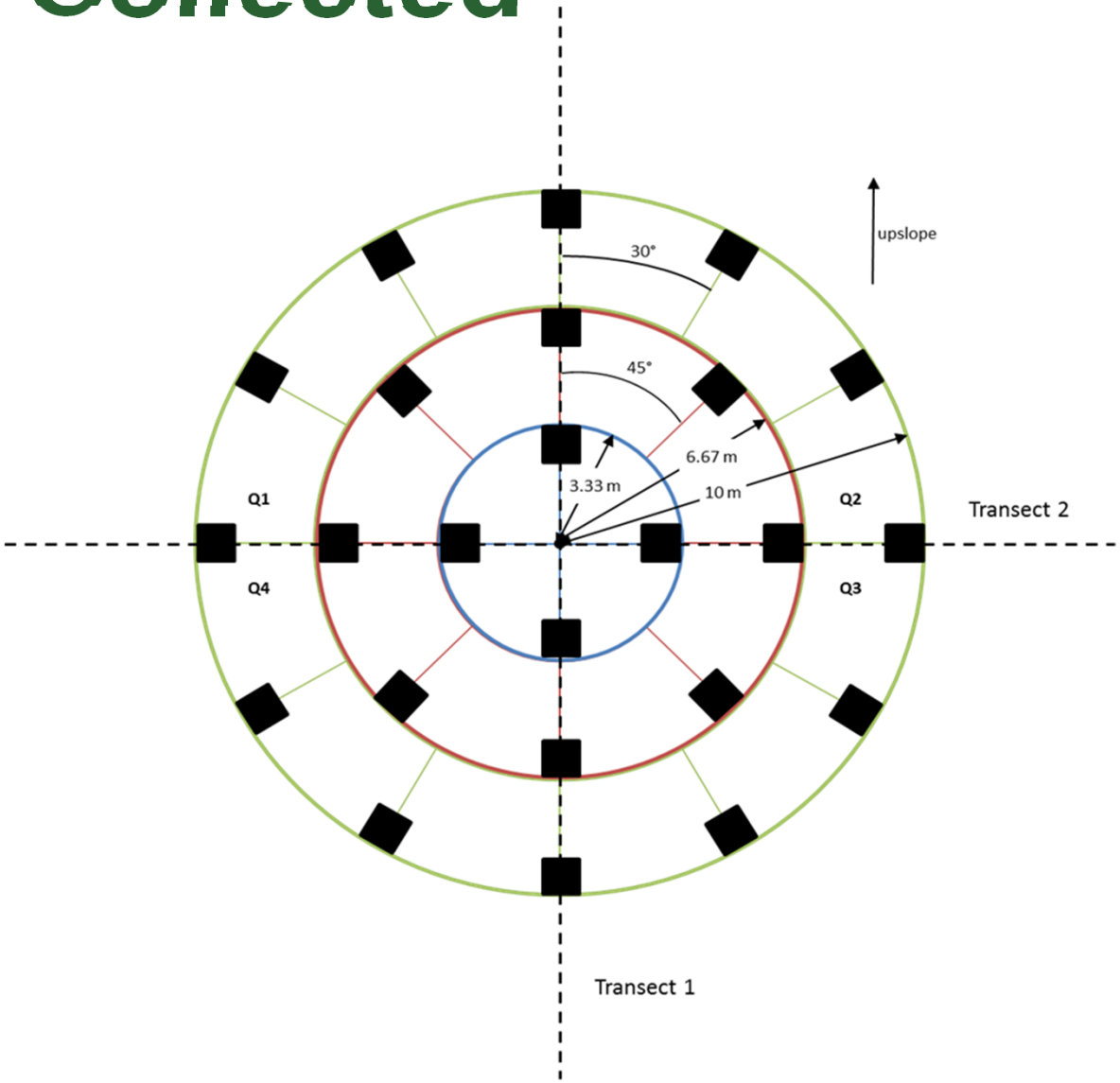
10 strata, 29 treatment plots, 6 control plots#

Data Collected

Environ. Predictor Variable	Type	Fire Predictor Variable	Type	Response Variable
Location (UTM X, Y)	N-Field	Burn severity	C-Field	annual brome
Elevation	N-Field	Fuel reduction	N-Field	Canada thistle
Slope grade, aspect	N-Field	Litter & Duff reduction	C-Field	houndstongue
Slope position	C-Field			sweetclover
Distance to nearest road	N-GIS			common mullein
Type of nearest road	C-GIS			Russian & spotted knapweeds
Vegetation type	C-GIS			Scotch, musk & bull thistles
Soil type	C-GIS			leafy spurge, black henbane
Disturbances	B-Field			common St. Johnswort
Tree, pole, seedling density	N-Field			oxeye daisy, white horehound
Basal area	N-Field			sulfur cinquefoil
Fuel (1, 10, 100, 1000-hr)	N-Field			Dalmatian & yellow toadflaxes
Litter & Duff	N-Field			common tansy
Understory cover by class*	N-Field			Russian thistles (*Salsola)*
Bare ground cover*	N-Field			
Canopy cover	N-Field			

B = boolean (yes/no); C = categorical; N = continuous

Data Collected



Daubenmire cover in 24 subplots, plot-wide abundance (categorical) for each target
Canopy hit/miss at each subplot corner

Analysis

- Simple t-tests for 2011 vs. 2010 cover of target species
- Principal Components Analysis on predictors
  - many highly correlated variables
  - reduce number of predictor variables
  - combined American Elk and Centennial at WICA
  - did not include control plots
- Information Theoretic Approach
  - build *a priori* models from principal components and a few other variables not used in PCA
  - select most plausible models

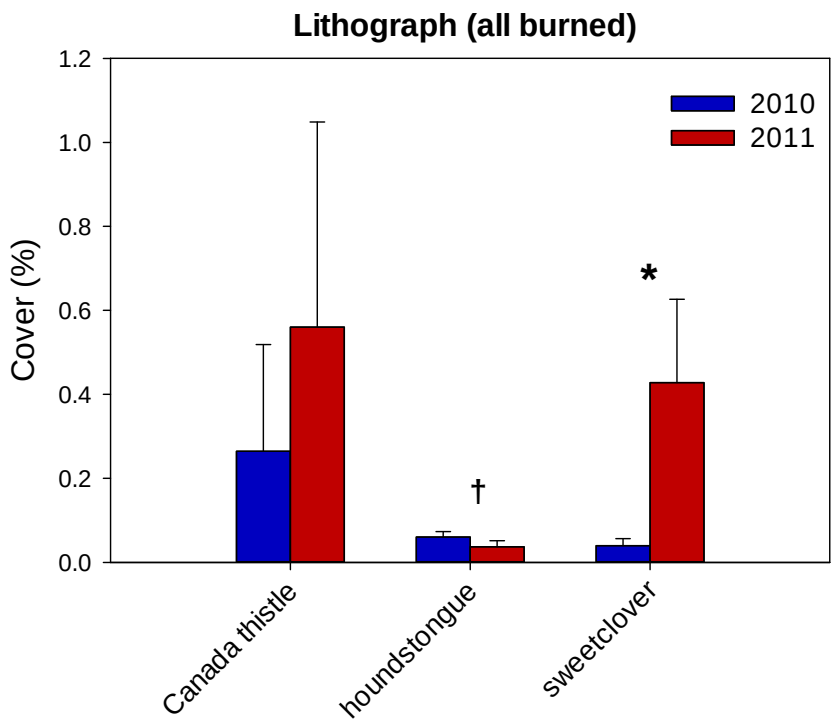
PRELIMINARY!!!

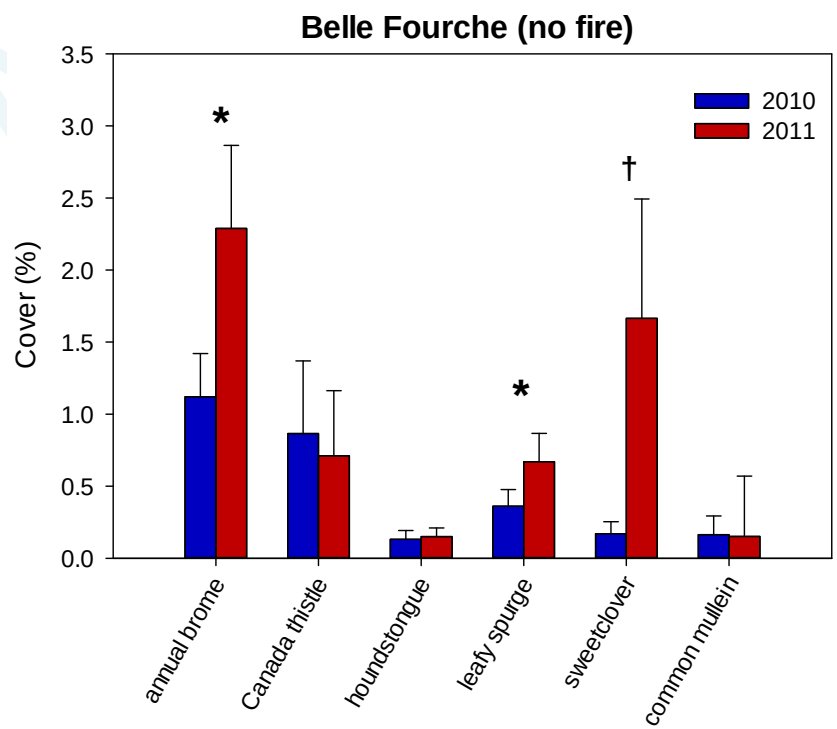
Data Used in PCA/IT

Environ. Predictor Variable	Type	Fire Predictor Variable	Type	Response Variable
Location (UTM X, Y)	N-Field	Burn severity	C-Field	**annual brome**
Elevation	N-Field	Fuel reduction	N-Field	**Canada thistle**
Slope grade, aspect	N-Field	Litter & Duff reduction	C-Field	**houndstongue**
Slope position	C-Field			**sweetclover**
Distance to nearest road	N-GIS			**common mullein**
Type of nearest road	C-GIS			leafy spurge
Vegetation type	C-GIS			Scotch, musk & bull thistles
Soil type	C-GIS			black henbane
Disturbances	B-Field			common St. Johnswort
Tree, pole, seedling density	N-Field			oxeye daisy
Basal area	N-Field			sulfur cinquefoil
Fuel (1, 10, 100, 1000-hr)	N-Field			Dalmatian & yellow toadflaxes
Litter & Duff	N-Field			common tansy
Understory cover by class*	N-Field			Russian thistles (*Salsola)*
Bare ground cover*	N-Field			Russian & spotted knapweeds
Canopy cover	N-Field			white horehound

B = boolean (yes/no); C = categorical; N = continuous

Results – Change with fire?





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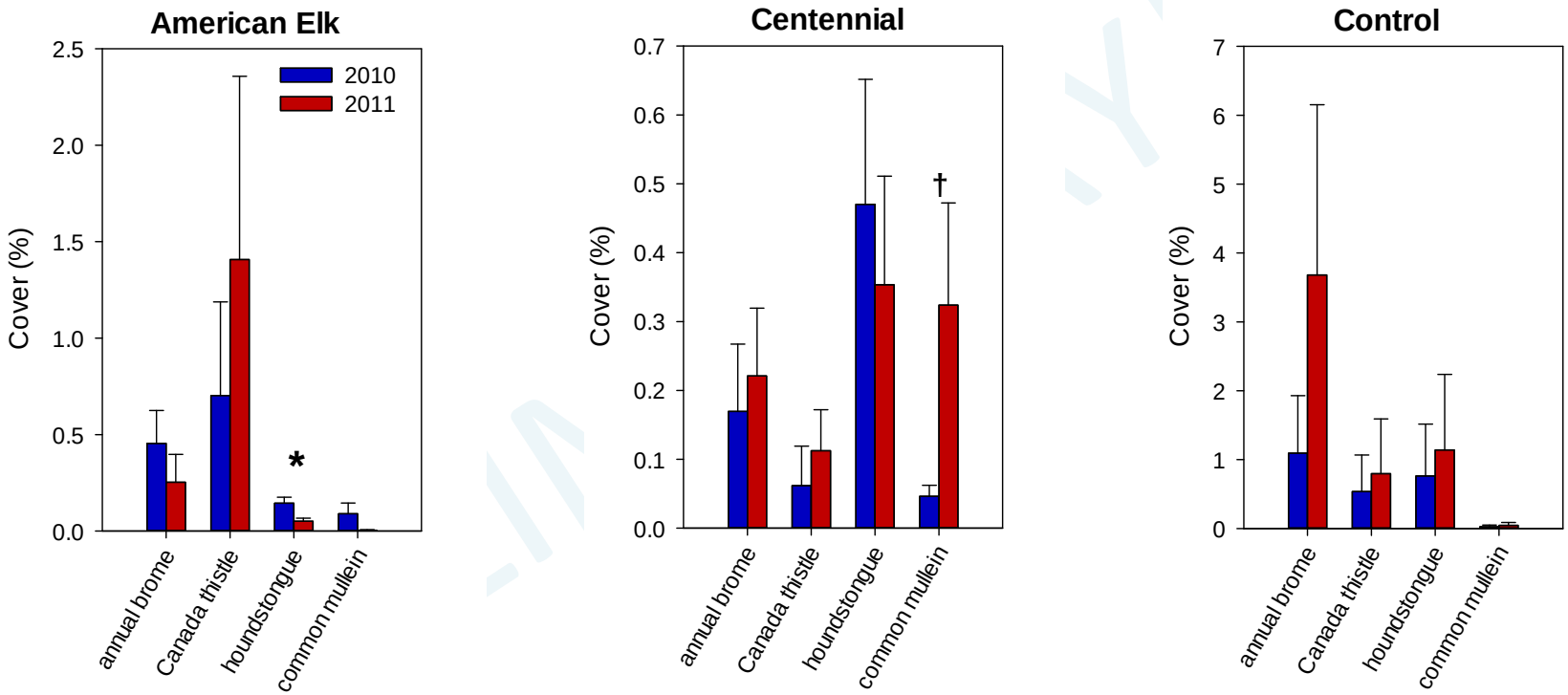


No huge outbreaks, and where there were changes, species responses differed among burn units.

Results – Targets Predictable?

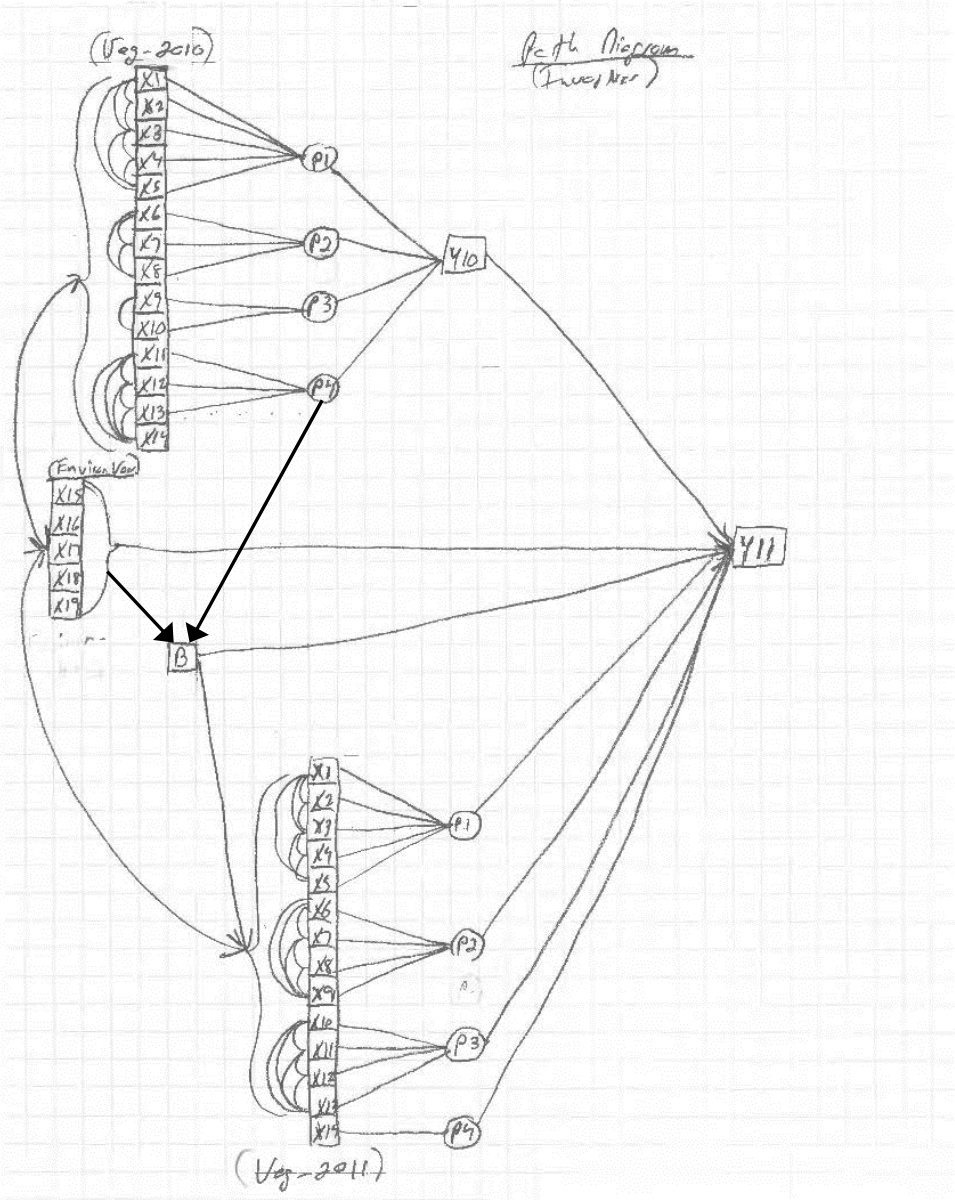
- Canada thistle most amenable to modeling
  - but not at Jewel Cave
- Generally, it's more abundant in less dense forest with lower woody fuel load and less litter and duff, regardless of fire or fire severity.
- Houndstongue at Devils Tower, but only in 2010, more common in NW portion of unit, in more dense forest but in areas with less litter and duff.

PRELIMINARY!!!

Tablespoon of Salt

- One year to respond, with some measurements done probably too early in season.
- Models built by a statistician, not an ecologist.
- Better approach is probably something like structural equation modeling.

To do…



(Veg-2010)
Path Diagram
(Environ Var)
X1
X2
X3
X4
X5
X6
X7
X8
X9
X10
X11
X12
X13
X14
X15
X16
X17
X18
X19
P1
P2
P3
P4
Y10
Y11
B
(Veg-2011)

Conclusions

- Target species abundance is not alarmingly high before or one year after a fire
  - on average; there are “hot spots”
- Individual species response to fire:
  - Sweetclover increased from 2010 to 2011 in two burn units, but only one of these units burned.
  - Houndstongue seems to be negatively impacted by fire.
  - Mullein increased in one burned unit.
- Jury still out on predictability

Thanks to…

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- Annie Cooper

- Jeff Symstad
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USGS

NATIONAL PARK SERVICE