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## What Controls the Abundance of Tall Fescue in Native Grassland Restorations in Kentucky?

Rebecca L. McCulley

*University of Kentucky*, [rebecca.mcculley@uky.edu](mailto:rebecca.mcculley@uky.edu)

Sarah Hall

*University of Kentucky*

Ben Leffew

*University of Kentucky*

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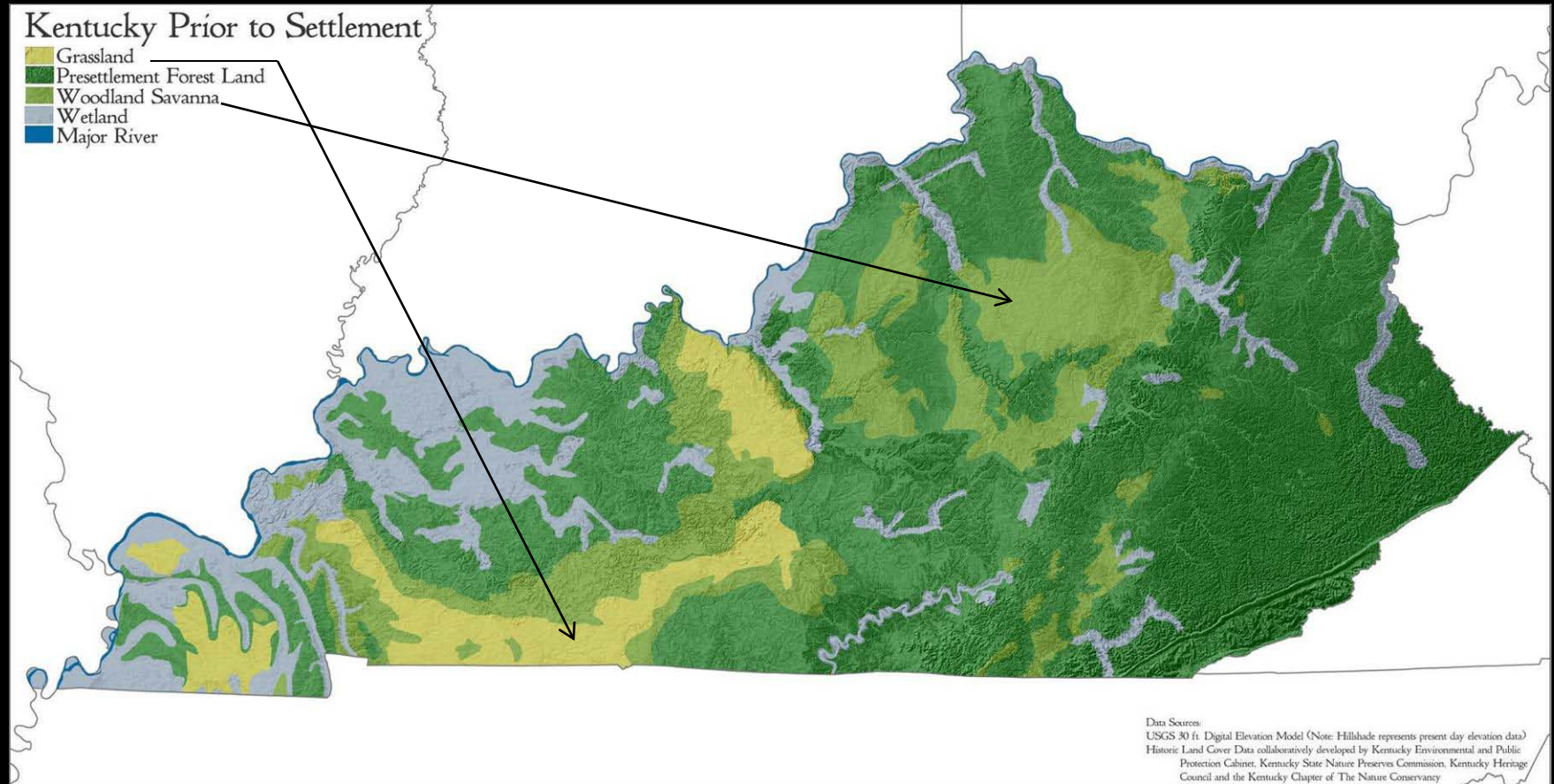
# What controls the abundance of tall fescue in native grassland restorations in Kentucky?



Rebecca McCulley, Sarah Hall, Ben Leffew

Dept. of Plant & Soil Sciences, Univ. of KY

# Grassland Restoration in Kentucky

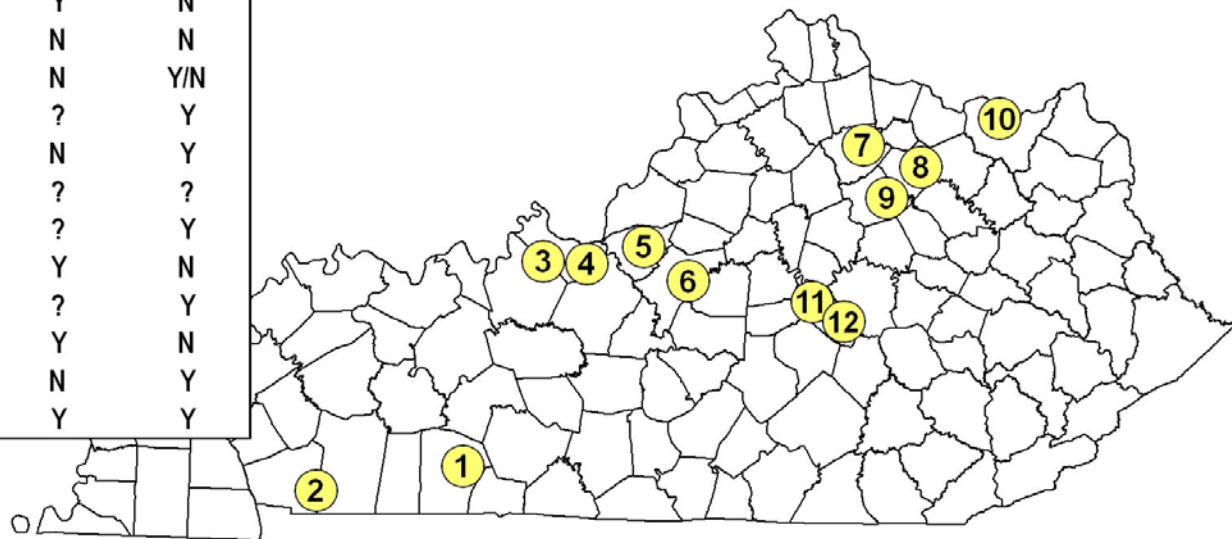




# Grassland Restoration in Kentucky



Site #	Agency	Contract	Burned?	Herbicide?	Seeded?
1	KSNPC	(none)	Y	Y	N
2	US Army	(none)	Y	N	N
3	TNC/KDFWR	GRP	Y	N	Y/N
4	KDFWR	CRP	Y	?	Y
5	TNC	(none)	Y	N	Y
6	TNC	WHIP	Y	?	?
7	TNC	LIP	Y	?	Y
8	KSNPC	(none)	Y	Y	N
9	TNC	LIP	Y	?	Y
10	KSNPC	(none)	Y	Y	N
11	TNC	WHIP	Y	N	Y
12	TNC	WHIP	Y	Y	Y



**Figure 1.** Location and management history summary for native grassland restoration sites identified by Drs. Sarah Hall and Robert Barney. Several sites had multiple units that differ in type and intensity of management.

# Grassland Restoration in Kentucky



Why is fescue successfully removed at some sites but not others?

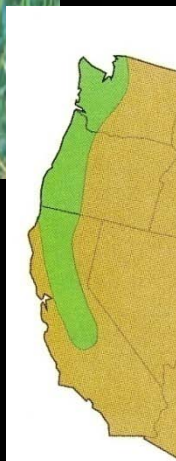




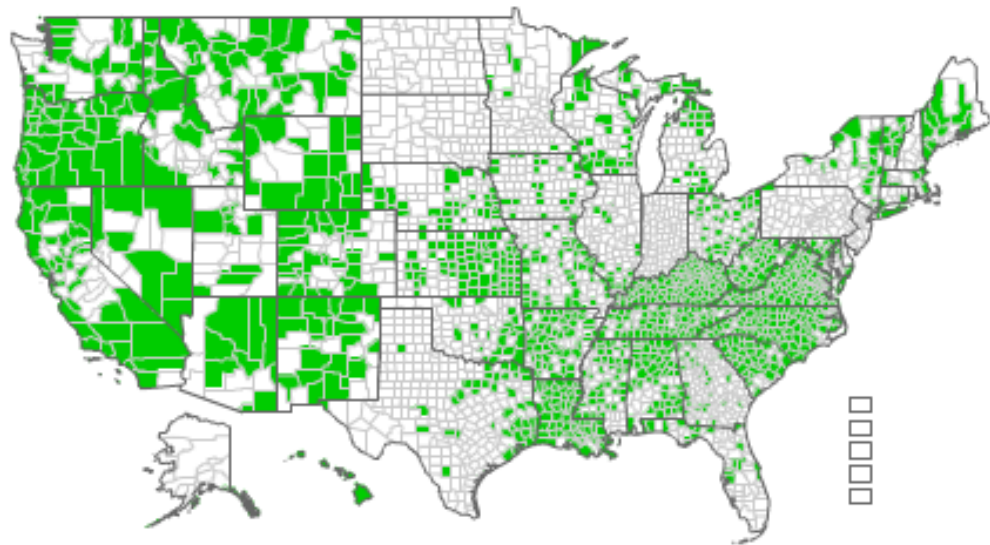


## Tall Fescue — *Lolium arundinaceum* (*Schedonorus phoenix*)

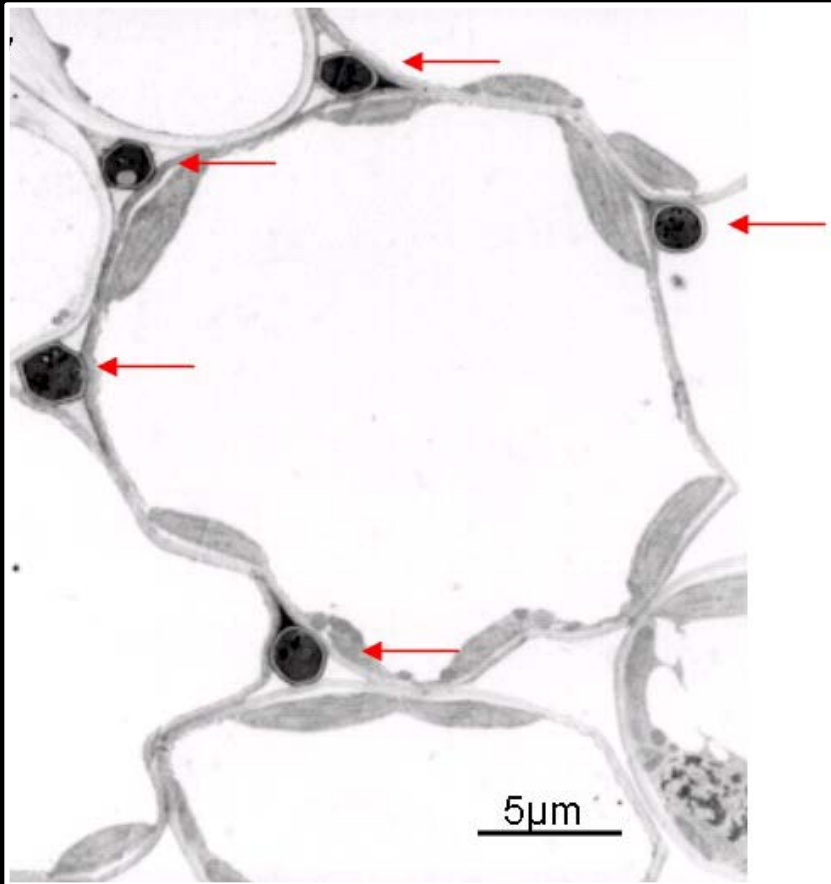
- Cool season grass
- Native to Europe, North Africa
- Introduced to US in 1800s
- Covers >14 million hectares today



**EDDMaps Distribution** - This map is incomplete and is based only on current site and county level reports made by experts, herbaria, and literature. For more information, visit: [www.eddmaps.org](http://www.eddmaps.org)



<http://www.invasive.org/browse/subinfo.cfm?sub=3037>



**Figure 17.** Hyphae (←) in intercellular spaces of leaf blade mesophyll – taken from Christensen & Voisey Chapter in Tall Fescue Online Monograph

## Fungal Endophyte – *Neotyphodium coenophialum*

- Grows intercellularly within plant
- Vertical, imperfect transmission
- Considered a symbiotic mutualist

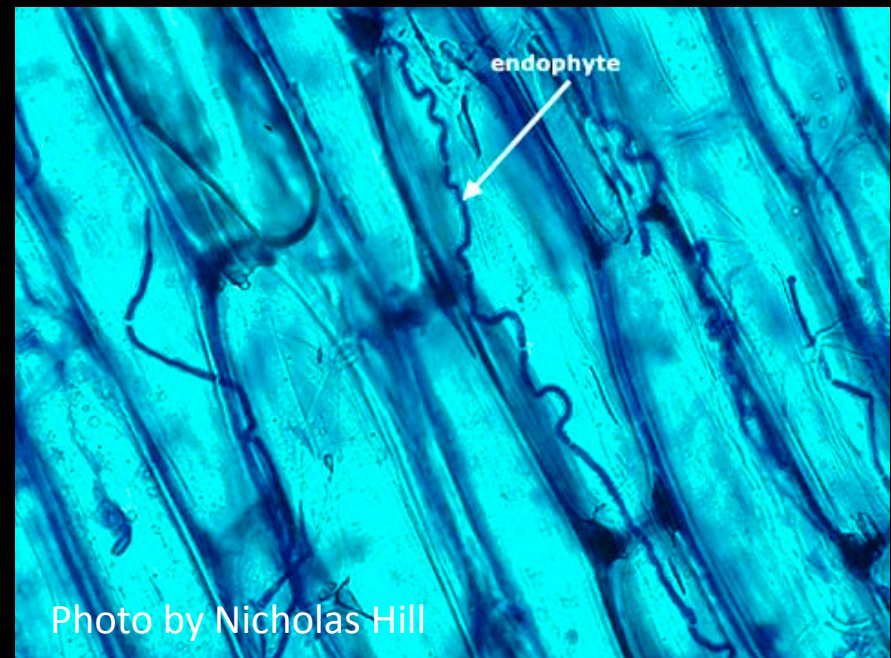


Photo by Nicholas Hill



# Effects of the tall fescue – *Neotyphodium* symbiosis are observed at all ecological levels.

- **Individual** (e.g., increases stress tolerance)
- **Community** (e.g., alters herbivory, plant diversity, & succession) ←
- **Ecosystem** (e.g., slows litter decomposition, alters soil nutrients)



- E+ plants more resistant to herbicide (Vila-Aiub et al. 2003)
- Re-establishment of E+ tall fescue following herbicide treatments (Smith 1989, Defelice & Henning 1990)
- E+ tall fescue suppresses mycorrhizal fungi (Antunes et al. 2008, Rudgers & Orr 2009)

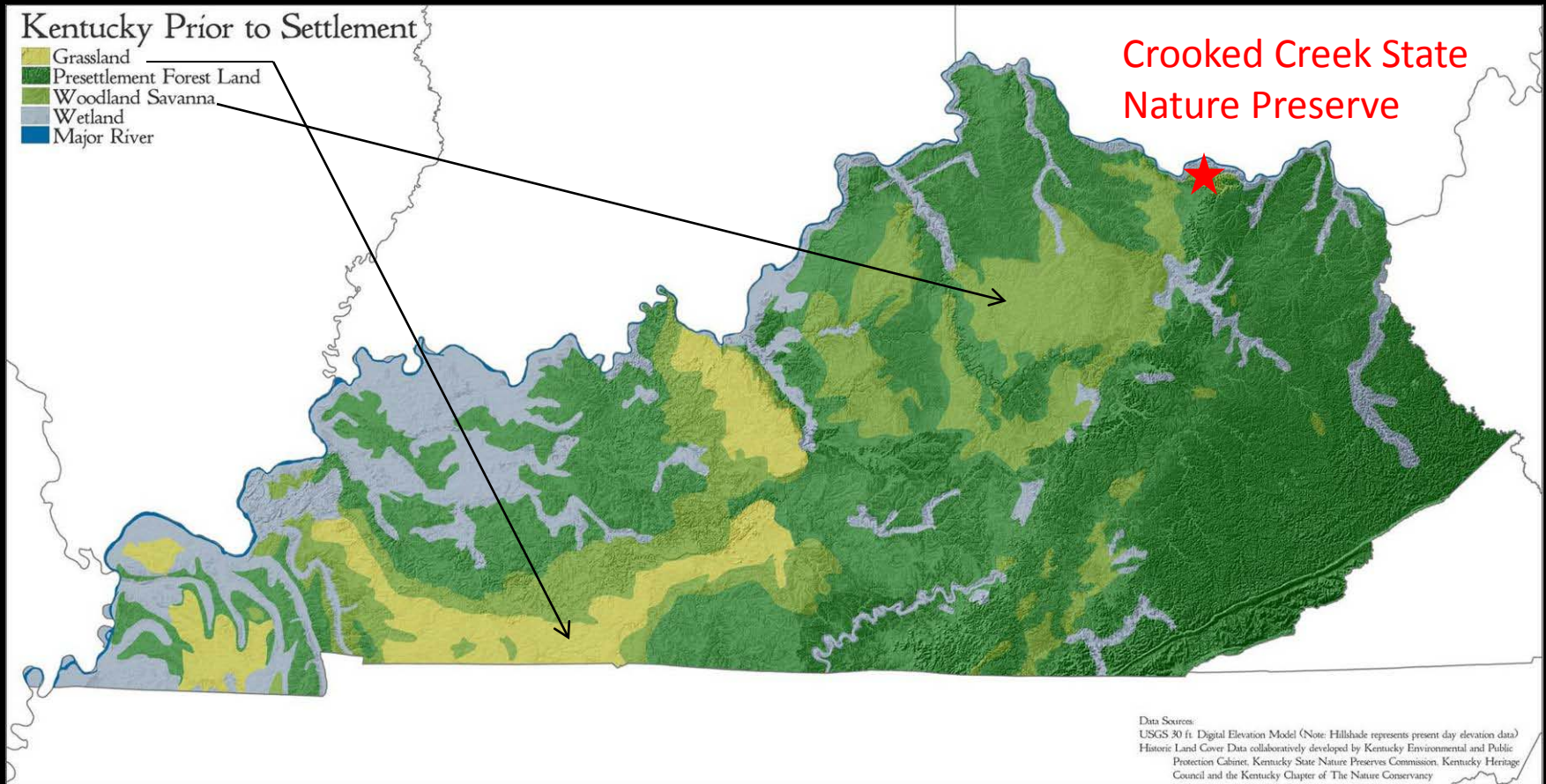
# Grassland Restoration in Kentucky



Endophyte effects???



# What controls the abundance of tall fescue in native grassland restorations in Kentucky?





- Does restoration management using prescribed burns and herbicide application preferentially eliminate E+ or E- plants?
- $H_1$ : Restoration management will “select for” E+ plants



**Table 1.** Management history of five subunits at CCSNP.

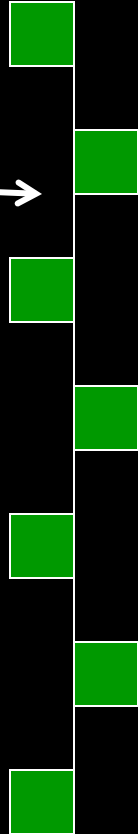
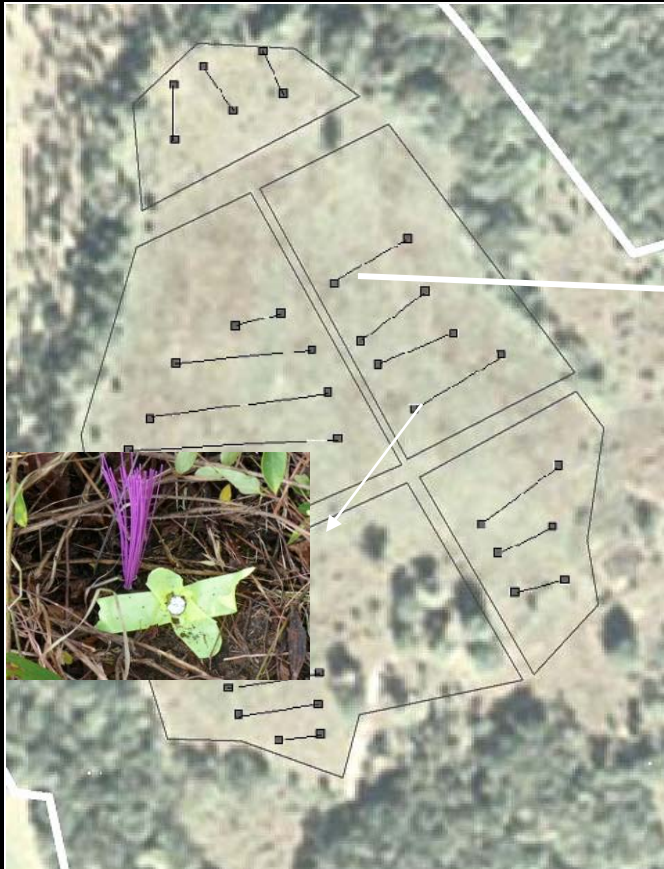
Subunit	1999	2000	2001	2002	2003	2004
A	B	H/B	B	H	—	B
B	B	H/B	H/B	H	—	B
C	—	H/B	H/B	H	—	B
D	—	—	—	—	—	B
Control	—	—	—	—	—	—

H indicates herbicide application (see methods for chemical and quantity used) and B indicates prescribed burn within a given year (none occurred 2005–2008).



# Methods

- Transects established across slope
- Vegetation sampling (species cover estimates) in 1% total area of all units= 261 m<sup>2</sup> quadrats
- Tall fescue tillers sampled in between transects



- H<sub>1</sub>: Restoration management will “select for” E+ plants.

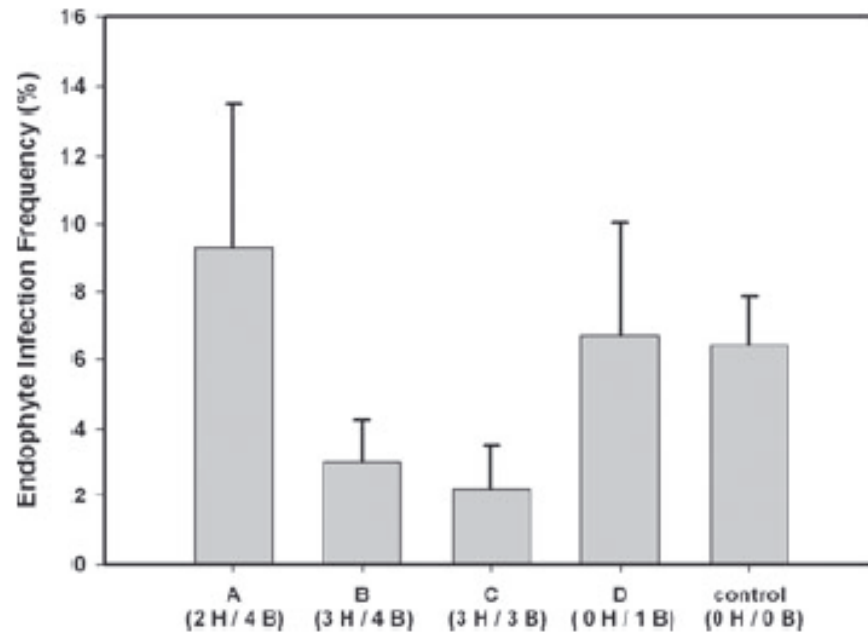
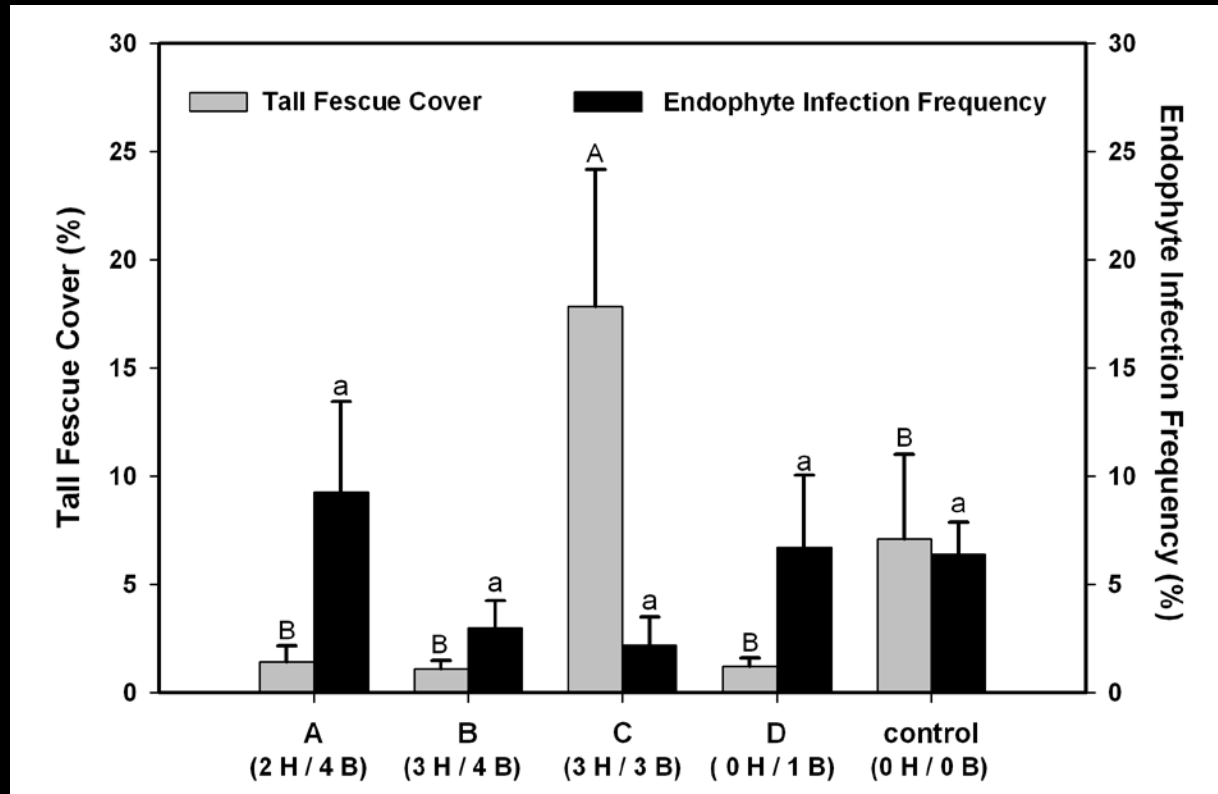


Figure 3. Mean ( $\pm 1$  SE) tall fescue endophyte infection rates in the four restoration treatments (A–D) and control. Number of herbicide treatments (H) and prescribed burns (B) are presented in parentheses below each subunit.

No evidence that grassland restoration management selected for E+ tall fescue. But overall endophyte infection frequency of the field was very low.

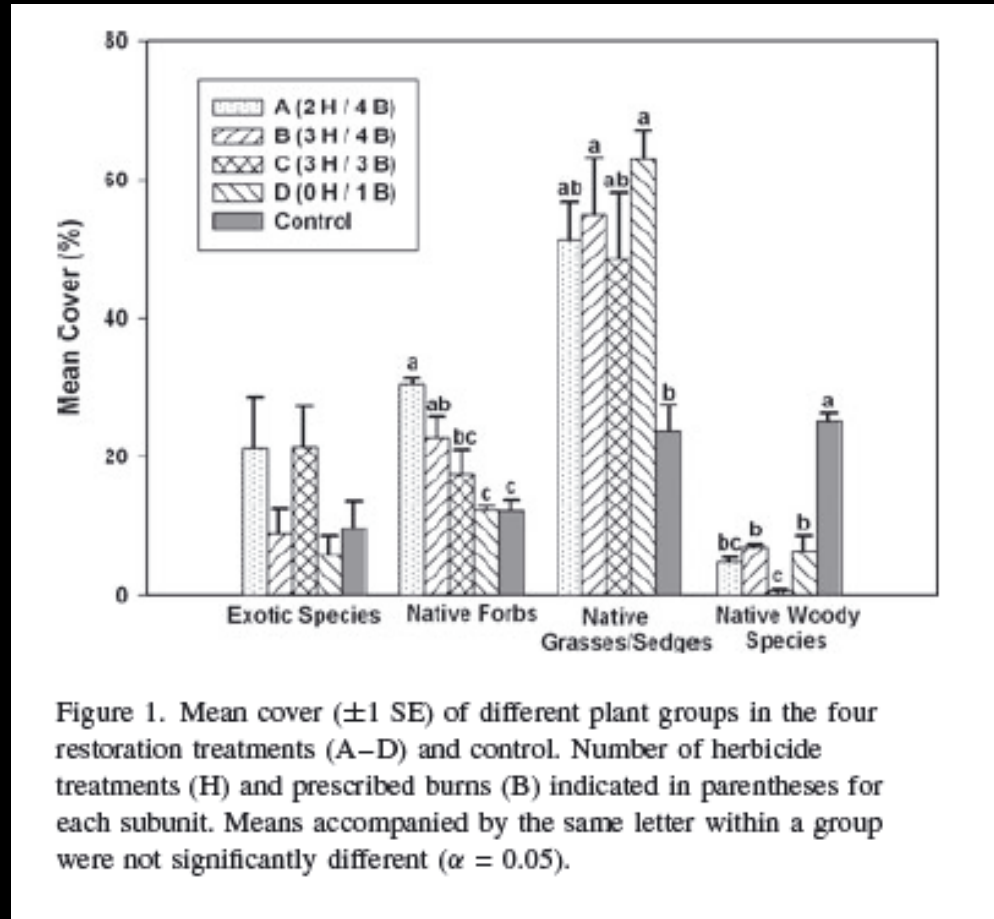


- Were restoration efforts successful at removing tall fescue at the site?



Not really. While overall fescue abundance was low, sub-unit C, despite receiving 3 herbicide and burn treatments, had more tall fescue than the control.

- Were restoration efforts successful at re-establishing native grassland species?



Yes!

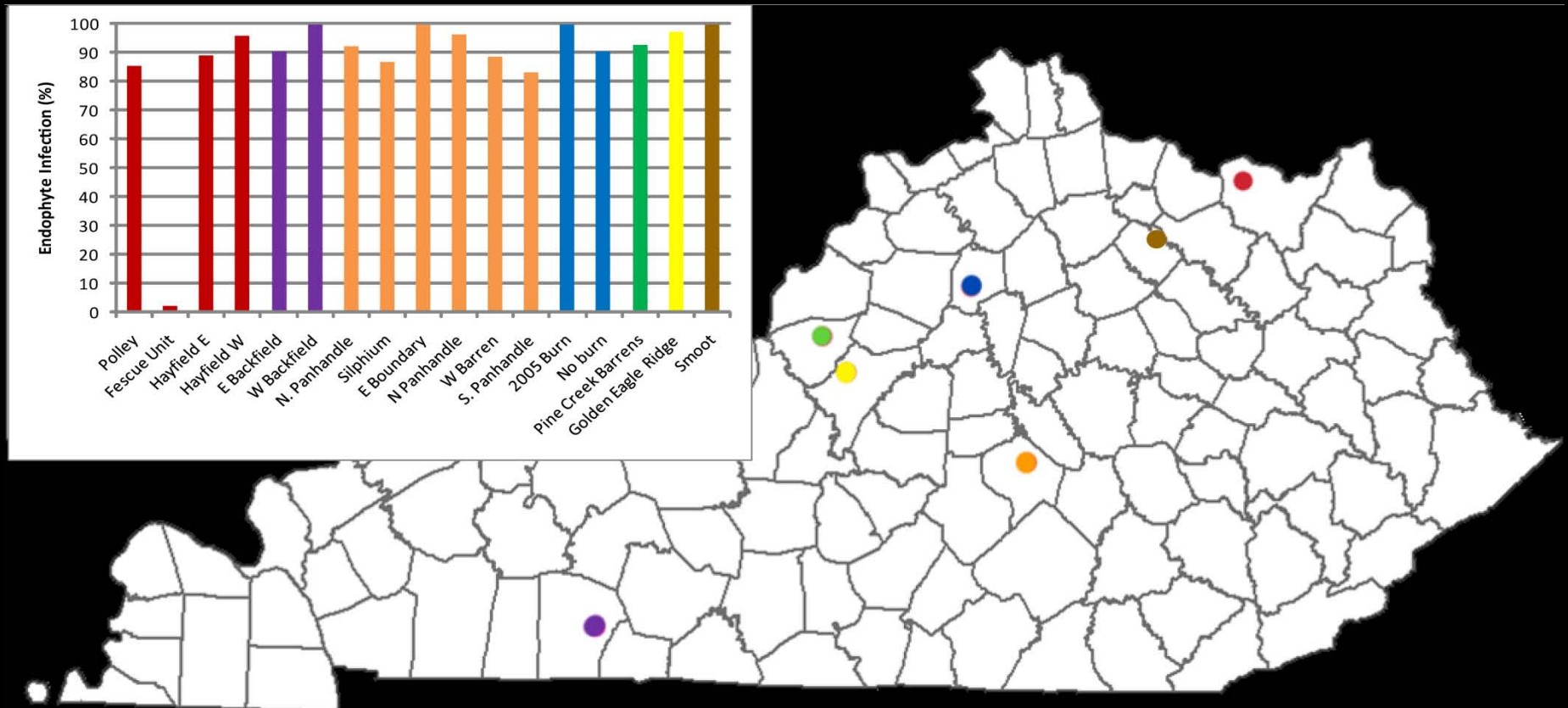
The fact that the tall fescue disappeared at this site is consistent with prior work demonstrating E- stands succeed quickly.



**Rudgers et al. 2007**



# Crooked Creek 'Fescue Unit' is different from other fescue areas being restored in the state.



Hall dissertation. 2011. University of Kentucky.

- Do E+ and E- plants exhibit differences in regrowth/recovery following prescribed burn treatments?

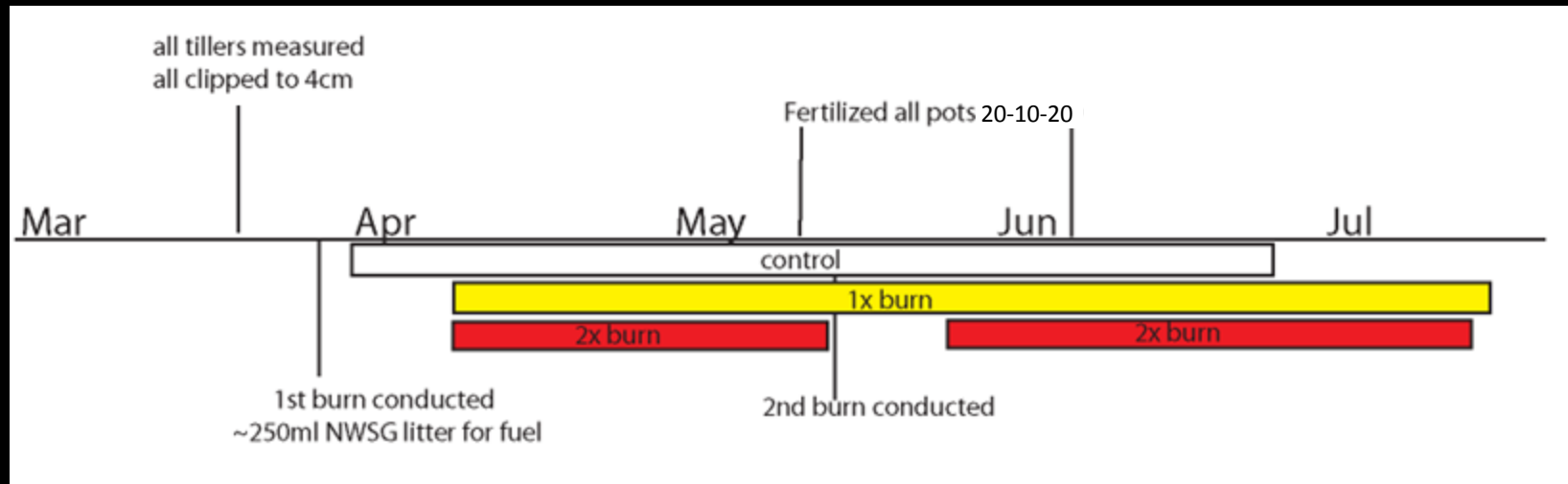
- H<sub>2</sub>: E+ plants will regrow/recover following treatments better than E- plants

Methods:

- Full Factorial Experimental Design
  - Endophyte Infection (E+ or E-)
  - Prescribed burn treatment (one burn, two burns, or unburned control)
  - Watering regimes (wet or dry)
  - 6 reps per combo
  - Length of the longest leaf on each tiller was measured weekly to bi-weekly

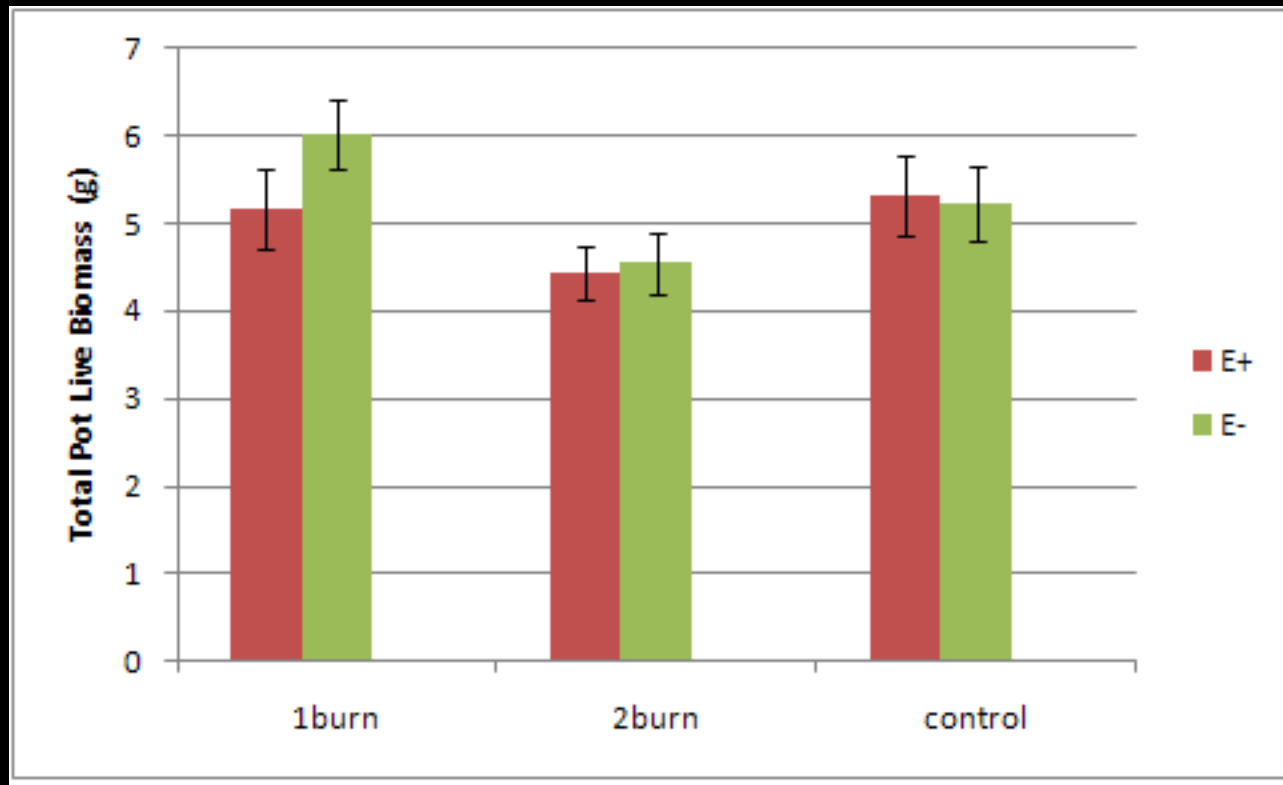


# Methods cont.



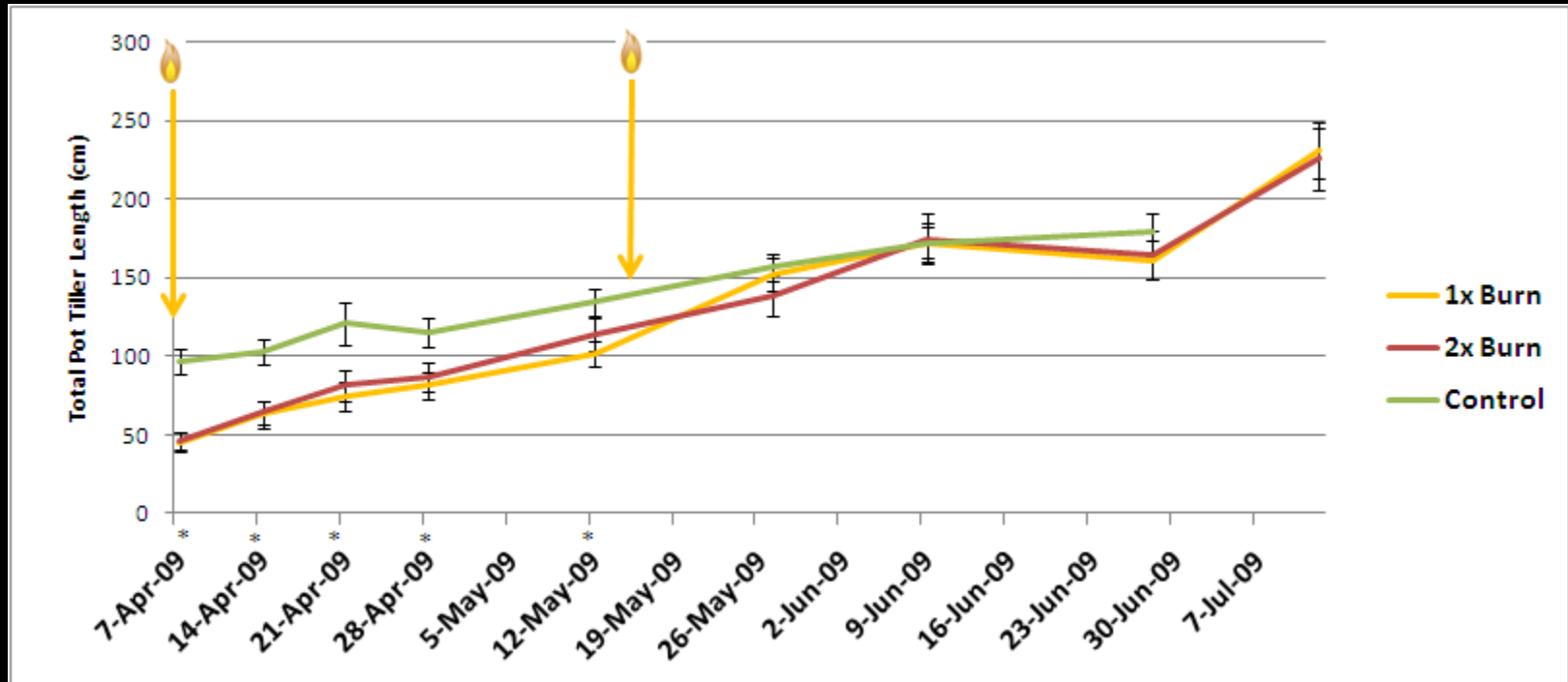
- At harvest:
  - Each fescue tiller tested for endophyte presence
  - All aboveground (for each tiller) and belowground (for whole pot) material was oven-dried and weighed

- H<sub>2</sub>: E+ plants will regrow/recover following treatments better than E- plants



No support for this hypothesis.

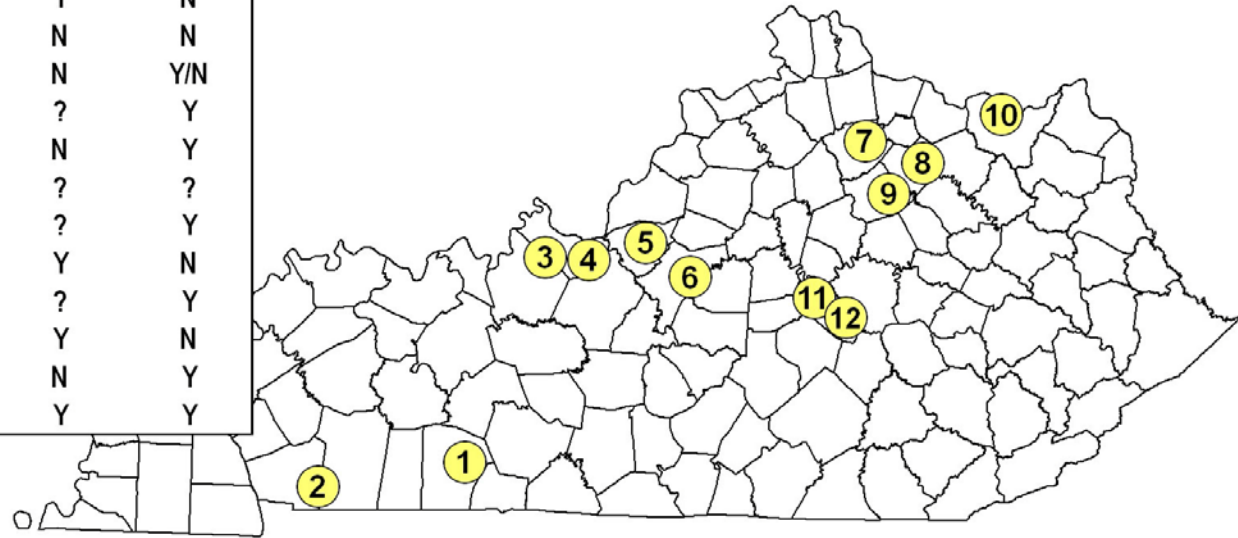




- We thought more burning would reduce tall fescue growth, but it didn't.
- Fire alone is unlikely to effectively remove tall fescue from these landscapes.

# So, what drives the landscape variability observed in success of tall fescue removals?

Site #	Agency	Contract	Burned?	Herbicide?	Seeded?
1	KSNPC	(none)	Y	Y	N
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**Figure 1.** Location and management history summary for native grassland restoration sites identified by Drs. Sarah Hall and Robert Barney. Several sites had multiple units that differ in type and intensity of management.

# Grassland Restoration in Kentucky



Endophyte effects???



Maybe it's spatial variability?

# Research Question

- What are the biotic/abiotic factors that influence tall fescue's ability to persist after eradication attempts?
  - Endophyte Infection Frequency
  - Where it occurs in the landscape
  - Fire temperature, duration
  - Herbicide contact
  - Competing vegetation





# Research Site

- Abandoned Cool Season Hayfield at Shaker Village of Pleasant Hill, KY (approx 80 acres)



# Shaker Village of Pleasant Hill



0 112.5 225 450 675 900 Meters





# Research Plan

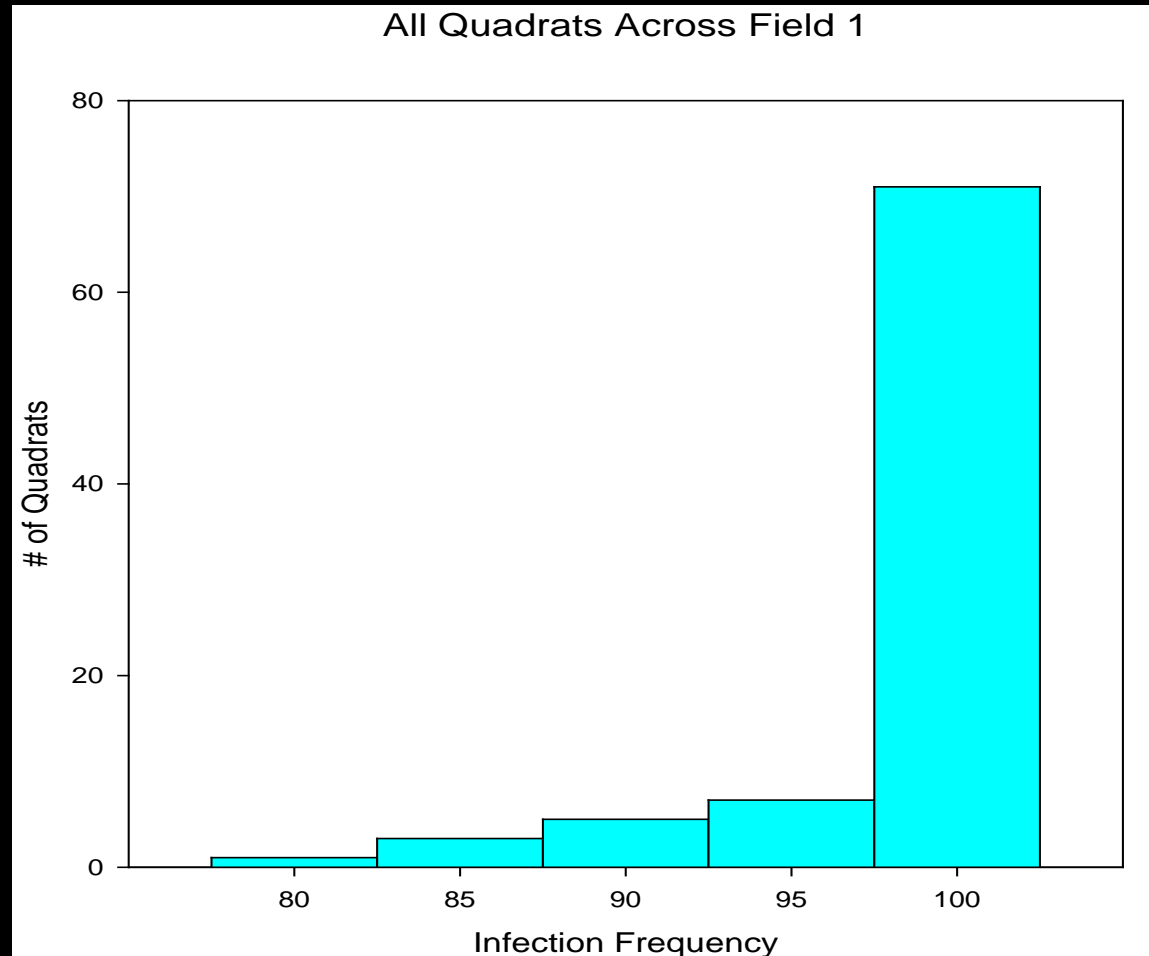
- 4 Transects with 1x1m quadrats spaced 15m apart. ~100 quadrats in the field.
- GPS coordinates and elevation data collected for all points.

# Pre-Treatment Data

- Soil Depth (Every quadrat)
- Soil Chemistry (Every other quadrat)
- Tall Fescue Cover
- Bluegrass Cover
- Standing Dead
- Thatch Height
- Other Species Observed in Plot
- Fescue Endophyte Infection Frequency

# Pre-Treatment Data

- Endophyte Infection Frequency











# Fire

- Data loggers with temperature probes at every other quadrat



# Herbicide Applications

- 1<sup>st</sup> Application 2qt/acre glyphosate, 6oz/acre imazapic (4/18/2011)
- 2<sup>nd</sup> Application 2qt/acre glyphosate (5/25/2011)



















# Herbicide Strip Data

- Droplets/cm<sup>2</sup>
- % Coverage
- Post Herbicide Green

# Planting

- Grass mix
  - Little bluestem
  - Prairie Dropseed
  - Sideoats Grama
- Forb mix
  - False Sunflower
  - Gray-Headed Coneflower
  - Purple Coneflower
  - Illinois Bundleflower
  - Black-eyed Susan
  - Partridge Pea









# Post-Treatment Measurements: Vegetative Cover Estimates

- End of 1<sup>st</sup> growing season
  - Estimate down to 1% cover of 1m<sup>2</sup> quadrats
  - Species richness
  - Tall Fescue found in 1 quadrat
- Another measurement late May/early June this year

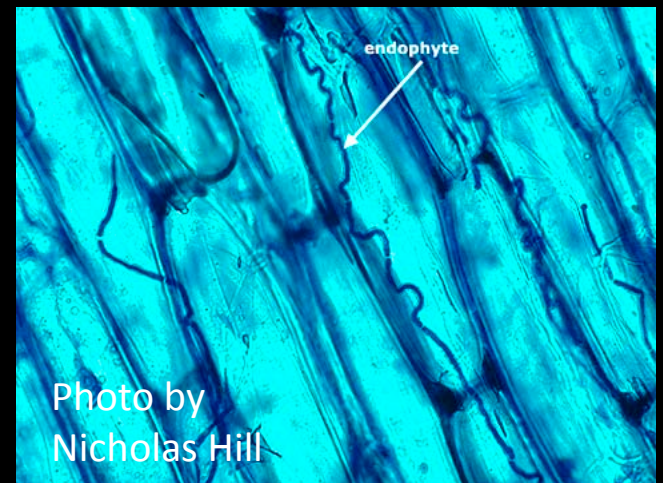
What are the biotic/abiotic factors that influence tall fescue's ability to persist after eradication attempts?

Results – Too soon to say.....An active work in progress.....

# Does endophyte infection help tall fescue invade, re-colonize, and persist in native grassland restoration?

We do not have evidence that endophyte infection is important in tall fescue's ability to persist, invade or re-colonize in these environments.

However, we hope to do more direct, controlled studies to further evaluate this possibility.



# Leffew 2<sup>nd</sup> Experiment

- Tall Fescue Response to Herbicide Application
  - Dr. Phillips' plots at Spindletop
  - KY 31 tall fescue; E+ or E-
  - Glyphosate & Imazapic
  - Evaluate whether there are differences in E+ and E- fescue in withstanding, coming back from spraying
  - Next month



# Grassland Restoration in Kentucky



Endophyte effects???



It seems likely that spatial variability in management factors (fire and herbicide), grazing, and other environmental parameters might be important in dictating where on a landscape tall fescue persists or re-colonizes.

# Acknowledgements:

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