The Successful Restoration of Fescue Grasslands in Southwestern Alberta

Lessons learned from the past 25 years of research and management of fescue grasslands

Steven Tannas

Tannas Conservation Services Ltd.

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Water

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History of Rough Fescue

- Dominant grassland species in the Foothills Fescue (*Festuca campestris*), Montane (*Festuca campestris*), Northern Fescue (*Festuca hallii*) and Aspen Parkland (*Festuca hallii*) natural subregions in Western Canada.

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Biology of Rough Fescue

- Rooting:
  - Bunch Type (*Festuca campestris*) – highly tufted
  - Creeping (*Festuca hallii*) – still tufted but slowly creeps
- Life Span: Long lived perennial (hundreds of years)
- Reproduction:
  - Sets seed infrequently (once every 3-5 years)
  - Viability of seed reasonably high (60-95% germination)
  - *Festuca hallii* uses slow moving rhizomes to spread

Biology of Rough Fescue

- Germination (Romo, 1991)
  - Temperature (*Festuca hallii*) – maximum germination between 15-20^{o}C, but germinates at other temperatures.
  - The plastic response of *F. hallii* to temperature suggests that while it does not eliminate regeneration it does have a significant impact on regeneration.

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Biology of Rough Fescue

- Germination (Romo, 1991)
  - Moisture (*Festuca hallii*) – under constant temperatures 77-80% of the variation was attributed to osmotic potential.
  - Germination occurs the fastest and in the greatest numbers and greatest ranges of osmotic potentials when temperatures increase from 10-25^{o}C.
  - Increased moisture significantly enhances germination.
    - Seeding during early spring while temperatures are increasing and soil moisture is high will result in the highest germination rates.

Biology of Rough Fescue

- Establishment and Germination
  - In controlled conditions within a greenhouse, germination requires 2-3 weeks for both *Festuca hallii* and *Festuca campestris*.
  - Establishment in the greenhouse of a plant equal in size to a two year old plant takes 4 months for *Festuca campestris* and 6 months for *Festuca hallii*.

Biology of Rough Fescue

- Establishment and Germination
  - Moisture Requirements
    - Seedlings are highly susceptible to moisture deficits. Drought conditions even for a few days in the greenhouse can result in significant mortality. (ESRS, 2007-2013)
    - In field seeding trials moisture deficits may be one of the key factors that have caused significant establishment failures (Tannas, 2011).

Biology of Rough Fescue

- Establishment (In freshly tilled soil with at least 1 year weed control)
  - Growth Rate of Surviving Seedlings
    - Yr 1= 2-6 tillers, (3)
    - Yr 2 = 5-30 tillers, (15)
    - Yr 3 = 30-150 tillers, (100)
    - Yr 4 = 50-1500 tillers (300)
  - Growth Rate of Plugs after planting
    - Yr 1 = 10-40 tillers, (20)
    - Yr 2 = 30-200 tillers, (100)
    - Yr 3 = 50-1500 tillers, (400)
    - Yr 4 = 50-1500 tillers, (400)
  - Growth rates are estimated based on information collected within all of the discussed experiments. Only live plants are counted and survival % is not taken into account.
  - Plant Size Determined By: soils, climate, and competition, genetics, disturbance, and age.


October 2008


March 2009


August 2009


August 2010

Biology of Rough Fescue

- What Constitutes a Season?
  - Growth: Early spring (April-June).
  - Initiating Growth:
    - Differentiation of growth point during cooling temperatures (Fall)
    - Warming temperatures cause growth to initiate (Spring)
      - May 1, 2013 planting to July 2014 (14 Months) = 1 Season
      - October 1, 2013 planting to July 2014 (7 Months) = 1 Season
  - Fall Planting of plugs:
    - Reduces time to next growth phase by 50%
    - Reduces time for invasive species to establish by 50%


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Biology of Rough Fescue

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Biology of Rough Fescue

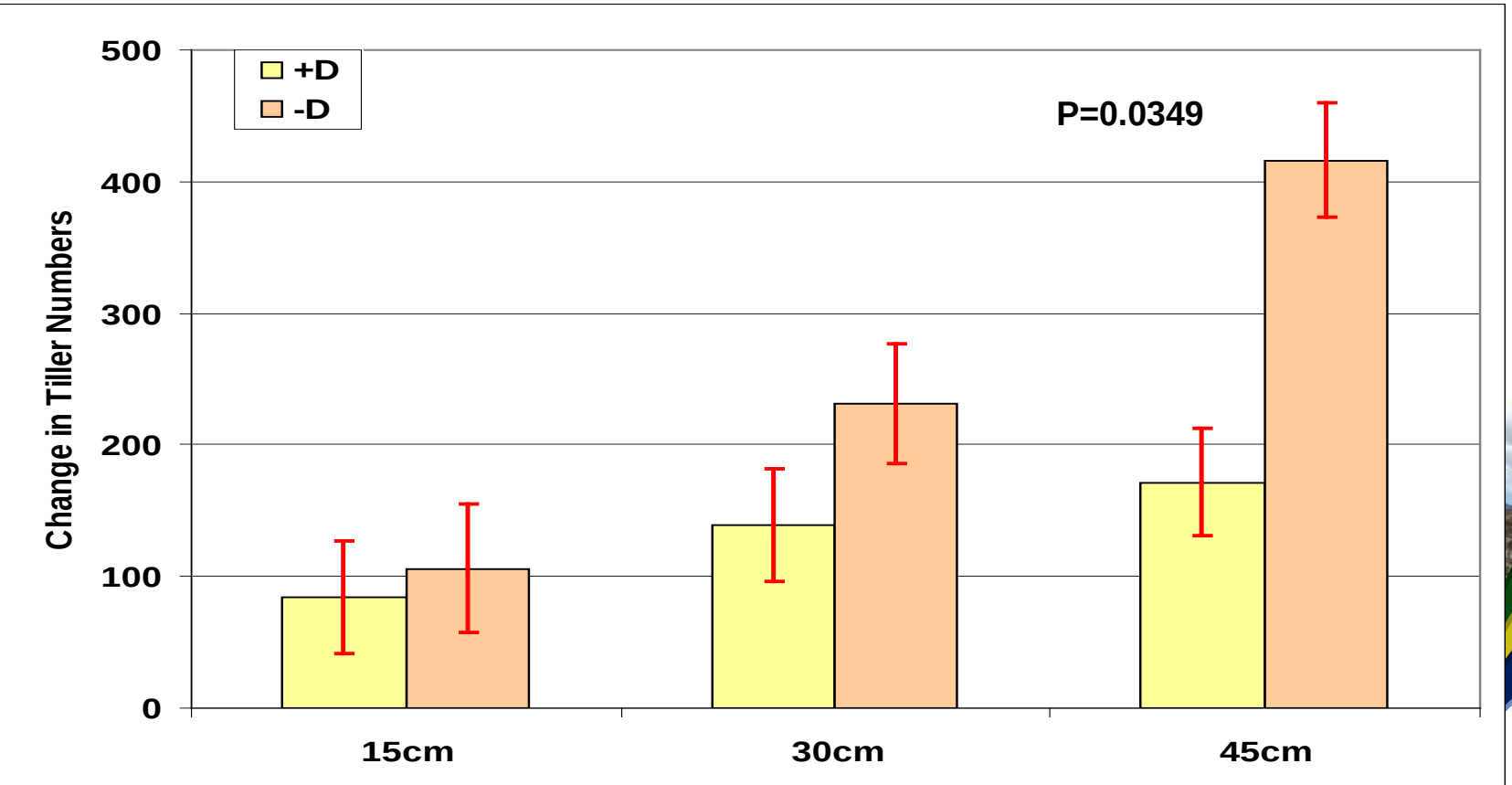
- Establishment
  - Competition (Tannas, 2011)
    - Kentucky bluegrass (*Poa pratensis*) has a significant negative impact on the fitness of establishing plugs, cuttings from mature plants and seed. (Tannas, 2011)
    - *F. campestris* biomass significantly decreased (p=0.05) from 54.1 ±5.3g to 39.1 ±5.3g when *P. pratensis* was a neighbor (Tannas, 2011).
  - Temperature
    - As part of evapotranspiration is an important factor in establishment

Biology of Rough Fescue

- Establishment
  - Disturbance
    - Slow regrowth potential has a significant impact on the ability of rough fescue to respond to disturbance.
    - Disturbances such as mowing, grazing, tillage, trampling among other disturbance types can have significant negative impacts on the establishment of this species (Tannas, 2011; Tannas, 2012)
    - When competition is combined with disturbances the impact can be devastating.

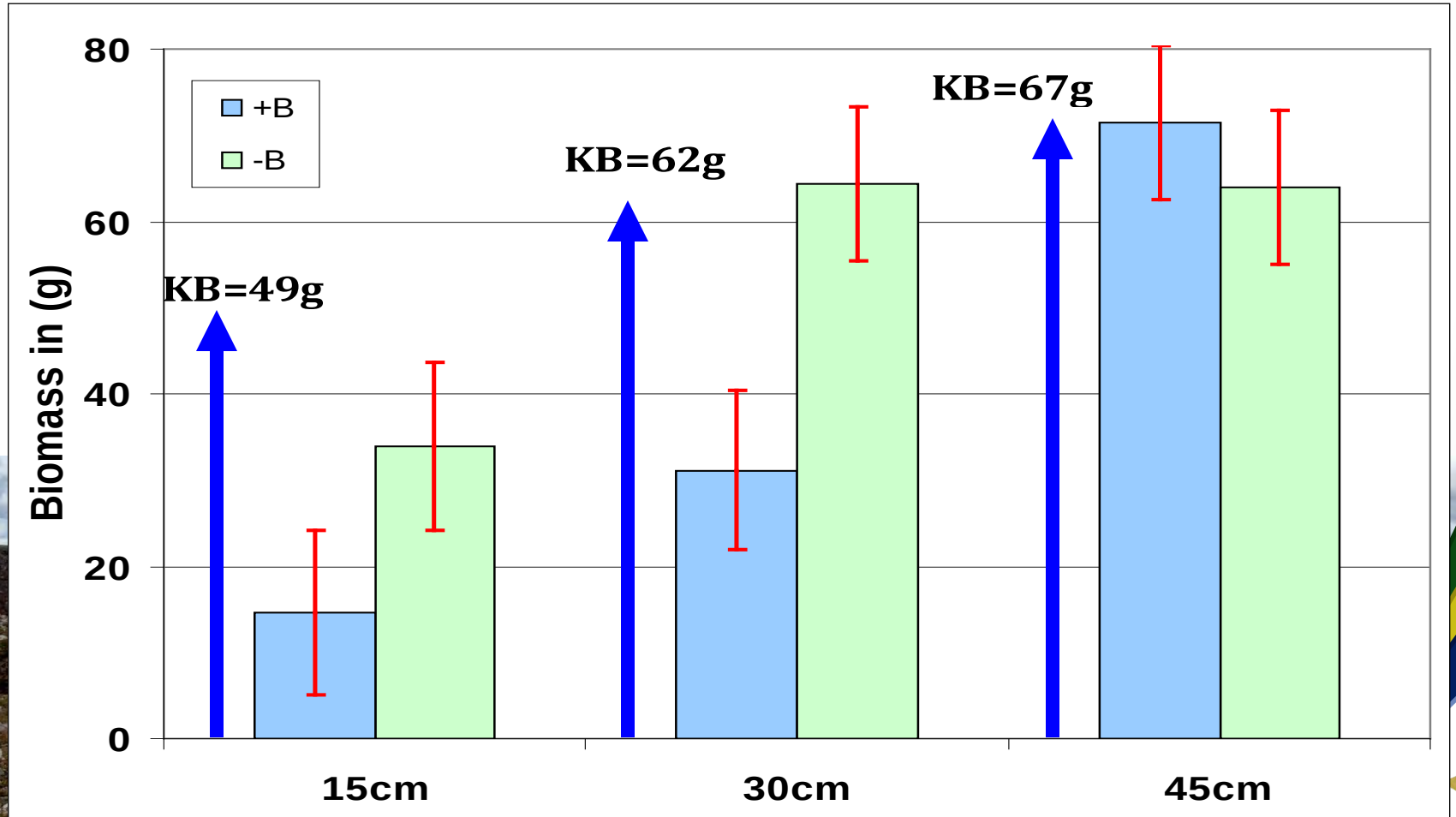
Defoliation of Rough Fescue

- Change in tiller numbers within focal fescue plants grown under three densities, with and without defoliation.



Competition with *P. pratensis*

- Biomass of focal fescue grown at 3 densities with and without neighboring bluegrass invasion (blue arrows signify bluegrass biomass).



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History of Growing Rough Fescue

- Over 30 years of growing native species three successful establishments of Rough Fescue using seeding are documented by ESRS. Others examples will exist.
  - Early 1990's unknown conditions (Tannas Farm, 6 acres)
  - 1995 – during extremely wet year (ESRD, 3-5 acres)
  - 2005 – during extremely wet year (Tannas Farm, 5 acres)

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History of Growing Rough Fescue

- Another 15 failures to establish Rough Fescue from seed occurred (2000-2009) with more recent attempts not looking favorable
  - 2000-2004 – 4 failed attempts to establish 5 acres (Tannas Farm)
  - 2005 – 1 failure to establish *Festuca campestris*
  - 2006 – 1 failure to establish *Festuca campestris*
  - 2007 – 2 failures to establish *Festuca hallii*
  - 2008 – 3 failures to establish *Festuca campestris*
  - 2009 – 3 failures to establish *Festuca campestris*
  - 2013 – 1 failure (It is early but does not look good) (*Festuca campestris*)
- Many more failures have been observed in the parkland and foothills throughout this period, but on sites not managed by TCS

Compton Research Program

- Site Preparation:
  - Tilling for a minimum of 1 year (up to 3 years)
  - Spraying with Glyphosate annually during tillage years
- Planting:
  - 4 wells and one pipeline were seeded (25-35kg/ha)
  - *Festuca campestris* planted (1plug/m^2)
- Monitoring:
  - Plots were located on each site to monitor plug mortality
  - Transects were used to monitor cover on an annual basis
  - Mowing occurred between 3-4 years after planting

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Seed Mixes for Wells (25-35kg/ha)

Well 1	
Foothills rough fescue	40%
Parry's oat grass	24%
Alkali bluegrass	24%
Awned wheatgrass	10%
Idaho fescue	3%

Well 2	
Foothills rough fescue	40%
Parry's oat grass	3%
Alkali bluegrass	24%
Awned wheatgrass	10%
Idaho fescue	24%

Well 3	
Foothills rough fescue	35%
Northern wheatgrass	5%
Idaho Fescue	15%
Awned wheat grass	5%
Blue grama grass	5%
Parry's oat grass	15%
Alkali bluegrass	20%

Well 4	
Plains rough fescue	50%
Alkali bluegrass	20%
Northern wheatgrass	5%
June grass	10%
Green needle grass	10%
Western Wheatgrass	5%

- Well 3 – one species, Idaho Fescue, turned out to be *Festuca ovina*
- Well 1-3 – no parry's oat grass has shown up from seed
- Well 1-4 – no rough fescue has shown up from seed

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Seed Mixes for Wells

- When 30-70% of the seed does not establish the effective seeding rate is significantly reduced.
  - Diversity was significantly reduced due to two species not establishing
  - It appears the *Idaho fescue* in well 3 was actually *Festuca ovina* seed
  - Establishment of rough fescue was only achieved through plugs, but at a cover sufficient to pass the reclamation criteria on the three sites being reclaimed.
  - The fourth site is still an active well pad.

Fescue Establishment Results

- Plug survival rates over the first four years of establishment

		Survival			
	Species	Year 1	Year 2	Year 3	Year 4
Well 1	*F. campestris*	100%	98%	98%	98%
Well 2	*F. campestris*	100%	100%	100%	100%
Well 3	*F. campestris*	99%	99%	99%	-
Well 4	*F. hallii*	92%	78%	-	-

Unknown numbers are due to the initiation of the mowing programs to control litter buildup.

Well 1: during the first 3 years

Trans Canada Pipelines Research Program

- 10 sites were located across 5 ranches south of Longview Alberta
- A baseline assessment was completed prior to the experiment being initiated
- A control on and off RoW was monitored annually
- Plugs of rough fescue were established in the vegetated pipeline RoW
- Weed control was implemented on an annual basis (Mowing, Wick Application, and M+W)
- Mortality of *F. campestris* and cover of invasive species was monitored on an annual basis

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- Experimental Design

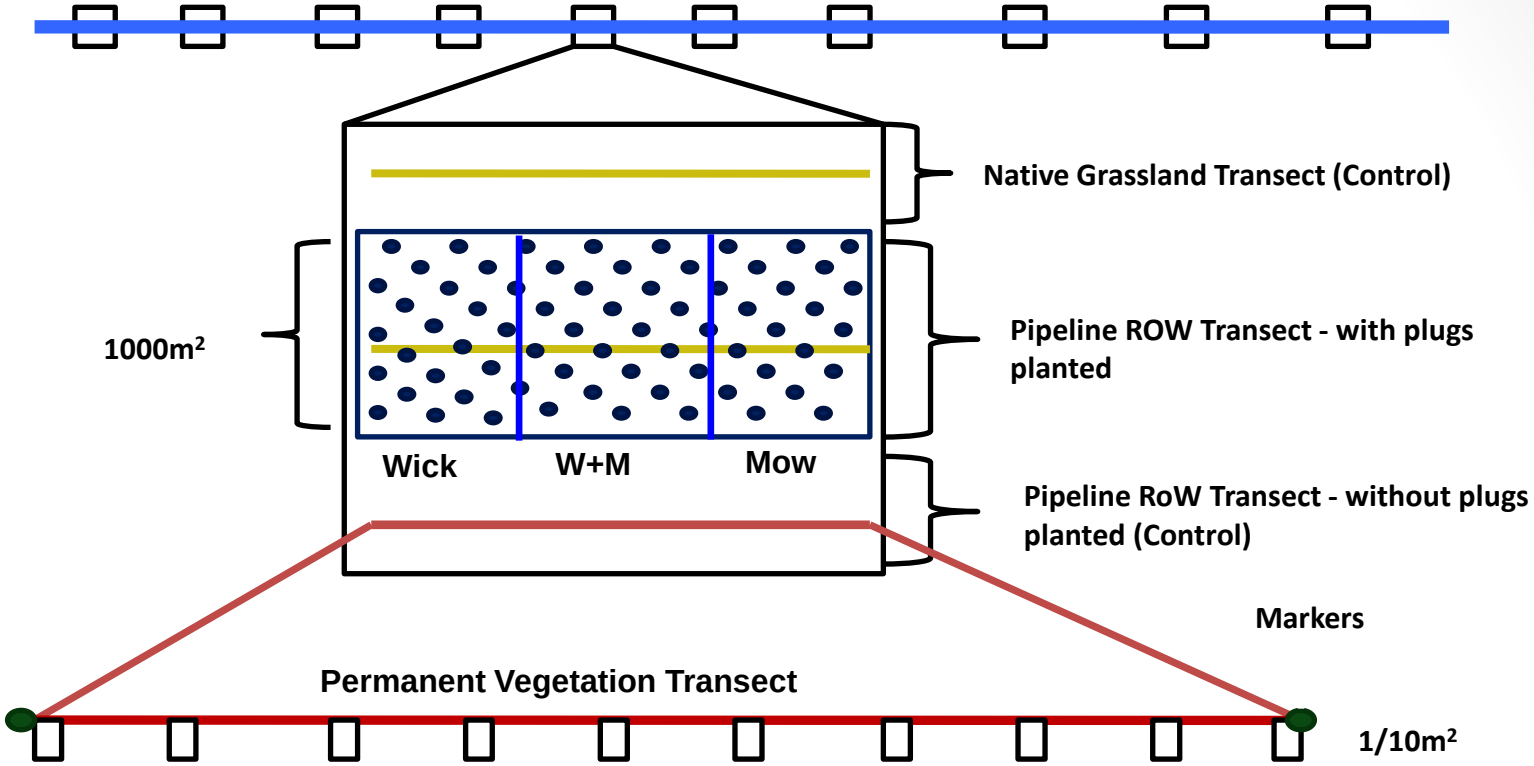
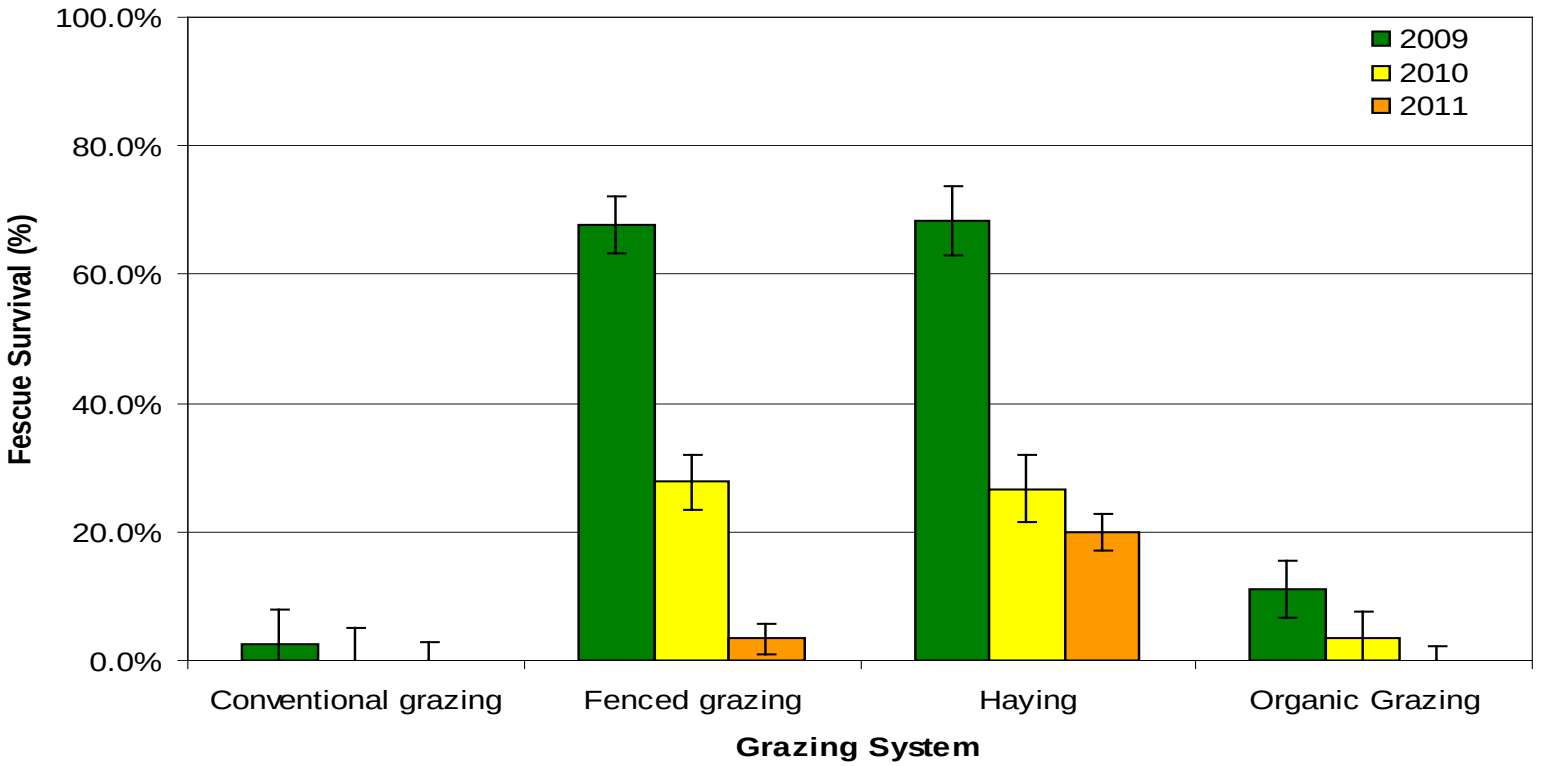


Fig 1: Site Layout with blue line representing the pipeline and each red line representing the vegetation transect within each site (White Block)

Plug Establishment

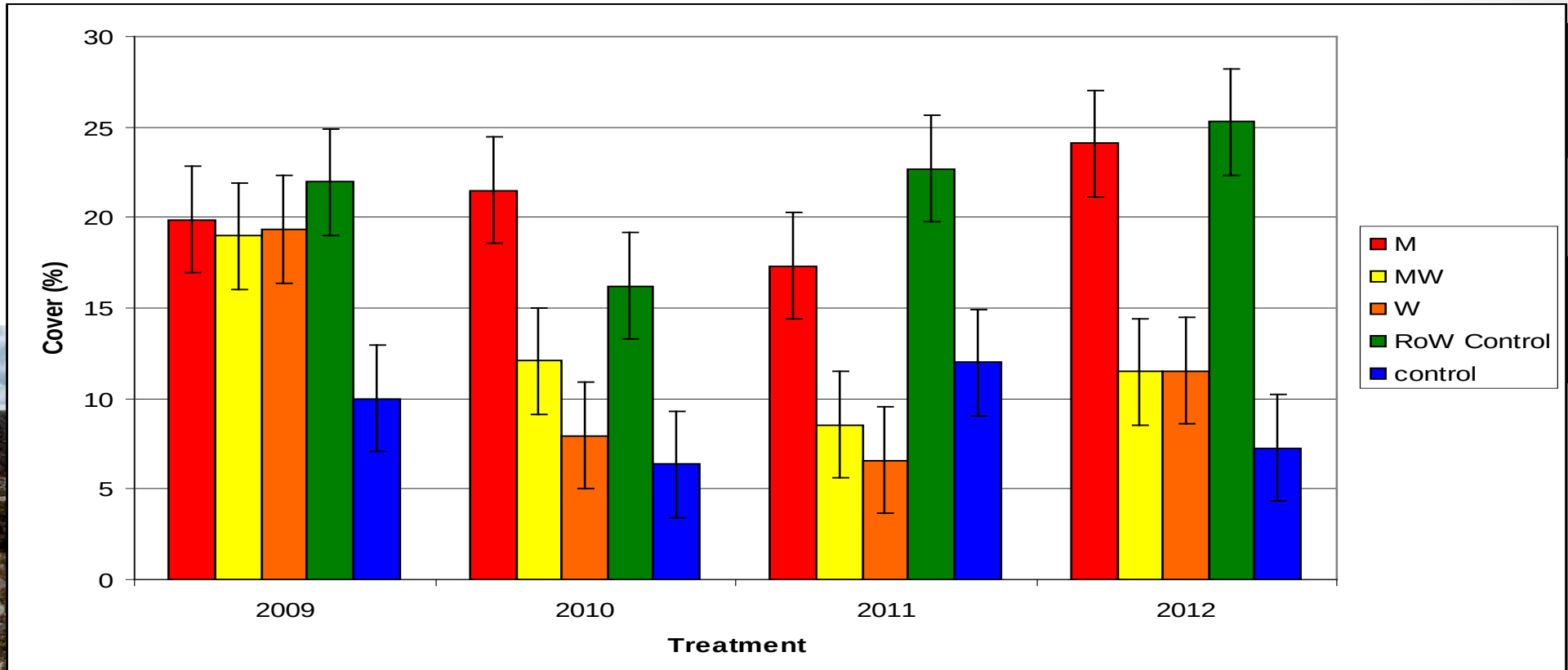
- 1000 plugs established in each of the 10 sites
- Survival of plugs in all sites was extremely low
- Highest survival was in the sites with the highest amount of bare ground



Smooth Brome Control

- Wick Application with or without Mowing was the only method to significantly reduce smooth brome.
- Sooth brome was reduced to levels found in off RoW Controls

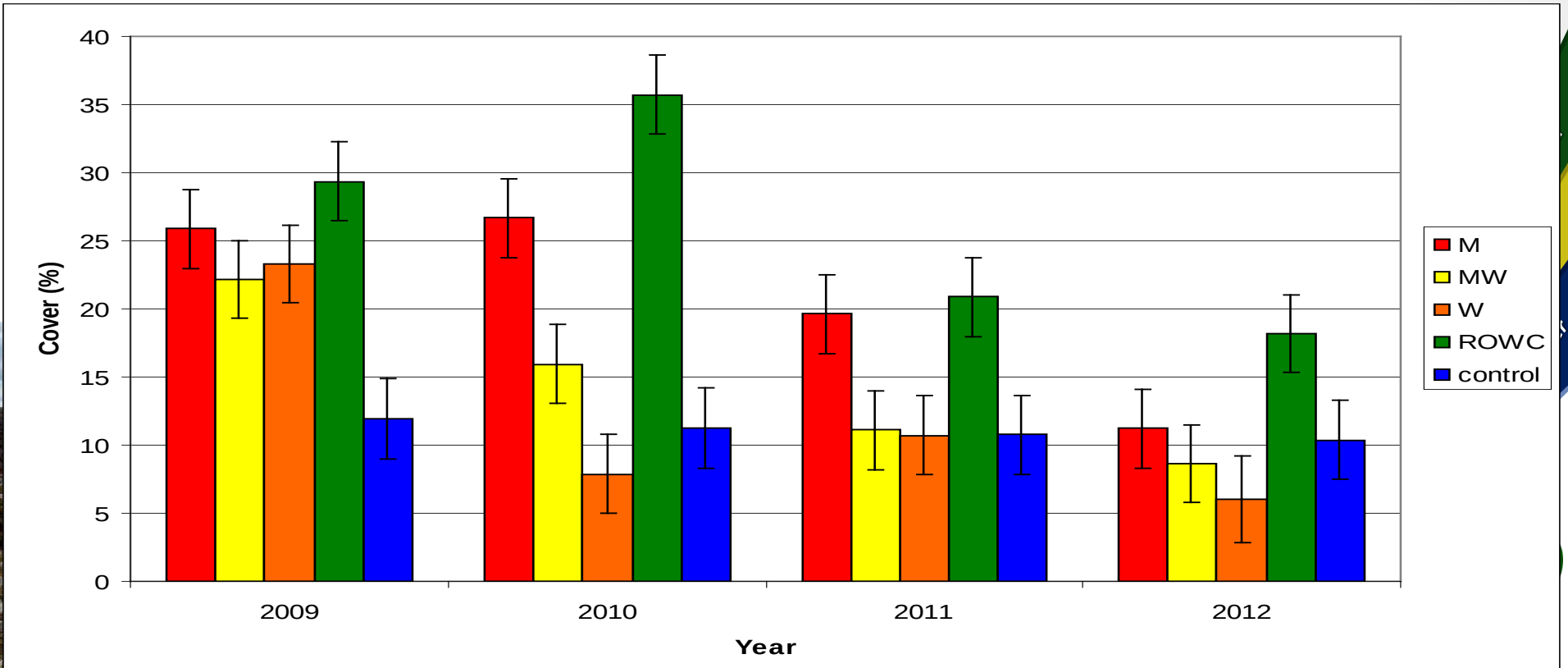
P<0.0001



Timothy Control

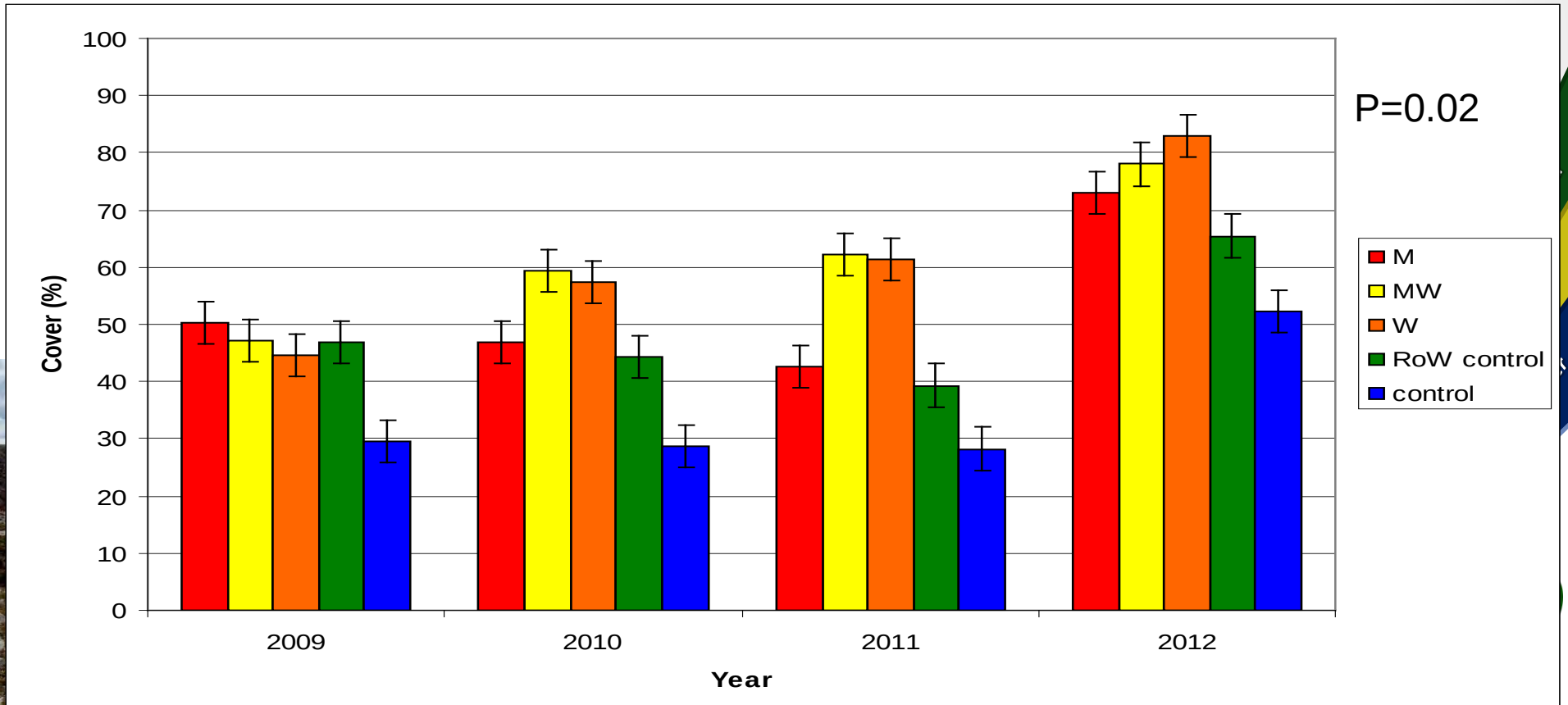
- While wick application was the most efficient at reducing timothy, all treatments effectively reduced timothy to that seen in the control

P<0.0001



Kentucky Bluegrass

- Response of Kentucky bluegrass to treatments
- Kentucky bluegrass was opportunistic and replaced the timothy and smooth brome



PhD Thesis Work

- Four Experiments (2005-2010)
  - In-situ Grassland Study
  - Restoration of Fescue Grasslands
  - **Plant Density Study**
  - Greenhouse Competition Study

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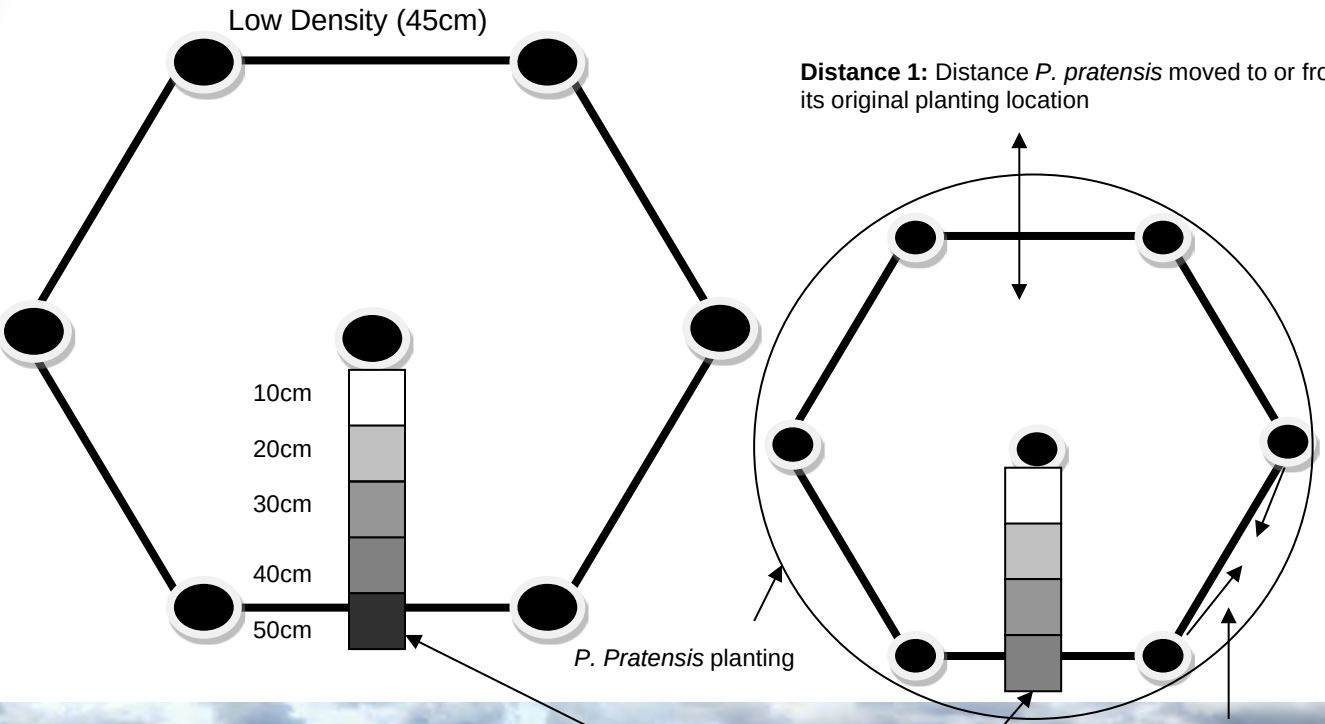
Density Study

Standardized configuration of *F. campestris* and *P. pratensis* plants and measurements taken within the variable density study.



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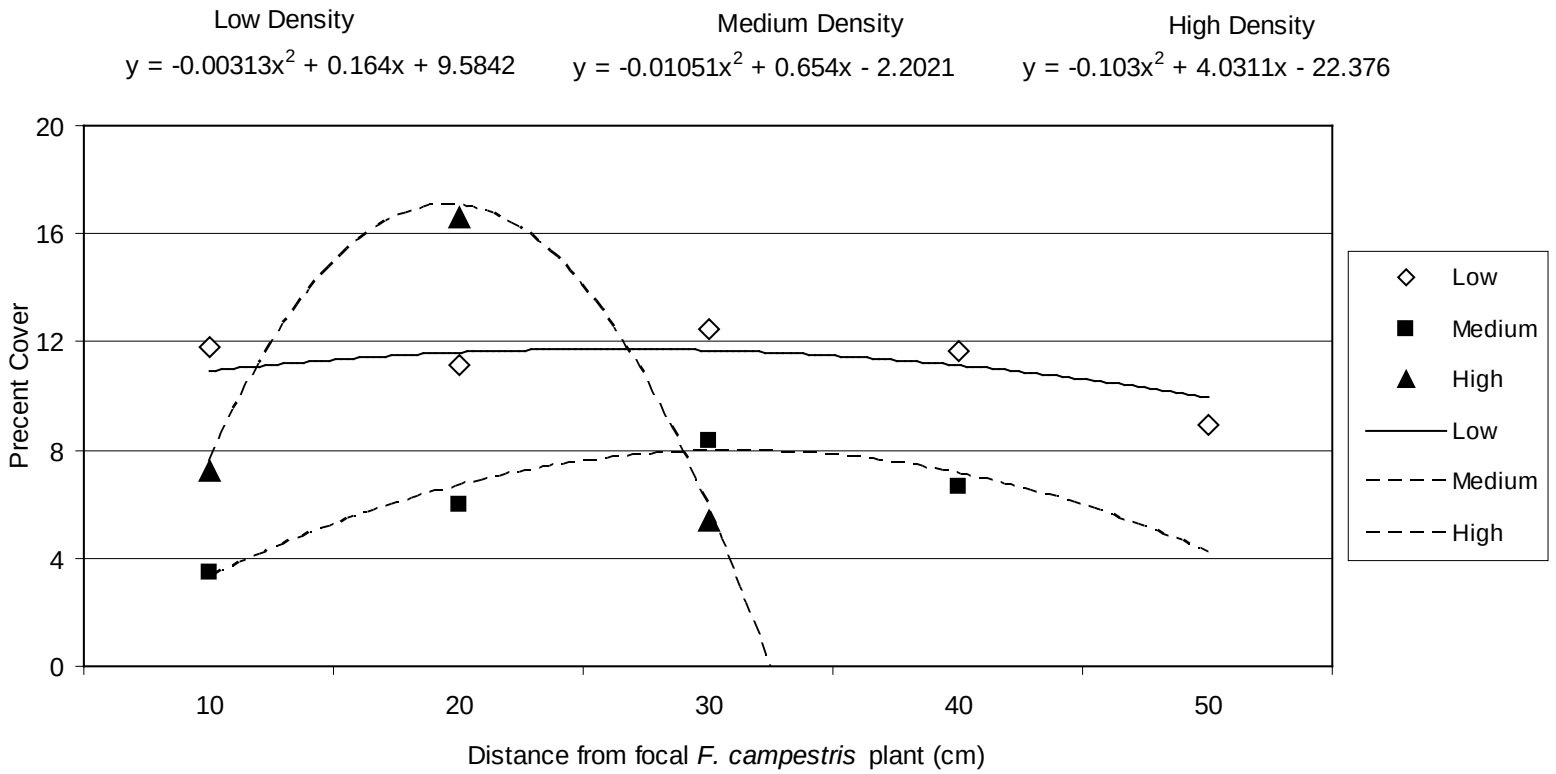
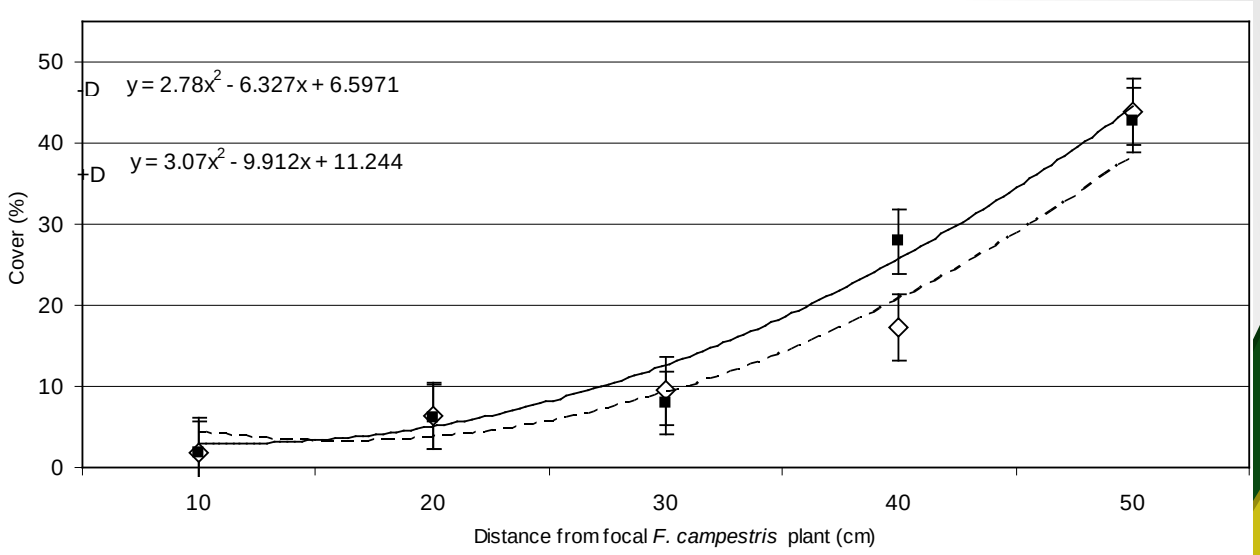
Fescue Germination

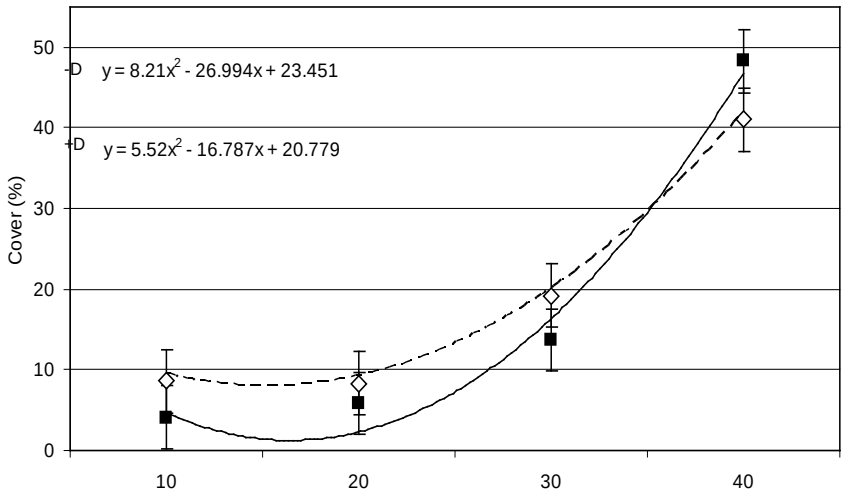
- The interaction of planting density and distance from the focal plant on the cover of *F. campestris* seedlings as measured during the final assessment in 2008. Points represent the mean of all samples within a density x distance combination.

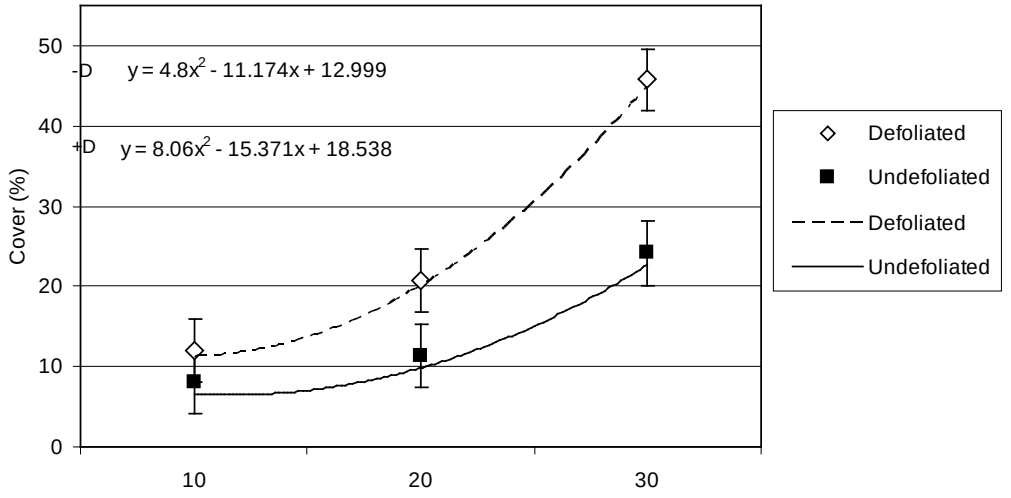


Kentucky Bluegrass Invasion

- The interaction of distance from the focal *F. campestris* plant and defoliation on the cover of *P. pratensis* within stands planted with *F. campestris* at high (top), medium (middle) and low (bottom) density. Means and error bars are from the mixed model analysis.

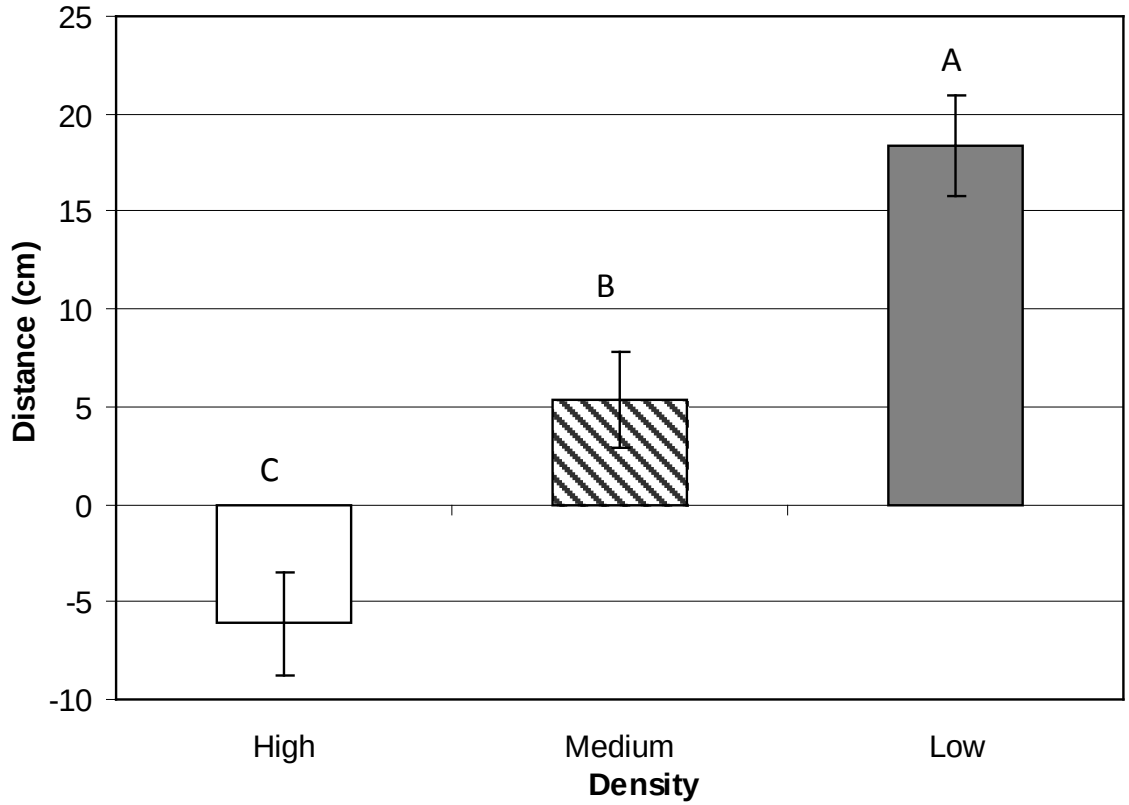






Kentucky Bluegrass Invasion

- The mean distance (SE) of *P. pratensis* encroachment from the perimeter into the plot towards focal *F. campestris* plants at each of 3 different planting densities. Letters show significant differences P<0.05.



Recommended Best Practices

- Designing Your Reclamation Plan
  - Complete a pre-site evaluation
    - Species composition (in native control areas)
      - Complete Species list (run a transect, it is more accurate than a health assessment, you need litter levels, dominant species, rare species, invasive species. This will become part of the trajectory of the site
    - Soils assessment
      - Know the target soils before you start putting soil back
      - Assess soils prior to the re-vegetation component of your plan
    - Erosion issues
      - Assess all erosion types (wind, water, animal related, ATV)

Recommended Best Practices

- Designing Your Reclamation Plan
  - What is the surrounding vegetation like (State and Transition Model)
    - Successional Level (early, mid, late, climax)
    - What obstacles are present to modify the transitional pathway
      - Invasive Species (*P. pratensis, P. prantense, B. inermis, Agropyron cristatum*)
      - Disturbance regime (grazing, haying, mowing, high traffic trampling, flooding…)
  - What Technique is Appropriate: (Natural Recovery, Intensively managed restoration, some form of hybrid

Recommended Best Practices

- Designing Your Reclamation Plan
  - What is the chance native propagules will land on site (Island Biogeography),
    - Edge Effect: How much of the site is on the edge (pipeline vs well vs mine)
    - Location: How close are the native plants
    - Location: How close are the invasive species

Recommended Best Practices

- Designing Your Reclamation Plan
  - Create a seed mix and planting design based on the assessment
    - Seed mix is calculated on seeds/m^2 rate depends on location, site conditions, soil type, timing of seeding, disturbance regime.
    - Seed mix is modified
      - Every time seeding rate is modified
      - When soil types and conditions change
      - When disturbance regime changes
      - When time of the year changes

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Recommended Best Practices

- Designing Your Reclamation Plan
  - Seed sourced should be local and most importantly verified to be what it is labeled as.
    - Fescue species (*Festuca saximontana, Festuca idahoensis, Festuca campestris, Festuca hallii*)
    - *Festuca scabrella* ???
  - Design seed mixes based on topography and site moisture and soil gradients.
    - Dry sites require more *Festuca idahoensis, Danthonia parryii, Koelaria macrantha*…

Recommended Best Practices

- Site Preparation
  - At least one year of weed control is required prior to re-vegetation
  - Spraying with glyphosate for grassy weeds is required
  - Assessment by an experienced re-vegetation specialist is required to determine if site characteristics are suitable to re-vegetation and to ensure invasive species are suitably under control.
  - Tillage should be minimized, but used for seed bed preparation
- Adaptive Management
  - Constant monitoring is required to determine the timing of each action

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Recommended Best Practices

- Re-vegetation
  - Seed all species using a Brillion seed drill where ever possible
  - Seed rough fescue as part of the seed mix (if it does catch it is ideal)
  - Plant rough fescue plugs immediately following seeding (1/m^2= 20-30% cover) to ensure the climax species will be present on site
  - Fall planting of plugs appears to minimize the amount of time weeds have to establish while maximizing the growth of rough fescue

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Acknowledgements

- **Research Support (PhD Thesis)**
  - Dr Edward Bork, Dr Anne Naeth, Dr Walter Willms, Dr J.C. Cahill
- **Financial Support**
  - Compton Petroleum, Apache Canada, Trans Canada Pipelines, Alberta Conservation Association
- **Research Assistants**
  - Alicia Entem, Alethea Bell, Cara Stone, Shauna Fankhauser, Matthias Stone, Michelle Mcleod, Tina Dohms, Eileen Tannas
- **Materials and Land**
  - Eastern Slopes Rangeland Seeds, Many Landowners

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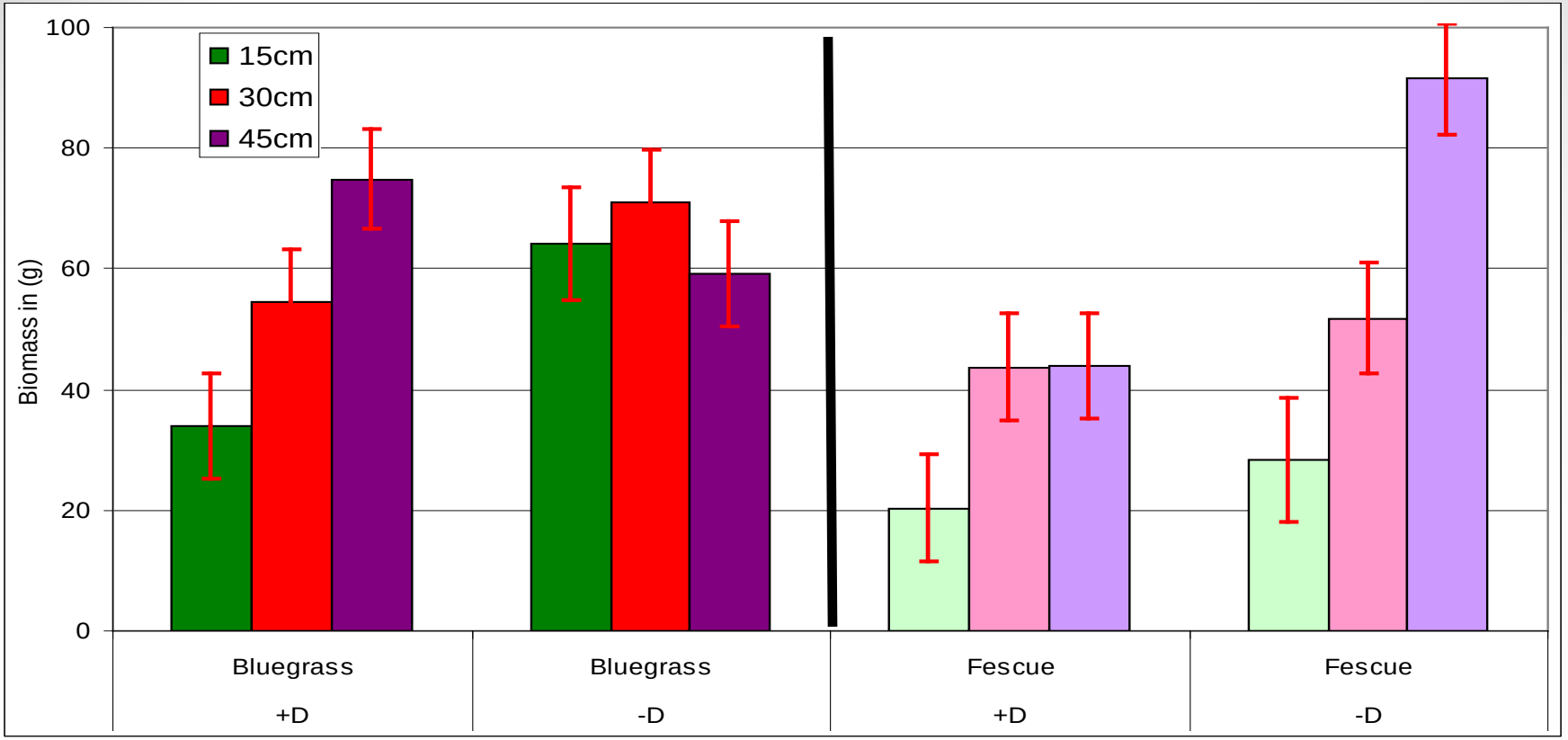

Figure 1: Biomass of bluegrass at 3 densities with and without defoliation of rough fescue.

Figure 2: Biomass of rough fescue grown at 3 densities with and without defoliation.

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