Summary Report
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FPInnovations
Wildfire Operations Research
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Less flammable vegetation for linear industry rights-of-way

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Introduction

Fires can easily ignite and spread quickly in cured (dying and drying) grasses, which respond quickly to changes in air moisture. Once ignited, grass fires respond rapidly to changes in wind direction and speed making them unpredictable and dangerous. The Alberta Biodiversity Monitoring Institute shows that Alberta has 1.4 million kilometres of linear rights-of-way[3] (pipelines, powerlines, seismic lines, railways, and access roads) most of which have been colonized by a variety of grass species. Over the past several years, Alberta has experienced a number of large and challenging wildfires where cured grasses within rights-of-way (ROWs) were a contributing factor (e.g., Chisholm Fire in 2001, House Creek Fire in 2002). In 2005, FPInnovations launched a multi-year study to determine whether a less-flammable, herbaceous species could replace the flammable grasses that typically colonize linear ROWs.

Phase I

Species Selection

Research by Hogenbirk (1996a and 1996b) identified several characteristics that an herbaceous plant must possess to be favorable at mitigating fire hazard:

- Greens up early and cures late
- Maintains a high moisture content through-out the growing season
- Grows low to the ground
- Produces little dead material; decomposes quickly
- Outcompetes other plants
- Can re-establish dominance following a disturbance

Partnering with Alberta Innovates Technology Futures (AITF), we selected five herbaceous species and designed two specialty seed mixes:

Species:

- Rocky Mountain Fescue (*Festuca saximontana*)
- Alsike Clover (*Trifolium hybridum*)
- White Clover (*Trifolium repens*)
- Yarrow (*Achillea millefolium*)

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[3] http://www.abmi.ca/abmi/humanfootprint/hfsummary.jsp

- Fireweed (*Epilobium angustifolium*)

Mixes:

- Agronomic Mix (40% Boreal Creeping Red Fescue; 20% Buffalo Brand Timothy; 20% AC Parkland Crested Wheatgrass; 20% Alsike Clover)
- Rocky Mountain Fescue #4 Mix (12% Sloughgrass; 25% AEC Hillcrest Awned Wheat; 14% Fowl Bluegrass Nutricoat; 27% Nortran Tufted Hairgrass; 22% Fringed Bromegrass Nutra)

Plot Preparation

Individual Species Plots

In May 2005, we prepared and seeded seven 4 x 4 m test plots under fairly controlled conditions at the AITF facility in Vegreville, Alberta. After the first growing season, Rocky Mountain Fescue, Alsike Clover, White Clover, the Agronomic Mix and the Rocky Mountain Fescue #4 Mix showed good growth. Yarrow showed marginal growth, and Fireweed showed poor growth.

Fire Behaviour Plot

In September 2005, we prepared a single 1 ha test plot at the AITF facility in Vegreville, AB. Based on the summer's growth results, we seeded the centre of the plot with all the test species and mixes, except Fireweed. We seeded the west and east sides of the plot with Meadow Bromegrass (*Bromus commutatus*), a flammable grass species (Figure 1).

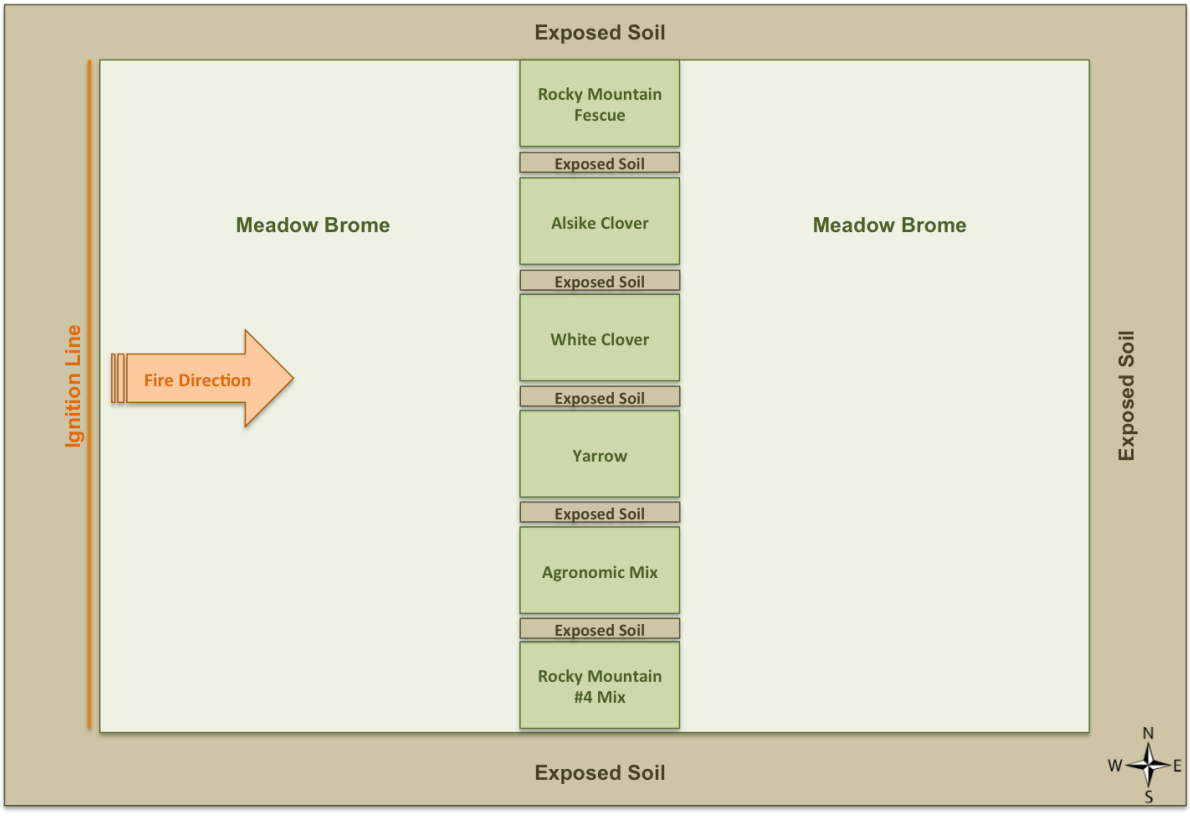

Figure 1. Layout of the 1 ha fire behaviour test plot at the AITF facility in Vegreville, Alberta.

Burn Tests

From 2006 to 2008, we performed a series of two-minute ignition tests in the small individual species plots three times a year: spring, summer, and fall. The fuel load (tonne/ha), plant height, and degree of curing (% dead) were assessed prior to each ignition trial.

In 2007, we ignited the 1 ha fire behaviour test plot (Figure 1). The fire conditions were less extreme than we had hoped, but we were still able to achieve a moderately intense fire (960 kW/m) with a rate of spread of 5 m/min. White Clover, Alsike Clover, and Yarrow stopped the fire abruptly; the Rocky Mountain Fescue and the Agronomic Mix reduced fire behaviour sufficiently to be easily controlled; and the Rocky Mountain Fescue #4 Mix caused no change in the fire behaviour.

Phase II

Species Selection

Based on our measurements and burn trial results from 2006 to 2008, we continued the tests with only three species: Rocky Mountain Fescue, White Clover, and Yarrow. This phase allowed us to evaluate the competitiveness of our test species under typical field conditions.

Rocky Mountain Fescue (Festuca saximontana)

This is a small, densely tufted grass species that sends up long spikelets. It grows well on dry sites and greens up early. The spikelets cure in early fall, but the base remains green. It is a good colonizer, but it can be outcompeted by more aggressive species.

White Clover (Trifolium repens)

This is a small herbaceous perennial plant with creeping, freely rooting stems and long-stalked heads of white to pale pink flowers. White Clover was introduced from Europe as a forage plant, but is now common across North America. It can perform well in infertile soil with good moisture, but in fertile soil it will outcompete native plants and grasses.

Yarrow (Achillea millefolium)

Yarrow is an herbaceous perennial plant with feather-like leaves and flat-topped clusters of little white flowers. Yarrow can grow to 75-80 cm tall. It prefers well-drained soil and full sun, but can tolerate less ideal conditions. Yarrow is drought resistant.

Plot Preparation

With the help of AITF and Alberta Environment and Sustainable Resource Development (ESRD), we chose a study area near Chisholm, Alberta, and in the fall of 2008 we prepared three sites: a low, damp site; a midslope site; and a drier, upland site. The sites were mowed and sprayed with herbicide. The dead vegetation was then burned, and the soil turned over.

The existing vegetation on the lowland site was primarily Bluejoint Reedgrass (*Calamagrostis canadensis*) and Smooth Bromegrass (*Bromus inermis*); Wild Vetch (*Vicia americana*), Tufted Vetch (*Vicia cracca*), and Alsike Clover (*Trifolium hybridum* at the midslope site; and Smooth Bromegrass (*Bromus inermis*) and Timothy (*Phleum pratense*) at the upland site.

The sites were seeded in May 2009. With help from AITF researchers, we designed four treatments:

- Treatment 1: 100% Rocky Mountain Fescue
- Treatment 2: 70% Rocky Mountain Fescue; 30% Yarrow
- Treatment 3: 70% Rocky Mountain Fescue; 30% White Clover
- Treatment 4: 60% Rocky Mountain Fescue; 20% Yarrow; 20% White Clover

To encourage fire spread across the sites, we seeded Agronomic Mix on the perimeter of the treatments. Although our tests results from the Agronomic Mix in Vegreville showed it to be effective at slowing fire spread, we found that it cured earlier than our other test species and became extremely flammable.

Each of the three sites had three replicates of Treatments 1-3. We also seeded a small area at the upland site with Treatment 4. Each site had a slightly different layout because of available space. The lowland site had the largest area and we were able to space out the treated areas and seed the Agronomic Mix around them (Figure 2). A control area was set up across the road to the west of the treated areas. The midslope site was smaller, so we lined up the treatments in an east–west direction across the slope and seeded the Agronomic Mix only along the north and south sides of the treated areas (Figure 3). The upland site was smaller still, so we did not use the Agronomic Mix at all (Figure 4). Treatment 4 was located 30 m northwest of the treated areas at the upland site. There was no space to set up a control area at either the midslope or the upland site.

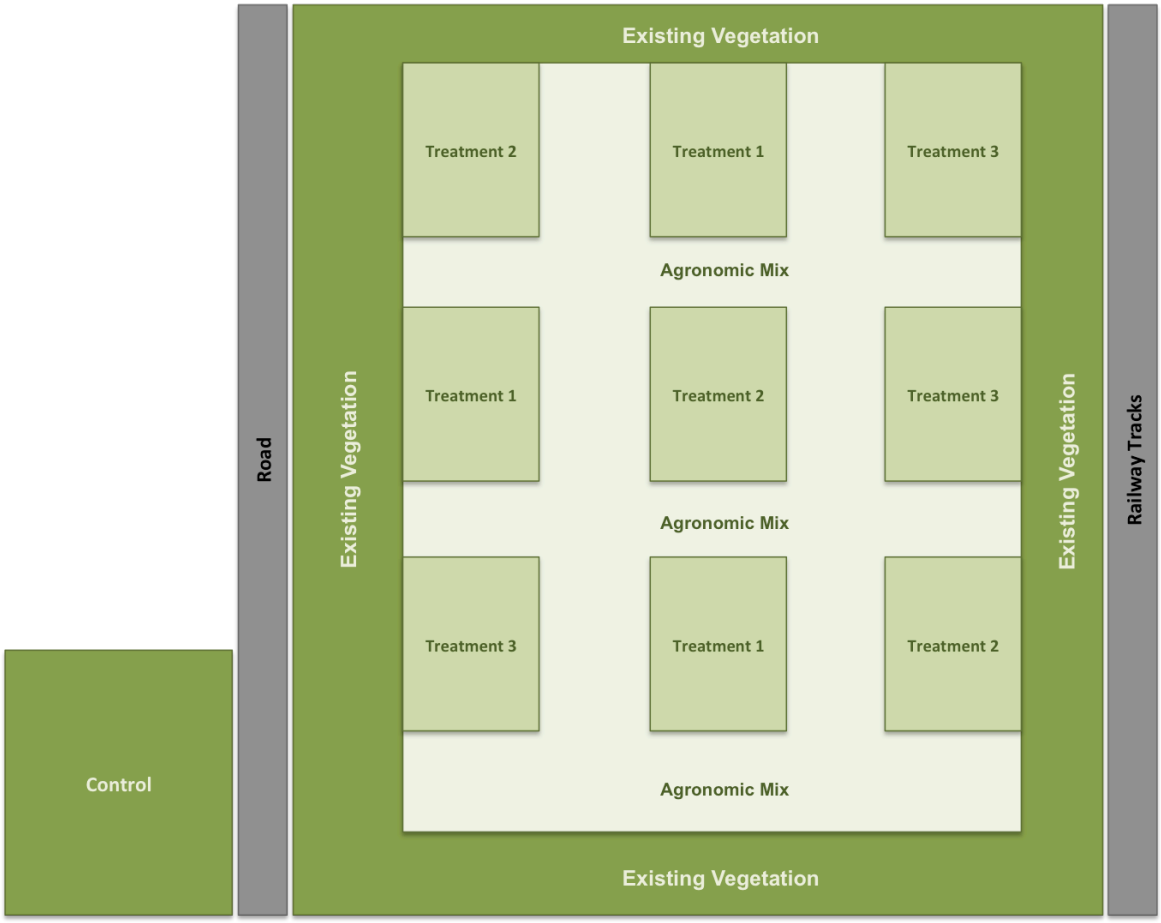

Figure 2. Layout of the lowland site at Chisholm, Alberta.

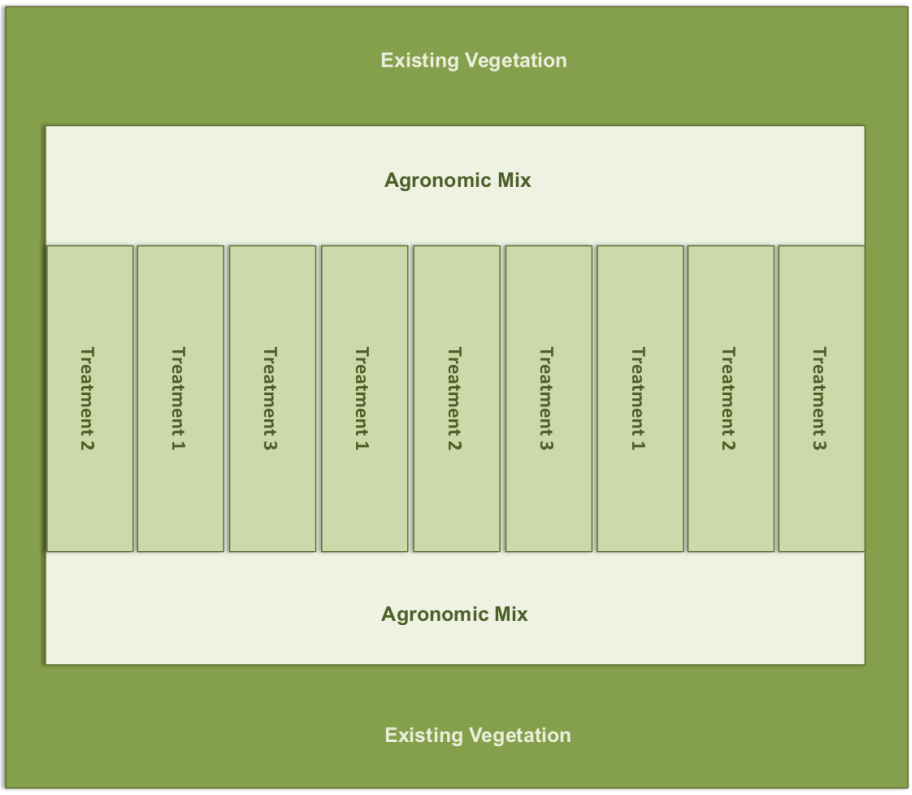

Figure 3. Layout of the midslope site at Chisholm, Alberta.

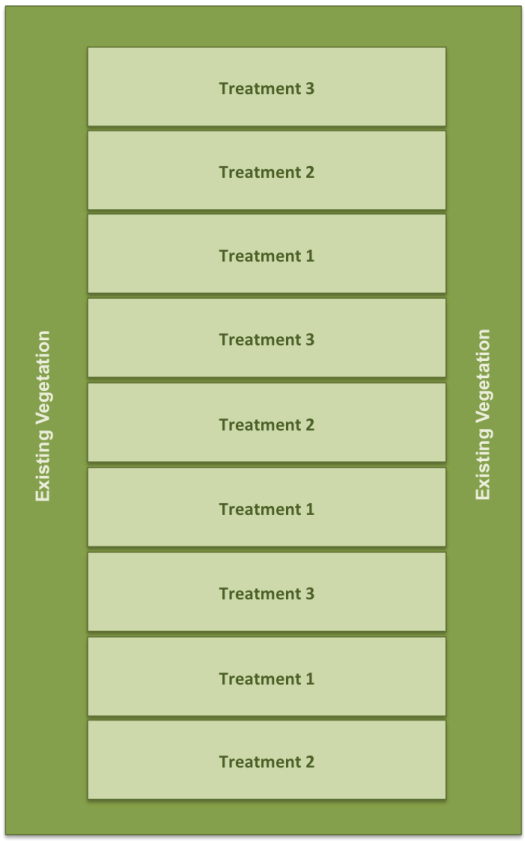

Figure 4. Layout of the upland site at Chisholm, Alberta.

Species Competiveness

We visited the sites regularly over two years to observe growth and competition. By fall 2009, the test species at the lowland site established well and showed good growth rates. The midslope site had been over-run by the two vetch species, which prevented our test species from establishing. We mowed, sprayed, and re-seeded the midslope site. Our test species did not establish well at the upland site, presumably because of the dry sandy soil, and needed to be re-seeded as well.

Plant inventories in 2010 showed that numerous incidental species had established in the treated areas at the lowland site. Nevertheless, our test species still accounted for more than 50% of the vegetation present that year. We burned the lowland site in October 2010. At the midslope site, however, vetch had completely outcompeted our test species, and at the upland site our test species continued to suffer from poor establishment and slow growth.

In 2011, our test species had re-established at the lowland site. But Bluejoint Reedgrass, an aggressive colonizer, had also made an appearance. The midslope site continued to be dominated by the two vetch species, and before we had a chance to evaluate the upland site, wildfire suppression crews had turned it into a fireguard destroying our treatments. Later in 2011, however, we were able to seed an 800 m portion of that fireguard with 100% Rocky Mountain Fescue.

By 2012, Bluejoint Reedgrass had overtaken the lowland site and completely outcompeted our test species. The vetch continued to dominate the midslope site. Along the fireguard, however, the Rocky Mountain Fescue had established and was growing well.

In 2013, we officially abandoned the lowland site because it had been completely dominated by Bluejoint Reedgrass. At the midslope site, we mowed and sprayed to remove the vetch, and re-seeded our test species. The Rocky Mountain Fescue had colonized the fireguard extremely well and although numerous incidental plant species were present, Rocky Mountain Fescue accounted for nearly 70%.

Burn Tests

The only site we burned during this study was the lowland site (2010). The test species had grown well and were still green while the existing vegetation and the Agronomic Mix had cured nearly 100%. Before we ignited, we measured the fuel load and moisture content in both the treated areas and control. The fuel load in the treated areas averaged 3.7 t/ha; in the control the fuel load was 7.5 t/ha. The moisture content of the vegetation in the treated areas averaged 44%; in the control the moisture content of the vegetation was 18%. The vegetation in the treated areas was slightly shorter (1.0 m) than that in the control (1.25 m).

We used three ignitions for the lowland study site. We first ignited the top row of treatments in Figure 2 and burned from left to right. As the fire reached Treatment 2 (100% Rocky Mountain Fescue; 30% Yarrow) the wind was 10 km/hr, gusting to 20 km/hr. Yarrow's tall cured flower heads carried the fire with flame lengths reaching 1.5 m. As the fire reached Treatment 2 (100% Rocky Mountain Fescue), the flame length dropped to <0.5 m, and the fire crept along slowly until it self-extinguished. The fire never reached Treatment 3.

We then ignited the second and third treatment rows. The wind gusted less often and a slow creeping surface fire passed through the treatments. Fire intensity was minimal and the vegetation was only partially consumed. The high moisture content within the treatments resulted in a lot of grey smoke.

The third ignition was the control. The vegetation was >90% cured and weather conditions were the same as the second ignition. Flame lengths ranged from 1.5 to 2.5 m and rate of spread was 45 m/min. The vegetation in the control was completely consumed.

Table 1. Fire behaviour in the control and treated areas at the lowland site in Chisholm, Alberta.

	Average Flame Length (m)	Fire Intensity (kW/m)	Rate of Spread (m/min)
Treated	0.75	168	Nil
Control	2.25	1500	45

Findings

The three species we tested for this study did reduce fire behaviour. Although we were only able to burn one of our three sites, we had several treatment replicates all of which showed a minimal rate of spread and low flame heights compared to a control plot of existing vegetation burned under the same conditions. We had some problems with existing species successfully competing against the test species despite several attempts to control the existing species thorough site preparation and herbicide application. Re-vegetating a site dominated by aggressive species with low-growing vegetation is not always easy, and the competitiveness of your preferred species will depend on site conditions and the aggressiveness of existing vegetation.

Without question, significant costs are involved in the preparation, seeding, and maintenance of areas slated for species conversion. For this study, these costs totaled approximately $38,000. But these costs can vary significantly depending on how much and what kind of site preparation is required; the regional variations in the price of seed; and the extent of maintenance required throughout the growing season. These costs must be balanced against the cost of suppressing a wildfire and the cost associated with damaged homes and infrastructure.

Although the original intent of this study was to identify plant species that could be used in industry ROWs, these species could also be used to replace flammable grasses in wildland-urban interface areas, or anywhere where flammable grasses pose a fire hazard.

Undoubtedly, there are numerous other species of plants that may also be very effective at reducing fire behaviour. We tested only three. While terrain and site conditions will determine the species most suitable for a given area, provincial legislation will ultimately dictate which species can be used. In Alberta, the provincial government has produced *A Guide to Using Native Plants on Disturbed Lands*[4], which provides up-to-date information on native plants suited to the various natural regions and site types across Alberta. All three of the species we tested are listed in this guide.

For more details on this study including site preparation, burn tests, and photos, please refer to the following reports, all of which can be found on the FPInnovations Wildfire Operations website:

[4] http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex78

2011 Burn trial of a lowland site vegetated by less-flammable species

2010 Differences in species flammability: identifying less-flammable vegetation

2009 Update: Field planting less-flammable species at Chisholm, Alberta

2005 Update: Species flammability and resistance research

References

Hogenbirk, JC. 1996a. Report of the fire hazard reduction project. Ontario Ministry of Natural Resources. Toronto, ON.

Hogenbirk, JC. 1996b. The potential role of greenstripping in right-of-way vegetation management. Bell Canada, CP Rail System, and Laurentian University.