WILDLIFE MITIGATION BURN PERFORMANCE MONITORING AT THE FORDING COAL LTD. – FORDING RIVER MINE

C.R. Smyth[1], D. Paton[2], R. Berdusco[3], B. O'Brien[4] and G. Sword[5]

[1] EBA Engineering Consultants Ltd.
270, 200 Rivercrest Drive SE
Calgary, AB, T2C 2X5

[2] Anatum Ecological Consulting Ltd.
P.O. Box 382
Blairmore, AB, T0K 0E0

[3,4,5] Fording Coal Ltd. – Fording River Operations
P.O. Box 100
Elkford, BC, V0B 1H0

ABSTRACT

Fording Coal Ltd. – Fording River Operations implemented a prescribed burn program in 1997 with the intention of mitigating the effects of habitat loss associated with the Henretta Ridge mining development. The objective of the mitigation burns was to increase wildlife habitat suitability and to provide winter habitat for elk and moose. Mitigation burns were completed in six areas. Each of these areas was subjected to a similar prescribed burn.

A total of thirty-six transects were located in burned and unburned habitats. Vegetation, wildlife use and standing crop production (production clip) data were collected at each of the transects. The effects of the prescribed burn treatments on forest cover were evaluated with pre- and post-burn aerial photographs.

The prescribed burns have been very successful. Firstly, canopy closure has been reduced in the areas where previously there was extensive crown closure. Secondly, plant species dominance has been altered. The change in species dominance has resulted in a greater abundance in herbaceous species and, therefore, potential forage. The increased cover of palatable grass and forb species is particularly beneficial for the enhancement of elk winter range. Standing crop production measurements have revealed that forage production and, consequently, Animal Unit Months (AUMs) have increased greatly. Thirdly, there has been a change in stand structure. The tall shrubs present prior to the burn are now producing forage within reach of the ungulates.

INTRODUCTION

Expansion of mining activities in the Henretta Valley at Fording Coal Limited – Fording River Operations area will, when completed, disturb 131.0 hectares of Class 2 and Class 3 elk winter range and Class 3 moose winter range on the south slopes of Henretta Ridge (Fording Coal Limited 1996). Consequently, Fording Coal Limited initiated a prescribed burn program in 1997 to mitigate the effects of the Henretta Ridge development on the indigenous populations of ungulate species.

Six mitigation burn areas totaling 390.0 hectares (87.1 hectares of habitat improvement) were identified by Fording River personnel in consultation with the British Columbia Ministry of Water, Land and Air Protection. Three of these areas, the focus of the monitoring program described in this paper, were burned in the spring of 1997. The purpose of the enhancement was to mitigate the impacts to wildlife by the mining activities through increasing the habitat suitability of the proposed enhancement area. The specific objective of the mitigation burn was an increase in habitat suitability for 5.5 elk for the onsite areas and 4.0 elk and 1.5 moose for the offsite areas (Table 1).

Table 1.
Controlled-burn target areas and expected increases in suitability for elk and moose.

Site	Priority	Total Area (ha)	Total Area of Habitat Improvements (ha)	Expected Increase
On-site Areas				
Turn Creek (TC)	2	32.5	9.8	0.5 elk
Henretta East (HE)	3	25.5	8.2	1.0 elk
Turnbull South (TS)	1	165.0	25.0	4.0 elk
Off-site Areas				
Lookout Draw (LD)	6	39.5	5.9	0.5 elk
Lookout Bowl (LB)	5	87.5	26.2	3.5 elk
Britt Creek (BC)	4	40.0	12.0	1.5 moose
Total		390.0	87.1	9.5 elk / 1.5 moose

The enhancement areas are located in the ESSFdk and ESSFdkp subzones of the Engelmann Spruce – Subalpine Fir biogeoclimatic zone and are characterized by six physiognomic classifications: (1) grassland (2) shrubland, (3) deciduous (aspen) forest, (4) open coniferous forest, (5) closed coniferous forest and (6) mixed conifer/aspen forests. The North Greenhills prescribed burn areas are located off the mine property on the west slopes of the Greenhills Range immediately below and to the north of the fire lookout tower. The prescribed burn areas are located on the mine property on south- and west-facing slopes of Henretta Ridge and Turnbull Mountain.

MONITORING OBJECTIVES

The objective of the monitoring program was to evaluate the results of the prescribed burn in terms of a reduction in forest cover and an increase in forage production and wildlife utilization.

METHODOLOGY

The monitoring methodology follows, for the most part, the *Procedures for Environmental Monitoring in Range and Wildlife Habitat Management* (Habitat Monitoring Committee 1996). Three paired (unburned control and burned treatment) transects were established in each enhancement area. The use of paired transects enables monitoring or trend analysis and permits direct comparisons of treated and untreated vegetation stands.

The monitoring program has a sampling frequency of once every two years for a period of six years and then a single monitoring “event” after a subsequent period of five years. Monitoring began in the year following the burns at these sites.

Site Description

Habitat descriptions were recorded for each transect location. 'Signs' or indirect evidence of wildlife presence were part of the general site descriptions as well. Evidence of wildlife utilization included indirect 'sign' observations, e.g., sounds, home-site, browse utilization, territorial markings and excavations. The additional indirect observations provide valuable habitat-use information other than changes in habitat forage production and utilization.

Vegetation Monitoring

Vegetation was sampled within 15 microplots placed randomly along 30 metre transects. At each microplot location, a 20 centimeter x 50 centimeter microplot was used for grasses and forbs. The canopy coverage method of Daubenmire (1959) was used for the microplot sampling. Low shrub cover was estimated using $1m^2$ quadrats. A single 20 metre x 20 metre macroplot was located at the center of each transect to estimate the canopy coverage of trees and tall shrubs (stems > 2.5 metre). A densitometer was used to estimate tree canopy cover.

Transects were located in broadly representative locations. Transects located in sloping terrain were positioned parallel to slope contours. Both ends of each transect were marked permanently with painted (florescent orange) survey stakes to facilitate future plot locations.

Cover estimates for all species found within the microplots were recorded to the nearest percent. Species distribution and vigor data were also recorded. Plant specimens were identified to species.

Differences in dominant and understory vegetation between the control (non-burned vegetation) and treatments (prescribed burn) were analyzed by the Multi-Response Permutation Procedure (MRPP), by the Kruskal-Wallis Analysis of Variance and by Indicator Species Analysis.

Species Composition

Species percent cover data was used to calculate diversity measures within the controls and treatments. Three measures of diversity, i.e., species richness, diversity and evenness, were calculated.

Herbaceous Forage Production

The success of prescribed burn to enhance wildlife habitat is determined, in large measure, by increases in forage available to the target ungulates. Therefore, herbaceous forage production was measured for the control and treatment sites and the results were compared. In this monitoring program, three pairs per treatment/control per area were located.

The forage production assessments were completed as the vegetation and site assessments were being completed. At each transect, a representative 50-centimeter x 100-centimeter rectangular quadrat or sampling unit was clipped to a height of 2 centimeters. Another clip was made within the exclosure cage. Litter was removed and bagged prior to clipping. The clipping material was separated into shrubs (< 2.5 metres) grasses (and grass-like vegetation) and forbs and placed into labeled bags for drying. Only the current year's growth of shrubs was clipped (Bonham 1989). Herbage production clips (samples) were weighed, oven-dried and re-weighed to the nearest 0.1 gram. Production (kilograms/hectares) was calculated from raw data (grams/0.5 $metres^2$) using a conversion factor (x20). Animal Units (AUs) were calculated using the formula described by Gayton (1993).

Pellet Group Surveys

Ungulate fecal pellet group surveys were conducted at each transect location using method 4 (Luttmerding et al. 1990). All pellet groups present within the segments were removed from the segments following each observation to enable comparisons between years (Lancia et al. 1994). The results of the pellet group counts were used to examine the relative differences in elk and moose activities between treatment and control areas. The pellet group data have been used to estimate the abundance of elk or moose previously (Neff 1968). The equation provided by Stordeur (1984) was used for the abundance estimate. In these calculations, the defecation rate for moose was assumed to be 13 times per day, and the defecation rate for elk was assumed to be 11 times per day (Harestad and Bunnell 1984). The deposition period is thought to be 150 days/year (Demarchi 1995).

RESULTS AND DISCUSSION

The following text describes the results of the monitoring undertaken at both the onsite and offsite prescribed burn mitigation areas.

Site Description

The burn/control areas are located on moderately steep to steep, warm slopes. The mesoslope positions range from lower to upper slopes. The ecological moisture regime of the sites varies between subxeric and mesic, but most of the sites are submesic. The ecological nutrient regime ranges from submesotrophic to mesotrophic. The predominant structural stages for the vegetation are young coniferous or deciduous forests.

Prescribed Burn Evaluation

The overall success of the burn was determined by examining before and after aerial photographs. Assessment was also undertaken on the ground using the criteria developed by Ryan and Noste (1985) and Brown and Simmerman (1986).

Burn statistics are provided in Table 2. The proportion of area burned in each of the enhancement areas ranged from 10.0 to 60.0 percent.

The grassland and shrub land areas were subjected typically to light or moderate ground fires and although the litter and some of the mineral soil were charred, burning was patchy, and the bases of some of the plants were not burned deeply. The aspen enhancement areas were subjected to moderate to high intensity burns that would be classified as stand replacement fires. Most of the twigs and small branches were burned completely, and many of the larger branches were deeply charred. The few remaining live trees have numerous fire scars. The majority of the mixed coniferous stands were subjected to moderately intense burns. These burns were patchy because rock outcrops break up the topography. Variable topography enhances the likelihood of low severity or mixed severity burns (Smith and Fischer 1997). Fire severity was moderate in most of the closed coniferous forest stands. In several stands, the shade–tolerant species growing in the understory appear to have provided fuel ladders into the crown.

Table 2. Burn effectiveness.

Enhancement Area	Habitat Type	Percent Burned	Burn Intensity	Ground Char	Tree Mortality	Litter Consumption
Turn Creek (TC)	open coniferous	15	light – moderate	moderate	light	low (patchy)
	closed coniferous	25	light – moderate	moderate	light	moderate
Henretta East (HE)	open aspen / grassland	55	light – moderate	moderate	high	low (patchy)
	shrubland	55	light – moderate	moderate	moderate	low (patchy)
	mixed conifer / aspen	10	moderate	moderate	moderate	high
Turnbull South (TS)	closed coniferous	20	light – moderate	moderate	moderate	high
	open coniferous	45	moderate	light – moderate	moderate	moderate
	aspen	45	high	deep ground char	high	high
Lookout Draw (LD)	aspen	60	light	deep ground char	moderate	high
	grassland / open shrubland	60	light	light	moderate	low (patchy)
	mixed coniferous	10	moderate	moderate	moderate	low (patchy)
Lookout Bowl (LB)	aspen	35	moderate	moderate	moderate	moderate
	open coniferous	35	light – moderate	light – moderate	moderate	moderate
	closed coniferous	20	light	light – moderate	moderate	moderate
Britt Creek (BC)	aspen	60	extensive	deep ground char	high	extensive
	open coniferous	30	light – moderate	light – moderate	moderate	moderate
	closed coniferous	30	moderate - high	moderate - high	high	high

<u>Vegetation Monitoring</u>

Species richness (R) increased in the burn treatments over the monitoring period, and although still lower than the unburned controls, the difference decreased over the monitoring period. Calculation of Shannon’s diversity (H’) indicated very little change in species proportional abundance has occurred during the six years since prescribed burning. Evenness (E), the extent to which all species in a community are equally abundant, remained constant between the unburned control burned treatment during the monitoring period.

Total cover increased in each of the vegetation types and sites over the past six years although the greatest increase in cover occurred in the burn treatments. Shrub cover increased at each of the sites, but the burned treatments were typically lower than the unburned controls. Increases in shrub cover since burning ranged from 0.4 – 5.4 percent for the unburned controls and from 1.0 – 3.1 percent for the burned treatments.

Mean forb cover within the unburned controls increased by 2.5 – 2.8 percent while forb cover within the burn treatments increased by 4.8 – 7.9 percent. Mean graminoid cover within the unburned controls increased by 0.5 – 0.7 percent while graminoid cover within the burn treatments increased by 0.3 – 4.8 percent.

Species Change

The vegetation data was analyzed to examine change in species changes and changes in species dominance. In general, species turnover was small within sites and treatments.

Individual species response to prescribed burning was variable within the monitoring areas. Mortality of lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Franco) and Douglas fir (*Pseudotsuga menziesii* var. *glauca* Franco) trees, saplings and seedlings was high, and only a few lodgepole pine seedlings were observed. Scorched boles (Miller 2000) are common in the burned areas that were forested previously.

The percent cover of woody species such as trembling aspen (*Populus tremuloides* Michx.), prickly rose (*Rosa acicularis* Lindl.), soapberry (*Shepherdia canadensis* L.), Scouler's willow (*Salix scouleriana* Barratt) and western thimbleberry (*Rubus parviflorus* Nutt.) decreased significantly due to the prescribed burn. However, shrubs such as Scouler's willow and Saskatoon (*Amelanchier alnifolia* Nutt.) re-sprout from root crowns following fire (Lyon and Stickney 1976), and their cover has increased in the last two years. As described by Bartos et al. (1994), aspen rejuvenation is progressing well within the burned trembling aspen stands at each site. The species listed above have been reported as moderately to highly fire resistant and long-lived seral species (Smith and Fischer 2000). Re-sprouting has been most prominent in Scouler's willow, prickly rose, thimbleberry, trembling aspen and birch-leaved spirea *(Spirea betulifolia* Pall.).

Extensive growth of showy aster (*Aster conspicuus* Lindl.) was observed at most of the sites. Showy aster is a moderately fire resistant facultative seral species that sprouts from surviving rhizomes (Smith and Fischer 2000). As well, species such as Hooker's fairy-bell (*Disporum hookeri* Torr.), heart-leaved arnica (*Arnica cordifolia* Hook.) that sprout from surviving rhizomes have returned.

Indicator species analysis revealed that showy aster (*Aster conspicuus* Lindl.), birch-leaf spirea (*Spirea betulifolia* Pall), fireweed (*Epilobium angustifolium* L.), western meadow rue (*Thalictrum occidentale* A. Gray) and thimbleberry all respond favorably to prescribed fire. In contrast, golden ragged moss (*Brachythecium salebrosum* B.S.G.), green trumpet lichen (*Cladonia fimbriata* L.), common pohlia (*Pohlia cruda* Lindb.), star-flowered Solomon's seal (*Smilacina stellata* Desf.) and soapberry are all negatively correlated with fire and have a strong affinity for undisturbed forested sites.

A multi-response permutation procedure analysis (MRPP) was applied to the vegetation data. The results of the analysis (T = – 2.11, $\sigma\delta_{observed}$ = 22.80, $\delta\sigma_{expected}$ = 23.46, p = 0.03) indicate that there is a statistical difference between the burn treatments and the unburned controls.

A Kruskal-Wallis One-way Analysis of Variance was applied individually to plant growth habit groupings, i.e., trees, shrubs, forbs, grasses, sedges, mosses and lichens. Significant differences statistically between the unburned and burned treatments were recorded for shrubs (Mann-Whitney U Statistic = 4.00, X^2 = 5.82 with 1df, p = 0.02) and grasses (Mann-Whitney U Statistic = 4.00, X^2 = 2.39 with 1df, p = 0.001).

Pairwise percent similarity comparisons reveal the efficacy of the prescribed burns in altering vegetation structure and species dominance. Species turnover, for the most part, has been small within sites and treatments. The paired transects with the greatest dissimilarity or lowest percentages were those in which the fire decreased effectively tree and shrub cover. In response to burning, these areas typically have much higher forb cover.

Forage Species Composition and Diversity

Willows and buffaloberry shrubs often grow beyond the reach of ungulates, and prescribed fire can promote their availability to ungulates by reducing their height (Payne and Bryant 1994) and the abundance of young shoots (Leege 1969). The effectiveness of wildlife habitat mitigation burns is determined by the degree to which stand structure is altered, and palatable forage species cover is increased. In the present study, both of these benefits of prescribed burning were observed in the burned treatments. To evaluate the efficacy of the burns at each site, between-treatment comparisons of forage cover were made from transect species lists.

The number of browsed shrub and herb species as well as the magnitude of their utilization has increased at each of the sites over the monitoring period. In contrast, the number of browsed shrub species has increased at both the unburned controls and burned treatments.

The percentage of browsed shrub species decreased during the first two years following the burn but increased in the subsequent 4 years. Mean shrub browse utilization for the unburned controls increased during the monitoring period by 2.0 to 3.4 percent while the percentage of browsed shrubs in the burned treatments increased by 9.7 to 15.8 percent.

The proportion of grazed herbs increased by a range of 5.6 to 7.2 percent for the unburned controls while the proportion of grazed herbs in the burned treatments increased by 13.1 to 22.9 percent.

Forage Production

In general, research indicates that burning produces positive results for elk (Davis 1977, Canon et al. 1987). During the first 5 to 10 years following stand-replacement fires, grass and forb biomass generally increases. Often, grass and forb biomass decrease the first season after fire but increase in the second and third growing seasons to above pre-fire levels. Typically, grass species recover more slowly than forbs (Bartos et al. 1994).

Total standing crop recorded for the burned treatments were consistently higher than the unburned controls at each of the sites although the differences were not significant statistically. Total production for the unburned controls during the past year has averaged 1888.3 kilograms/hectare while production has averaged 3019.3 for the burned treatments.

Shrub standing crop production during the past five years averaged 722.2 kilograms/hectare for the unburned controls and 730.9 kilograms/hectare for the burned treatments while forb standing crop production averaged 866.6 kilograms/hectare in the unburned controls and 1648.3 kilograms/hectare in the burned treatments. Graminoid (grass and sedge) production averaged 260.4 kilograms/hectare in the unburned controls and 678.8 kilograms/hectare in the burned treatments.

Wildlife Habitat Use

The following text describes the wildlife habitat associated with each of the monitoring transects. The wildlife forage production values were compared to the forage classes of Demarchi and Harcombe (1982). Both the unburned control and burned treatment had well over 1000.0 kilograms/hectare, indicating that both treatments would be classified as Class 1 forage capability.

Estimates of the number of animals as well as Animal Unit Months (AUMs) that can be supported in the enhancement areas were calculated using the statistics provided in Table 3. Maximum daily food intake by the respective species was chosen for the calculations. Based on these calculations, it would appear that the targets for increases in winter habitat suitability have been met or exceeded by the mitigation burns in these areas (Tables 4 and 5). Forage production in all three sites is classified as Class 1 forage.

Table 3.
Mean adult weights, daily food intake and forage consumed per month.

Species	Mean Weight (kg)	Daily Food Intake (kg)	Forage Consumed / Month
Animal Unit	455	12	360
Adult Elk	320	11 – 18	450
Adult Moose	450	18 – 27	675

Table 4.
Number of animals and animal unit month calculations for the Henretta East, Turn Creek and Turnbull South burn sites.

Site	Total Area	Area of Habitat Improvement	AUMs	Number of Animals			
				Total Area Unburned	Unburned (Control)	Burned	Increase Actual (Target)
TC	32.5	9.8	252.3	31.9	22.3	28.2	18.6 (0.5)
HE	25.5	8.2	113.5	18.8	12.7	10.0	3.9 (1.0)
TS	165.0	25.0	628.0	115.3	97.9	27.7	10.3 (4.0)
Total	223.0	43.0	993.8	166.0	132.9	65.9	32.8 (5.5)

* The values in the total area unburned column represent the number of animals present in the entire area based on forage production in the unburned control.

Table 5.
Number of animals and animal unit month calculations for the North Greenhills and Britt Creek study areas.

Site	Total Area	Area of Habitat Improvement	AUMs	Number of Animals			
				Total Area Unburned*	Unburned (Control)	Burned	Increase Actual (Target)
LD	39.5	5.9	139.8 (Elk)	23.1	19.7	8.3	4.9 (0.5)
LB	87.5	26.2	289.3 (Elk)	51.9	36.4	21.5	6.0 (3.5)
BC	40.0	12.0	33.8 (Moose)	4.5	2.5	4.2	2.2 (1.5)
Total	167.7	44.1	429.1 (Elk) 33.8 (Moose)	79.5	58.6	34.0	13.1 (5.5)

* The values in the total area unburned column represent the number of animals present in the entire area based on forage production in the unburned control.

Pellet Group Surveys

Pellet group surveys were conducted at each transect location. The number of elk pellet groups increased at the burned treatment transects during the monitoring period but decreased or remained the same at the unburned treatments. Very few moose pellet groups were observed in the onsite enhancement areas, but several were recorded in the offsite areas.

Population estimates were calculated using the pellet group data. Based on current pellet group data, the Turn Creek area has 0.8 elk, the Henretta East area has 0.4 elk and the Turnbull South area has 3.2 elk. The Turn Creek area has 0.1 moose while the Henretta East area has 0.03 moose. According to this data, the Lookout Draw area has 5.6 elk, the Lookout Bowl area has 24.4 elk, and the Britt Creek area has 1.5 moose.

SUMMARY AND CONCLUSIONS

Fording Coal Ltd. – Fording River Operations implemented a prescribed–burn program in 1997 with the intention of mitigating the effects of habitat loss in the Henretta Ridge mining development.

The capability of the enhancement areas, as determined by standing crop production measurements, indicates that forage production is higher and that the wildlife suitability for the areas has increased.

The prescribed burns have accomplished other important objectives. Firstly, canopy closure has been reduced in the areas where previously there was extensive crown closure. Secondly, plant species dominance has been altered. The change in species dominance has resulted in a greater abundance in herbaceous species and, therefore, potential forage. Thirdly, there has been a change in stand structure. The tall shrubs present prior to the burn are now producing forage within reach of the ungulates.

Site preference studies indicate elk prefer to graze on burned as opposed to unburned sites (Davis 1977, Canon et al. 1985, Peck and Peek 1991). In a British Columbia study, elk wintered primarily on post-fire grass and shrub communities, except during severe weather when conifers were used (Peck and Peek 1991). Following a burn, most preferred elk forage species have increased nutrient levels, but the increase in forage quantity is more important (Asherin 1973). In Glacier National Park, fires increased carrying capacity on winter range by creating a mosaic of thermal, hiding cover and forage areas.

A review of the literature describing fire effects on wildlife food provides the following generalizations:

1. Burning sets back plant development and succession, frequently increasing forage or improving forage for wildlife.
2. Fire may increase patchiness, providing wildlife with a diversity of vegetation types from which to select food and cover.
3. The biomass of plants usually increases post burning.
4. Seed production and legumes is usually enhanced by fire.
5. Burning can, but not always, increase the nutritional content and digestibility of plants.

Increases in forage production and forage species diversity are expected to continue for a period of 5 – 7 years depending on slope, aspect and pre-burning vegetation.

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