

A Comparison of Three Residual Distributions of Conifers

for

Enhancing Ungulate Forage and Timber Values

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by:

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Abstract

In the dry, low elevation forests of the Rocky Mountain Trench, long-term fire suppression and early logging practices have resulted in the establishment of a dense understory of conifers, an increase in woody debris accumulation and root diseases, and a decline in grass and shrub production. These factors have increased the risk of catastrophic fires and caused an overall deterioration in timber value, wildlife habitat and range condition. Forage use by elk, mule deer, white-tailed deer and cattle is increasingly concentrated on the remaining open areas.

The Kootenay/Boundary Land Use Plan (KBLUP) recommends periodic entries of prescribed burning, thinning and partial-cutting to maintain open forest conditions and rangeland values. Ecosystem restoration projects are currently underway in several areas of the Trench.

Three experimental harvesting treatments were applied in which stand density was reduced through logging to 250 stems/ha, but the spatial distribution of residual stems varied as follows:

1. Growth Basal Area (GBA). Stands are thinned to 250 stems/ha distributed evenly;
2. Clumped (CLP). Residual stems are left in clumps, centered around the largest diameter trees. No residuals were left standing between clumps;
3. Standard (LOG). Thirty to 50 of the biggest trees, and 200 others were left by logger choice;
4. Control. No logging.

Baseline measurements were taken in 2000 and 2001. Forest harvesting was originally scheduled for winter 2000-2001, but was deferred until winter 2002-2003.

Analysis of pre-treatment data collected in 2000 revealed that forage standing crop averaged slightly less than 140 kg/ha. Pinegrass contributed 42% of the forage production while bunchgrasses contributed 20%.

Only forage production data was collected in 2005 with the average increasing to approximately 760 kg/ha. Significant increases in forage standing crop were observed at all treatments between 2000 and 2005. Increases of between three and fourteen-fold were calculated for the GBA, CLP and LOG treatments, with the largest increases coming in the CLP and LOG treatments.

Pinegrass production increased by seven times and bunchgrass production increased by six times between 2000 and 2005. Distribution of production by species was unchanged from 2000.

Growing season precipitation may have enhanced treatment effect. Precipitation was 47% of the long-term normal in 2000 and approximately equal in 2005.

A "release" of herbaceous vegetation has occurred, and forage production should continue to increase in the short-term. Changes in plant cover or species composition, however, will require a longer-term to manifest themselves.

This project makes a valuable contribution to the knowledge base required to successfully implement KBLUP recommendations regarding open forest conditions and rangeland values. Additional monitoring will be required to fully ensure whether project objectives have been met.

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1.0 Introduction

1.1 Background

In the dry, low elevation forests of the Rocky Mountain Trench, long-term fire suppression and early logging practices have resulted in the establishment of a dense understory of conifers, an increase in woody debris accumulation and root diseases, and a decline in grass and shrub production. These factors have increased the risk of catastrophic fires and caused an overall deterioration in timber value, wildlife habitat and range condition. Cattle grazing in these forests is minimal. Forage use by all ungulates is increasingly concentrated on the remaining open areas. For elk (*Cervus elaphus nelsoni*), mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*), the decrease in preferred forage plants such as saskatoon¹, chokecherry, ceanothus, and bunchgrasses has meant a sharp decline in the quality of their winter range (Appendix 1). Dietary overlap with cattle compounds this problem (Ross 1997, Ross and Wikeem 2002).

The Kootenay/Boundary Land Use Plan (KBLUP) recommends periodic entries of prescribed burning, thinning and partial-cutting to maintain open forest conditions and rangeland values. Ecosystem restoration projects are currently underway in several areas of the Trench. Although some of these projects are examining shrub and bunchgrass response to various treatments, comparisons have involved prescribed burning, logging, and logging followed by burning. No studies have compared the effects of different types of logging on forage production.

1.2 Objectives

The principal objective of this project is to test three different spatial distributions of residual stem density (as below) to determine which will have the greatest positive effect on ungulate forage plants, and which will produce the greatest wood value. In addition, this project tests the Growth Basal Area (GBA) concept (Hall 1987) as a method of determining stand density for maximum timber value. An analysis using 60 mm diameter growth per 10 years resulted in a residual density of 250 sph, identical to the KBLUP open forest target at the time the project was launched (Steve Temple, pers. comm.). Targets have since been revised to 150 sph. Distributing these stems evenly should result in increased wood value over the long-term.

- 1) Growth Basal Area (GBA) – Even distribution of the residual stems following the methods described in Hall (1987);
- 2) Clumped (CLP) – Residual stems left in patches centered around the largest diameter trees with no residuals left standing between patches;
- 3) Standard (LOG) – Thirty to 50 of the biggest trees, and 200 others by logger choice, will be left. This is the guideline for NDT4 open forest harvest in the Trench; and
- 4) Control – No logging.

¹ Plant species names follow Hitchcock and Cronquist (1973).

Baseline information was collected in 2000 and 2001. Timber cruise data were acquired for each treatment in order to determine the functional relationship between the basal area (BA) and diffuse non-intercepted light (DIFN). The primary value of this research is to aid forest companies in refining stocking levels and residual distributions in order to accomplish KBLUP targets.

1.3 Description of the Study Area

The study area is located west of Highway 93 within 5 km of Tembec's Elko mill (Figure 1). The experimental stands are found within CP 209, a large extent of age class 4 and 5 Douglas-fir stands (Table 1).

1.4 Landforms and Soils

The study area lies within the Rocky Mountain Trench physiographic region (Holland 1976). Topography is defined by morainal, glaciofluvial, and to a lesser extent, glaciolacustrine processes (Lacelle 1990). Overlying loess (windborne) deposits are common. Glaciofluvial derived soils predominate on the north end of the study area. Morainal deposits, in the form of NW/SE oriented till/rock formations, cover most of the south portion.

Open grassland and open forest polygons are commonly present on south to southwest aspects on slopes of 0° to 20°, although 30° slopes can be found within the study area. Elevation ranges between 860 and 930 m.

The Fishertown soil association predominates in the north portion of the study area. (Figure 2). These soils have developed in silty or sandy fluvial or aeolian veneers overlying gravelly glaciofluvial outwash plains, terraces and fans. Texture in the upper soil horizon varies from silt loam to fine sandy loam. In the lower glaciofluvial subsoil texture ranges from very gravelly loam to very gravelly loamy sand and may have substantial amounts of coarse fragments. The soil association phase mapped for this area (FX2) is classified as an Orthic Dark Brown or a Calcareous Dark Brown Chernozem (Lacelle 1990). These soils developed under grassland vegetation or at the grassland/forest ecotone.

Morainal soils are represented by the Wycliffe soil association (Figure 2). These soils developed on limestone-derived morainal parent material (till) on valley floors and lower valley sides. They are mostly well-drained, gravelly silt loams characterized by a clay accumulation layer (B₁), and a 'C' horizon with white carbonates on the underside of coarse fragments (Lacelle 1990). Wycliffe soils in the study area are classified as Orthic Eutric Brunisols.

Rockbluff soils, which are formed on colluvium from limestone-derived parent material, are confined to the steep, north-facing slopes on Sheep Mountain (Figure 2).

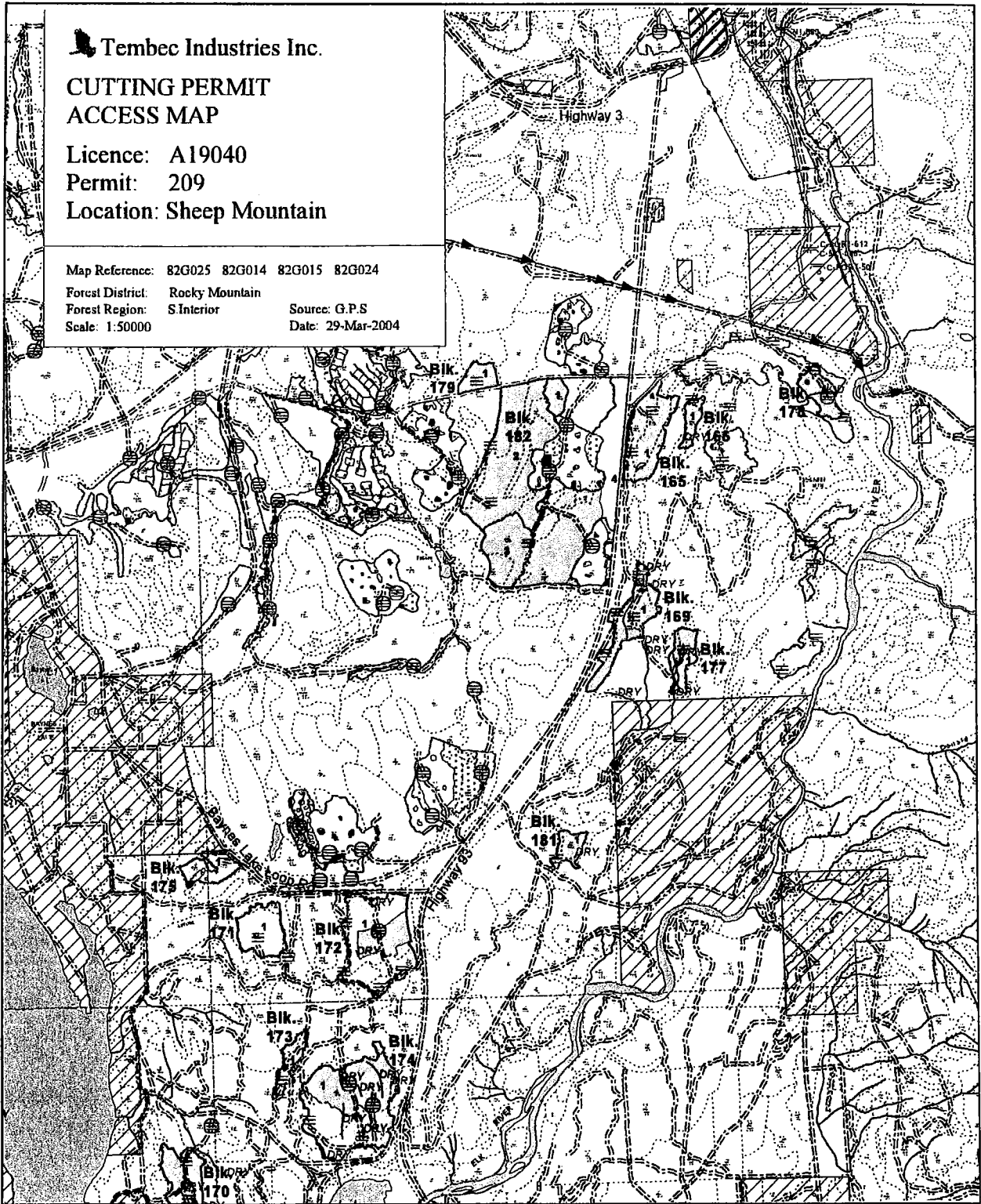
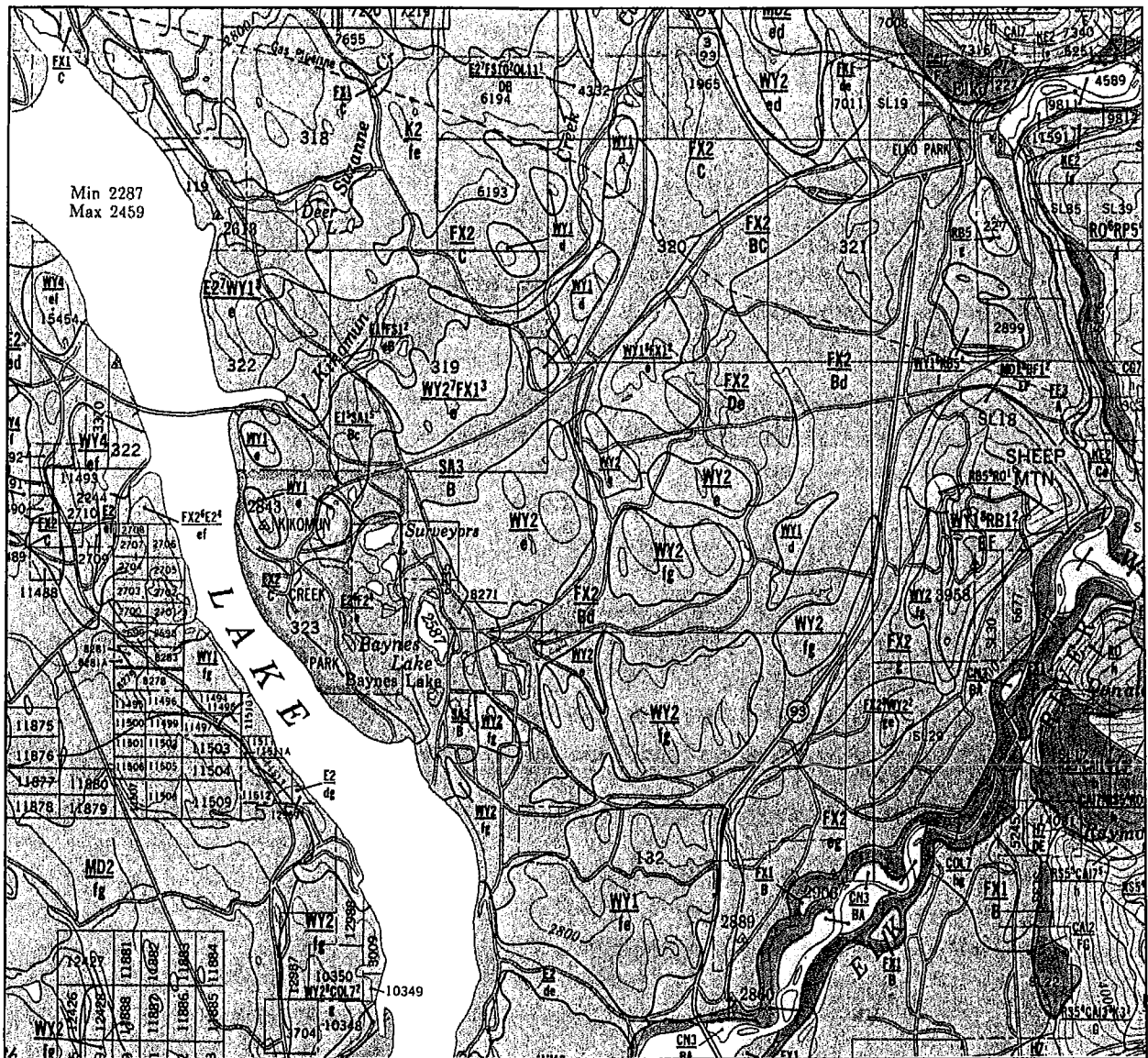


Figure 1. Elko study area (1:50,000).

Table 1. Landforms, soils, harvest blocks and forest cover types at Elko.

Site	Landform	Soil	Slope (°)	Aspect (°)	Harvest Block	Forest Type/ Site Index ¹
Control	glaciofluvial	Fishertown	1-5	110-240	182	Fd (Py) 4305-21
CLP-1	glaciofluvial/ moraine	Fishertown/ Wycliffe	1-5 (20)	110/250/340	182	Fd Py 5304-16
CLP-2	moraine	Wycliffe	1-5 (20)	260 (070) 180	174	Fd Py 5303-13
CLP-3	moraine	Wycliffe	1-5 (20)	260 (070) 180	174	Fd Py 5204-13
GBA-1	glaciofluvial	Fishertown	1-5	210 (260/340)	182	Fd (Py) 4306-16
GBA-2	glaciofluvial	Fishertown	1-10	060/310 (240)	179	Fd (Py) 4305-21
GBA-3	moraine/ colluvium	Wycliffe/ Rockbluff	1-20	030-060	178	Fd L 4206-14
LOG-1	moraine	Wycliffe	1-10	110-180-240	182	Fd Py 6303-15
LOG-2	moraine	Wycliffe	1-5	060/240 (180)	172	Fd Py 5305-14
LOG-3	moraine	Wycliffe	1-10	060/240 (180)	172	Fd Py 5305-14

¹ BC Ministry of Forests. Inventory Branch (2001). Forest cover maps 82 G, 014, 015, 024, 025.



Symbol	Soil Assoc.	Parent Material	Texture	Drainage	Soil	Vegetation Zone	Description
FX2	Fishertown	glaciofluvial	gsil	r	Orthic Dark Brown, Calc. Dark Brown Chernozem	PP- IDF sub-zones	gravelly basic soils shallow solum
RB1	Rockbluff	colluvium	gsil	r	Orthic Eutric Brunisol	PP- IDF sub-zones	stony, limestone soils, steep slopes
WY1	Wycliffe	moraine	gsil	w	Orthic Eutric Brunisol	PP- IDF sub-zones	limestone derived shallow solum soils

Figure 2. Soils of the Elko area (1:100,000) (Lacelle 1990).

1.5 Vegetation

The study area is contained within the Ponderosa Pine (PP) and Interior Douglas-fir (IDF) biogeoclimatic zones (Braumandl and Curran 1992). The most common sub-zones are the "Kootenay Dry, Hot Ponderosa Pine Variant (PPdh2) and the "Kootenay Dry, Mild Interior Douglas-fir Variant (IDFdm2). Douglas-fir is the dominant tree species, however, ponderosa pine, western larch, trembling aspen and lodgepole pine are also present (Appendix 1).

Common shrubs within the area include bitterbrush, snowberry, rose, saskatoon, juniper, bearberry, chokecherry, soopolallie, bog-birch, and mountain alder (Appendix 1).

Grass and grasslike species that are present throughout the study area include bluebunch wheatgrass, needle-and-thread, prairie junegrass, Kentucky bluegrass, Canada bluegrass, rough fescue, Idaho fescue, western needlegrass, Columbia needlegrass, Richardson's needlegrass, pinegrass, bearded wheatgrass and blue wildrye (Appendix 1). Hairy goldaster, western yarrow, shaggy fleabane, compound fleabane, balsamroot, asters, pussytoes and twinflower are common forbs. Sedges, rushes, redtop, foxtail barley, bluejoint and silverweed characterize riparian areas.

1.6 Wildlife and Cattle

Lands which have moderate to very high (Class 1, 1W, 2W and 3) capability to support ungulates occur in the area (Canada Land Inventory 1976). Elk, mule deer and white-tailed deer use the study area for migration routes and winter/spring range.

The study area is located in Airport (GBA-2), Fusee Lake East (Control, GBA-1, CLP-1, LOG-1), Baynes (CLP-2 and 3, LOG-2 and 3) and Sheep Mountain South (GBA-3) pastures in the Waldo Range Unit. Fusee Lake East and Baynes are most affected by these harvest treatments. Fifty and 153 animal unit months (AUM's), respectively, are currently allocated to cattle grazing in these pastures.

2.0 Methods

The study area comprises a total of ten cutblocks. Three replicates of each treatment described in Section 1.2 were laid out in 2000. One additional cutblock was assigned as an unlogged control. Cutblock size varies between approximately eight and 35 hectares (ha). The sampling area within each cutblock, however, was standardized to eight ha. All experimental units have had similar past land use with respect to previous logging, wildlife use and cattle grazing. Pre-treatment tree density was similar among stands.

Baseline forest cover, available light, and forage standing crop data were collected in 2000, while plant community, ungulate use, timber-cruise and GPS location data were collected in 2001. Specific methodology can be found in "A Comparison of Three Residual Distributions for Enhancing Ungulate Forage and Timber Values" (Ross 2001a, 2001b, 2004). Forest harvesting was originally scheduled for winter 2000-2001, but was deferred until the December, 2002 to February, 2003 period.

2.1 Forage Standing Crop

At each macroplot, two 20 m sub-transects were laid out at right angles to the main vegetation transect to generate random plot locations for forage standing crop sampling. Two ungrazed (caged) plots accompany each transect for a total of 16 plots per treatment. Cages were placed in April, 2003, following forest harvest. Sample sizes were based on forage production data from similar forest types in the East Kootenay (Ross 1997; Ross 2000).

Standing crop is determined by clipping plots in late September/early October. Plots (1m²) are clipped to 2 cm above ground level and litter is sorted from the current annual growth. On all treatments, forage was stratified into bluebunch wheatgrass, Idaho fescue, rough fescue, Columbia needlegrass, Richardson's needlegrass, pinegrass, other grasses and forbs. Each sample was stored in an individually labeled bag, oven-dried for 48 hr at 70°C, and then weighed to the nearest 0.01 g.

Forage standing crop differences between treatments and years are analyzed with ANOVA (SAS 1988). Means separation was accomplished with orthogonal and polynomial contrast tests (Zar 1984).

3.0 Results

3.1 Forage Standing Crop

The influence of the overstory on understory diffuse light conditions is borne out in the amount of forage standing crop. Pre-treatment production ranged from about 80 kg/ha at the LOG treatment, to approximately 210 kg/ha at the Control (Table 2). The average of all treatment means was slightly less than 140 kg/ha. Forage standing crop was not significantly different ($p > 0.05$) among the Control, GBA and CLP treatments, but production at these treatments was significantly higher ($p < 0.05$) than at the LOG treatment (Table 2).

Forage standing crop in 2003, the first post-treatment year, was higher ($p < 0.05$) than in 2000. The average of all treatment means increased to about 170 kg/ha, an increase of approximately 24% (Table 2). The average of the CLP, GBA and LOG treatments increased from about 130 kg/ha in 2000 to 170 kg/ha in 2003.

Standing crop at the CLP treatment in 2003 was significantly greater ($p < 0.05$) than at the other treatments. No differences were found among the Control, GBA and LOG treatments (Table 2).

Significant ($p < 0.05$) increases in forage standing crop were detected at the CLP and LOG treatments between 2000 and 2003 (Table 2). Standing crop in 2003 was 36 and 79% higher for the CLP and LOG treatments, respectively.

Table 2. Forage standing crop by treatment at Elko in 2000 and 2003.

Site	2000			2003		
	Weight (kg/ha)	SE (kg/ha)	Treatment ¹ Differences	Weight (kg/ha)	SE (kg/ha)	Treatment Differences
CONT	209.2	122.9	a	159.1	76.4	b
Differences Among Years ²	a			a		
CLP	153.7	131.5	a	209.6	131.0	a
Differences Among Years	a			b		
GBA	151.1	81.5	a	158.3	79.4	b
Differences Among Years	a			a		
LOG	81.0	87.0	b	145.0	86.6	b
Differences Among Years	a			b		
Overall Mean	136.7	105.7		169.8	96.7	
Differences Among Years	a			b		

¹ Note: numbers within columns (Treatments) followed by the same letter are not significantly different (P>0.05).

² Note: numbers within rows (Years) followed by the same letter are not significantly different (P>0.05).

In 2004 forage standing crop averaged 430 kg/ha over all sites, and was approximately 500 kg/ha at the treated sites (Table 3). Production at the CLP and LOG treatments was significantly ($p < 0.05$) higher than at the GBA and Control.

Averaged over all treatments, forage standing crop in 2004 was greater ($p < 0.05$) than in 2000, and increased at all treatments except the Control (Table 3). At the CLP and LOG treatments production increased to nearly 600 kg/ha from approximately 150 and 80 kg/ha, respectively, while production more than doubled at the GBA treatment.

In 2005, forage standing crop was significantly ($p < 0.05$) higher than in 2000 at all treatments (Table 4). At the CLP and LOG treatments production increased to approximately 980 and 1220 kg/ha, respectively, while at the GBA treatment forage production was nearly 600 kg/ha. Forage production at the Control was approximately 280 kg/ha. For the treated units these increases in forage production ranged from a three fold increase at the GBA treatment to nearly 14 fold at the LOG treatment.

The "release" of herbaceous vegetation has steadily increased in the post-treatment years (Figure 3). However, it appears that at least two years were required for the treatment effects to manifest themselves.

Distribution of production among the key species is an important part of this analysis. In 2000, pinegrass was the most abundant grass averaging nearly 60 kg/ha or 42% of the production (Table 5, Figure 4). Collectively, the five bunchgrass species contributed about 20%. Rough fescue and Columbia needlegrass are present at all treatment units, but production averaged approximately 12 and 7 kg/ha, respectively. Idaho fescue was not present at the Control and production never exceeded 4 kg/ha. Richardson's needlegrass was only found on two treatments, but averaged nearly 14 kg/ha at the CLP treatment. Bluebunch wheatgrass was only clipped at the Control in 2000. Forb production ranged between 10 and 22 kg/ha (Table 4). When production is averaged over all treatment units, forbs provided approximately 30% of the total.

Distribution of production among key species was unchanged following harvest. Pinegrass was still the leading species in 2003, averaging more than 80 kg/ha among treatments (Table 5, Figure 4). Small increases were seen for all other species except bluebunch wheatgrass and Columbia needlegrass.

Pinegrass and forbs contributed the most to overall forage production in 2004, as they did in 2000 and 2003. However, increases were noted for all species (Table 5, Figure 4). When the production of the bunchgrasses species is totaled and averaged across treatments, it has increased from less than 25 kg/ha in 2000 to nearly 70 kg/ha in 2004. Bluebunch wheatgrass is poorly represented in the plant community and experienced only small increases in the CLP and LOG treatments, while Columbia needlegrass production was lower. However, Idaho fescue, rough fescue, Richardson's needlegrass and other grasses all increased by three to five fold.

