

# **EAST KOOTENAY TRENCH RESTORATION PROGRAM**

## **Plant Community Response Following Dry Forest Ecosystem Restoration**

### **Final Report**

**prepared for:**

**Rocky Mountain Trench Natural Resources Society  
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**by:**

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## Abstract

Dry forest types in the East Kootenay region of British Columbia suffer from excessive forest ingrowth. In the Rocky Mountain Trench and adjoining side-valleys between the U.S. border and the Golden area, there are approximately 250,000 hectares of land in the Ponderosa Pine and Interior Douglas-fir biogeoclimatic zones. A loss of 3,000 hectares (ha) of grazing lands annually is estimated in these zones. This is accompanied by a loss of wood volume and wood quality. Partial-cutting systems can be used to rehabilitate over-stocked forests. This project examined the plant community response following dry-forest ecosystem restoration. Four 20 ha treatments were installed in 1996; Harvest, Harvest/Burn, Burn and Control. Baseline measurements were made in 1996. Forest harvest took place in 1997. Prescribed burning took place in 1998. Monitoring continued until 2000.

Partial-cutting and slashing in the Harvest and Harvest/Burn treatment sites have opened the forest canopy considerably, reducing tree cover from 30% and 24%, respectively to approximately 10% in both treatments. A further reduction of 3.5% tree cover was achieved in 1998 through prescribed burning in the Harvest/Burn. The Burn had 5% less tree cover in 1998 following treatment. An additional 2% of ponderosa pine and Douglas-fir regeneration layer trees died in the Burn between 1998 and 1999. Between 1996 and 2000 forest cover increased at the Control by approximately 5%.

Forest overstory cover has increased in the Harvest, Harvest/Burn and Burn areas since treatments were applied. Although significant ponderosa pine and Douglas-fir canopy removal occurred in the overstory and understory, the percent cover of the regeneration layer, particularly of Douglas-fir, has increased in all treatments.

Grass and grasslike cover was dominated by rough fescue, pinegrass, Richardson's needlegrass, Idaho fescue, northwest sedge and bluebunch wheatgrass. All of these grasses, except for pinegrass, have been shown to be important components of cattle and wildlife diets throughout the year in the East Kootenay region and are most common in open grassland and open forest communities.

Except for western yarrow, rosy pussytoes, black medic and tiny penstemon most forbs represented less than 1% cover. Bearberry was the dominant shrub at all sites. Other important shrubs are saskatoon and bitterbrush. These shrubs are important in wildlife diets throughout the year.

Variable precipitation patterns were observed during the duration of the study. Total precipitation at the Cranbrook Airport in 1996 was approximately 140% of the long-term normal. In contrast, in 1997 total precipitation was 75% of the long-term normal. Precipitation records from 1998 reveal that 124% of the long-term normal fell that year. In 1999 precipitation equaled the long-term normal. In 2000, recorded precipitation was the lowest of all years, less than 71% of the long-term normal.

Significant increases in forage production ( $p < 0.05$ ) were calculated between 1996 and 1999 in the Harvest, Harvest/Burn and Burn treatments. Forage production increased in all classes in the Harvest and Harvest/Burn between 1996 and 1999, and was more than 100% higher in both treatments. In the Burn, forage production was 25% higher. No difference was found at the Control between 1996 and 1999.

Treatment differences were likely masked somewhat in 2000 due to precipitation being nearly 30% below average. Despite lower precipitation in 2000, the harvest treatment has resulted in production increases in the order of 40% to 60% at the Harvest and Harvest/Burn sites. Differences in production resulting from the burn treatment were not significant ( $p > 0.10$ ) in 2000. No difference was found at the Control between 1996 and 2000.

Production by all bunchgrass species was higher in 1999 than 1996 in all treated areas. Although lower production was noted post-treatment, particularly in the Burn, production and cover appear to be slowly increasing. It may be that timing of the prescribed burn (April 3, 1998) inhibited growth somewhat.

Removal of forest cover seems to favour immediate increases in rough fescue production. Rough fescue produced more in all treatments in 2000 than in 1996. Rough fescue production increased by between 77% and 180% in the Harvest, Harvest/Burn and Burn in 1999, compared to 1996. Increases varied between 40% and 80% in 2000 as compared to 1996.

Trends in Idaho fescue and bluebunch wheatgrass production were less consistent. Idaho fescue production more than doubled in the Harvest, was equal in the Harvest/Burn and lower in the Burn in 1999 when compared to pre-treatment levels. Production was lower in 2000. Bluebunch wheatgrass production was two to eight times higher in the Harvest and Harvest/Burn in 1999, but 65% lower in the Burn treatments relative to 1996. In 2000, bluebunch wheatgrass was higher at the Harvest/Burn, and lower at the Burn.

In 1999, production of other grasses was 35% higher in the Harvest and more than 200% higher in the Harvest/Burn. In 2000, production was approximately 60% higher at both sites than in 1996, similar at the Burn and lower at the Control.

Forb production has increased in the Harvest/Burn and Burn treatments. Although cover was higher in all treatments in 1999, and more species were recorded in 1998, 1999 and 2000 than pre-treatment, forb cover has fluctuated throughout the study. Variable precipitation has likely influenced forb growth patterns more than the treatments to this point in the study.

Increases in forage production are more immediate than changes in cover. Species change ( $p < 0.05$ ) in the herbaceous plant community was not calculated at any treatment between 1996 and 2000. Two or three years post-treatment are not sufficient to differentiate significant individual species response to the forest harvest and prescribed burning treatments. Further monitoring will be required to more accurately assess the long-term effect of restoration treatments on individual species and the cumulative effect on forage production.

In the short- to medium-term the “release” potential of a site depends on the composition of the herbaceous and shrub layer. For ecosystem restoration at an operational scale, sites should be prioritized based on the proportion of bunchgrasses and desirable shrubs in the plant community.

Where there appears to be excellent potential for release of the herbaceous and shrub layers with partial-cutting systems, the amount of forest canopy cover remaining after treatment is likely the most important factor governing forage production.

Canopy removal through forest harvest is the most effective treatment in increasing forage production. However, failure to remove the regeneration layer will eventually negate any forage-derived benefits received from partial-cutting of the overstory and understory.

It is difficult to assess the long-term benefits of this dry forest ecosystem restoration program based on five years of data. Additional monitoring is required, particularly on the effects of prescribed burning. However, the post-harvest stand structure should result in increased benefits for all resource sectors.

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## 1.0 Introduction

Dry forest types in the East Kootenay region of British Columbia suffer from excessive forest ingrowth. In the Rocky Mountain Trench and adjoining side-valleys, between the U.S. border and the Golden area, there are approximately 250,000 hectares of land in the Ponderosa Pine (PP) and the Interior Douglas-fir (IDF) biogeoclimatic zones (Gayton 1997). Both zones are included in Natural Disturbance Type 4 and are characterized by “frequent stand maintaining fires” (BC Ministry of Forests/BC Environment 1995). Historically, fire returned to these sites every 5 to 50 years. Since the early 1930's, however, fire suppression and insufficient stand-tending activities have resulted in a serious forest ingrowth problem in these dry forest types. The Kootenay-Boundary Land Use Plan proposes periodic entries of prescribed burning, thinning and partial-cutting to maintain open forest conditions and rangeland values.

These dry forest zones also include the grasslands and open forest types which support the livestock industry, and provide important winter and spring range for ungulate populations; which in turn support the hunting, guiding and tourism industries. Additionally, these forest types provide year-round habitat for a whole range of wildlife species and other natural values. Open forests are slowly ingrowing with the following negative consequences for other forest resource users:

- 1) lowered forage production with a possible loss of 4,800 AUM's <sup>1</sup> annually,
- 2) more grazing and browsing pressure on the forage in grassland and open forest types,
- 3) general loss of the more palatable grasses, forbs and shrubs,
- 4) short-term proliferation of "increaser" species (sub-dominants in the plant community) with subsequent losses in production and palatability,
- 5) potential severe downgrading of plant community to weedy species with ultimate loss of seed sources, genetic variation and general biodiversity,
- 6) reduced carrying capacity for both large ungulates and livestock,
- 7) potential decline in the value of these habitat types as wildlife winter and spring range.

Preliminary results from a recent reconnaissance level study of aerial photographs from 1959 and 1994 placed a portion of the Trench into four canopy closure classes; 0-5%, 6-15%, 16-40%, and >40% (Gayton 1997). An estimated 3,000 hectares of grazing lands are lost annually as sites move from lower canopy cover classes through to higher classes where the canopy effectively shades the forage out of the forest floor. If canopy closure has proceeded at that rate since 1959, this would amount to a loss of more than 120,000 hectares. This is accompanied by a loss of wood volume and wood quality.

Partial-cutting systems can be used to remove excessive canopy cover and basal diameter from over-stocked sites. The "release" of forage and browse potential to maintain or improve these sites for other resource values such as wildlife habitat and livestock range should result. Timber resources, as well as forage and wildlife resources are expected to benefit from these treatments.

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<sup>1</sup> An AUM is defined as the amount of air-dried forage to maintain a 1000 lb. cow for one month. Usually 360 kg. (790 lb.)

This study is part of a collaboration between various agencies designed to investigate the efficacy of using partial-cutting systems to rehabilitate over-stocked forests in the Ponderosa Pine and Interior Douglas-fir biogeoclimatic zones. This information will promote integrated resource management and improved ecological health through integrated silviculture activities.

The objectives of this project were:

- 1) Examine the relationship between canopy closure and plant diversity, dynamics, and production.
- 2) Determine the forage and browse release potential of the herbaceous and shrub layer following a dry forest ecosystem restoration project.

### **1.1 Site Description**

The Cherry-TaTa Range Unit is located within the Cranbrook Forest District in the East Kootenay region of British Columbia, northeast of the town of Kimberley and south of the village of TaTa Creek (Figure 1). Highway 95A bisects the unit. The east boundary consists of private land along the Kootenay River, while the west boundary is the Upper St. Mary's Range Unit. To the north the unit is bounded by the TaTa/Skookumchuck Range Unit, part of the Invermere Forest District. Utilities corridors include the BC Hydro and BC Gas right-of-ways, both of which are located on the west side of Highway 95A. Private land lots are included within the range unit boundaries.

Forest tenure in the unit is held by Galloway Lumber Company. Other forest harvest is accomplished under the Small Business Forest Enterprise Program. There are also a number of Christmas Tree Permits within the unit boundaries.

The Range Unit is divided into 8 pastures of which 2, Lost Spring (700 ha.) and Beacon (1000 ha.), are included in the study area. There are 3 range permittees. The cattle grazing season runs from approximately May 5 to October 31.

### **1.2 Landforms and Soils**

The Cherry/TaTa Range Unit is located entirely within the Rocky Mountain Trench physiographic region (Holland 1976). Topography is described as moderately rolling, with prominent esker landforms (Lacelle 1990). The eskers are generally flat topped. Elevation ranges between 850 and 900 meters.

The Wycliffe soil association is the most common type in the study area (Figure 2). These soils developed on limestone-derived morainal parent material on valley floors and lower valley sides. These soils are mostly well-drained silt loams characterized by a clay accumulation layer (B<sub>t</sub>), and a 'C' horizon with white carbonates on the underside of

Figure 1 – study site

Figure 2 - soils

coarse fragments (Lacelle 1990). Wycliffe soils are well-drained, gravelly silt loams and are generally shallow solum soils classified as Orthic Eutric Brunisols. Wycliffe soil associations have developed in the Ponderosa Pine subzone of the Interior Douglas-fir zone (Lacelle 1990).

Elko, Flagstone and Fishertown soil associations in the range unit have developed on glaciofluvial parent material. These soils are silt loams or fine sandy loams in the upper soil horizon. Elko and Fishertown vary from very gravelly loam to very gravelly loamy sand in the lower glaciofluvial subsoil and may have substantial amounts of coarse fragments, while coarse fragments are generally absent from Flagstone soils. These soils have developed in silty or sandy fluvial or eolian veneers overlying gravelly glaciofluvial outwash plains, terraces and fans. The soil association component mapped for this area classifies these soils as Orthic Dark Brown or Calcareous Dark Brown Chernozems, which have developed within the Ponderosa Pine subzone of the Interior Douglas-fir zone (Lacelle 1990).

Kayook soils have developed in silty, calcareous, eolian veneers overlying calcareous, gravelly, glaciofluvial, and occasionally morainal deposits. They are commonly found on valley floors within the Ponderosa Pine sub-zone of the Interior Douglas-fir zone (Lacelle 1990). Texture in the upper horizons is most commonly silt loam, while the coarse fragment content of the sub-soil is between 50% and 70%. The Kayook soils mapped in this area are classified as Orthic Dark Brown Chernozems.

### **1.3 General Forest and Range Types**

The Cherry/TaTa Range Unit is contained primarily within the Interior Douglas-fir biogeoclimatic zone, with inclusions of the Ponderosa Pine zone (Braumandl and Curran 1992). Douglas-fir<sup>1</sup> is the dominant tree species, however, ponderosa pine, trembling aspen, lodgepole pine, western larch, black cottonwood and spruce are also present (Appendix 1).

Common shrubs within the area are bitterbrush, snowberry, rose, saskatoon, juniper, bearberry, chokecherry, soopolallie, bog-birch and low Oregongrape (Appendix 1).

Grass and grasslike species present on open grassland areas include; bluebunch wheatgrass, prairie Junegrass, Kentucky bluegrass, Canada bluegrass, rough fescue, Idaho fescue, western needlegrass and Columbia needlegrass (Appendix 1). Western yarrow, wild bergamo, nodding onion, balsamroot and Scottish bells are common forbs (Appendix 1).

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<sup>1</sup> Plant species names follow Hitchcock and Cronquist (1973).  
Herbaceous vegetation found in open forest and closed forest areas includes pinegrass,

rough fescue, Idaho fescue, bearded wheatgrass, asters and twinflower (Appendix 1).

Riparian areas are characterized by sedges, rushes, redtop, hair bentgrass and blue wildrye (Appendix 1). Domestic species commonly found in seeded areas such as roadsides, landings and utilities corridors include; orchardgrass, smooth brome grass, slender wheatgrass, crested wheatgrass, timothy, red clover, alsike clover, sweet clover and alfalfa.

There are areas in these pastures where the principal bunchgrass species, bluebunch wheatgrass, rough fescue and Idaho fescue, are still present under a comparatively open forest canopy, but these areas comprise a minor portion. The more common scenario is canopy closure exceeding 30%, where the bunchgrasses are still present but with reduced density and vigour. In other areas the understory vegetation appears to be dominated by pinegrass. In some cases there is no understory vegetation whatsoever; it has been completely buried by needle-cast.

Shrubs such as saskatoon, bitterbrush, rose and buckbrush are present in the understory in the more open regions. Like the bunchgrasses, however, they appear subject to the same declines in density and vigour with increased forest canopy cover.

#### **1.4 Trench Plan Polygons**

The entire range unit is included in the Trench Integrated Resource Management Plan (TIRMP). Polygons 33, 42 and 43 are within the unit boundaries (TIRMP 1993). Polygon 43 is forage-leading, and 33 and 42 are forage/timber polygons. General recommendations for these polygons include;

- 1) selective harvesting, uneven-aged stand management, juvenile spacing,
- 2) native forage species desired,
- 3) spring and fall livestock range,
- 4) elk and white-tail deer winter, spring, summer and fall range, and migration routes,
- 5) snow interception and thermal cover,
- 6) prescribed fire for stocking control, forage production or forage enhancement.

#### **1.5 Wildlife**

Lands which have very high (Class 1, 1W, and 2W on 1:250,000 maps) and moderate to high capability (Class 3 on 1:250,000 maps) to support ungulates occur in the area (Canada Land Inventory 1976). Principal species are elk, mule deer and white-tailed deer. Migration routes and winter/spring range is the primary use by elk and mule deer. White-tailed deer use the area throughout the year (TIRMP 1993). Waterfowl use the sloughs in the area, subject to water levels. Elk typically occupy the area between late October and early June (Jamieson and Hebert 1993).

#### **1.6 Water**

There is no flowing water accessible within the boundaries of Lost Spring and Beacon pastures. Open water occurs in sloughs, springs, small kettle ponds and in seasonal drainage channels. The kettle ponds are typically steep-sided and provide limited foraging areas. However, they may be important as watering points for livestock and wild ungulates, and as waterfowl habitat.

### **1.7 Recreation**

There are no officially designated recreation areas within the range unit. Hunting is a popular activity in this area.

## **2.0 Methods**

Baseline measurements were taken in late September and early October, 1996. Forest harvest took place in January to March, 1997, with some additional slashing in summer 1997. Prescribed burning was conducted on April 3 and April 11, 1998. Plant community response following dry forest ecosystem restoration within Lost Spring and Beacon pastures was monitored with the following methodology.

### **2.1 Stratification**

Stratification of the site by forest rehabilitation treatment was undertaken as part of a co-operative exercise between Galloway Forest Products and collaborators in the Nelson Forest Region - Forest Sciences section. Four treatments (Harvest, Burn, Harvest/Burn, Control), each consisting of a 20 hectare block, were laid out in the spring of 1996. The treatments were stratified by canopy cover class (open grassland 0-5%, treed grassland 6-15%, open forest 16-35% and closed forest >35%) on 1:20,000 colour airphotos.

### **2.2 Range Reconnaissance**

Following site stratification, a range reconnaissance survey was undertaken in order to delineate plant community types/canopy cover classes within treatments. Polygon boundaries were checked by means of field vegetation surveys. The reconnaissance level survey consisted of site visits for all treatment areas. The areas were walked and the existing plant community was determined by ocular estimate of percent foliar cover for each vegetation layer; tree/tall shrub, low shrubs, forbs and grass. Total bryophyte cover and estimates of percent bare soil were recorded. Other plants, such as indicator species, noxious weeds and poisonous plants, were noted during the reconnaissance survey.

The primary purpose of the survey was to ground-truth the polygon borders within the initial block stratification, particularly those between open forest and closed forest. By surveying the herbaceous, shrub and forest regeneration layers of the plant communities on these sites, and consulting the soils and biogeoclimatic site series designations, open

forest areas where ingrowth had occurred were delineated from closed forest sites. Harvest block boundaries tend to follow topographical borders, which do not always indicate ecological borders. As a result, areas of open grassland and open forest within logging block borders may be obscured. These areas are described in text and tables.

### 2.3 Vegetation Cover

Ten permanent 50 meter transects were established in a stratified random fashion within each treatment using the following methodology (see Appendix 2). Herbaceous vegetation was sampled in ten 20 cm. X 50 cm. Daubenmire frames which were randomly located along the transects such that 100 plots were read per treatment (Appendix 2) (Daubenmire 1959). These plots were nested within 1 m. X 2 m. plots. Tree and shrub cover was determined in these larger plots according to cover classes listed in Appendix 2. Transect ends were permanently marked with 1/2" rebar stakes, aluminum tags, and pink flagging tape. A tie-point consisting of a 7 cm. X 10 cm. aluminum tag was located on a prominent, nearby tree. Plot name, number and bearing and distance to the baseline were recorded on this tag. Plant species cover and frequency are presented in tabular form. Bare soil, bryophytes, litter and feces (amount and type) were also recorded. Aerial photographs were permanently marked with the transect location. Plot layout information is included in Appendix 3. A map of the study site is included in Appendix 4.

Percent cover for each species was calculated by averaging the cover estimates over all 100 plots at each treatment. Percent frequency for each species was calculated with the following formula:

$$\text{Frequency} = \frac{\text{Number of plots with species A}}{\text{Total number of plots sampled}} \times 100$$

### 2.4 Plant Community Similarity

Spearman's rank correlation procedure (Zar 1984) was used to compare plant community similarity. The procedure ranks each measure of a variable between the 2 communities, then the formula listed below is applied to the ranks to determine the Spearman rank correlation coefficient,  $r_s$ , where  $d_i$  is the difference between the ranks. The Spearman rank correlation coefficient, rho ( $r_s$ ), ranges in value between -1 and +1, and has no units.

$$r_s = \frac{1-6 \sum d_i^2}{n^3-n}$$

### 2.5 Forage Production

At each transect location two 40 meter sub-transects were laid out at right angles to the main vegetation transects. Four random plot locations are located on each of these sub-transects at 0 m, 10 m, 30 m and 40 m. Two caged plots accompanied each transect for a total of 20 plots per treatment.

Total annual production was determined from caged plots clipped in October. Plots (1m<sup>2</sup>) were clipped to 2 cm. above ground level and litter was sorted from the current annual growth. On all treatments forage was stratified into bluebunch wheatgrass, Idaho fescue, rough fescue, 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 gram.

Forage production between treatments and years was analyzed by means of a two-factor ANOVA (SAS 1988). Means separation was accomplished with Tukey's multiple range test (Zar 1984).

## **2.6 Permanent Photo-points**

Permanent photopoints were established at each transect location and marked with 7 cm. X 11 cm. aluminum tags. Representative photographs are included in Appendix 5.

## **3.0 Results**

Work in the first year of this study concentrated on site reconnaissance, transect establishment, and the collection of baseline measurements. Perhaps the most important objective in this project is determining the relationship between forest cover and the composition and production of the understory herbaceous and shrub communities. Accordingly, this project focused on gathering pre-treatment data in 1996, as harvesting operations were scheduled for late January to early March, 1997. Prescribed burning was conducted in April, 1998.

### **3.1 Plant Community**

1996

In 1996, total cover of grass and grasslike species ranged between 34% at the Harvest/Burn and 53% at the Control (Table 1). Cover of bunch-grasses; rough fescue, Idaho fescue and bluebunch wheatgrass ranged between 12% to 16%, 2% to 5%, and 1% to 2%, respectively at the 4 treatments (Table 1). These grasses have been shown to be important components of cattle and wildlife diets throughout the year in other studies (Ross 1997), and are most common in open grassland and open forest communities.

**Table 1. Cover and frequency of plant species at Cherry/TaTa Range Unit in 1996.**

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%-----								
<b>Grass and Grasslike</b>								
Bluebunch wheatgrass	1.3	17.0	1.2	12.0	1.2	14.0	1.9	14.0
Columbia needlegrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Idaho fescue	1.6	22.0	0.6	8.0	0.0	0.0	5.5	43.0
Kentucky bluegrass	0.2	1.0	0.0	0.0	0.4	2.0	3.7	13.0
Northwest sedge	3.1	21.0	2.2	18.0	1.5	15.0	1.2	9.0
Pinegrass	6.2	39.0	7.3	51.0	3.2	29.0	7.2	46.0
Prairie junegrass	0.8	8.0	1.4	19.0	2.7	23.0	3.0	21.0
Richardson's needlegrass	7.1	34.0	4.5	17.0	11.0	37.0	11.0	47.0
Rough fescue	15.9	68.0	16.1	69.0	12.8	69.0	12.9	55.0
Sand dropseed	0.0	0.0	0.0	0.0	0.2	2.0	0.4	5.0
Slender wheatgrass	0.3	4.0	0.2	2.0	0.6	5.0	2.3	11.0
Western needlegrass	0.3	4.0	0.0	0.0	0.9	5.0	3.7	19.0
Total Grass and Grasslike	36.8		33.5		34.5		52.8	
<b>Forbs</b>								
Baker's mariposa lily	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.0
Black medic	1.9	24.0	0.5	16.0	0.9	16.0	0.4	5.0
Compound fleabane	0.1	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Dune goldenrod	0.1	3.0	0.2	3.0	0.0	0.0	0.0	0.0
Early blue violet	0.1	2.0	0.2	6.0	0.2	3.0	0.1	3.0
Hairy goldaster	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Holboell's rockcress	0.0	0.0	0.1	2.0	0.0	0.0	0.0	0.0
Locoweed	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Nuttall's pussytoes	0.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Old man's whiskers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Pacific anemone	0.2	3.0	0.1	2.0	0.1	4.0	0.0	0.0
Rosy pussytoes	3.6	35.0	2.0	29.0	2.0	29.0	0.9	17.0
Showy aster	0.2	2.0	0.0	0.0	0.3	6.0	0.1	2.0
Silky lupine	0.0	0.0	0.1	23.0	0.0	0.0	3.6	30.0
Spiny phlox	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0
Stoneseed	0.0	0.0	0.0	0.0	0.3	2.0	0.3	3.0
Timber milkvetch	0.0	1.0	0.0	0.0	0.0	0.0	0.1	3.0
Tiny penstemon	2.8	35.0	2.2	27.0	1.6	26.0	1.0	16.0
Western yarrow	0.5	10.0	0.4	11.0	1.0	17.0	0.5	16.0
Wild strawberry	0.1	5.0	0.2	7.0	0.2	3.0	0.0	1.0
Total Forbs	9.8		6.2		6.6		7.1	

Table 1. (cont'd)

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%								
<b>Shrubs</b>								
Bearberry	27.4	83.0	21.3	74.0	17.0	69.0	9.5	41.0
Birch-leafed spirea	0.1	5.0	0.1	5.0	0.1	2.0	0.2	7.0
Bitterbrush	5.1	33.0	7.2	62.0	7.0	65.0	0.9	15.0
Low Oregongrape	0.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Rose	0.1	4.0	0.0	1.0	0.1	2.0	0.0	1.0
Saskatoon	2.4	40.0	5.3	53.0	5.6	57.0	1.5	18.0
Snowberry	0.0	0.0	0.0	0.0	0.1	2.0	0.0	0.0
Soopolallie	0.4	5.0	0.2	2.0	0.1	2.0	0.0	0.0
Total Shrubs	35.9		34.1		30.0		12.1	
<b>Trees</b>								
Douglas-fir	7.1	12.0	3.0	4.0	0.4	1.0	4.0	8.0
Douglas-fir r/g	3.8	28.0	4.2	48.0	2.4	23.0	2.7	31.0
Douglas-fir u/s	4.0	10.0	3.5	13.0	0.8	7.0	4.4	14.0
Lodgepole pine	0.2	2.0	0.0	1.0	0.0	0.0	0.4	1.0
Ponderosa pine	6.0	16.0	6.5	12.0	10.6	23.0	4.9	8.0
Ponderosa pine r/g	0.1	4.0	2.4	19.0	3.6	21.0	0.1	3.0
Ponderosa pine u/s	8.6	22.0	4.8	15.0	1.5	3.0	4.7	16.0
Trembling aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0
Western larch	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.0
Total Trees	29.8		24.4		19.3		22.3	
Total Trees and Shrubs	65.7		58.5		49.3		34.4	
<b>Others</b>								
Bryophytes	11.1	78.0	16.0	90.0	14.4	93.0	16.9	84.0
Cattle feces	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.0
Deer feces	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0
Elk feces	0.3	8.0	0.3	7.0	0.1	3.0	0.3	10.0
Litter	60.8	100.0	53.7	100.0	56.9	99.0	60.5	100.0
Rock	0.3	6.0	0.1	1.0	0.3	3.0	0.2	2.0
Soil	3.2	47.0	4.5	50.0	2.9	40.0	1.8	33.0

Other important grasses included Richardson's needlegrass (1% to 4%) and pinegrass (3% to 6%).

Forb cover varied between 3% and 6% (Table 1). Except for western yarrow, pussytoes and tiny penstemon most forbs represented less than 1% cover.

Total cover of trees and shrubs fell within a range of 34% at the Control to 66% at the Harvest (Table 1) in 1996. Forest cover was between 19% at the Burn and approximately 30% at the Harvest. Ponderosa pine and Douglas-fir dominated with forest cover ranging generally between 10% and 15% for each species when the overstory, understory and regeneration layers are combined. Ponderosa pine overstory ranged between 5% and 10%. Douglas-fir overstory cover was somewhat lower (less than 1% to 7%). Ponderosa pine regeneration ranged from less than 1% at the Harvest and Control to nearly 4% at the Burn, while Douglas-fir regeneration varied between 2% and 4%, with the highest levels at the Harvest and Harvest/Burn. Larch and lodgepole pine were also present.

Shrub cover was similar at the Harvest, Harvest/Burn and Burn sites accounting for 30% to 36% cover. Shrub cover was 12% at the Control. Bearberry was the dominant shrub at all sites. In the Harvest, Harvest/Burn, and Burn it provided between 17% and 27% of ground cover. Bearberry was also the dominant shrub in the Control, but it accounted for less than 10% cover. Other important shrubs are saskatoon (2% to 6) and bitterbrush (1% to 7%). These shrubs are important in wildlife diets throughout the year (Ross 1997).

Bryophytes, litter and bare soil were found to range between 11% and 17%, 50% and 60%, and 2% and 5%, respectively.

1997

In 1997, cover of grass and grasslike species was slightly less than in 1996, ranging between 28% at the Harvest/Burn and 37% at the Control (Table 2). However, the species composition was similar to 1996. Rough fescue cover was between 1% and 3% lower at all sites, but was still the dominant grass ranging between 8% and 13%, while Idaho fescue and bluebunch wheatgrass varied from 1% to 7% and less than 1% to 2%, respectively. Richardson's needlegrass (3% to 10%) and pinegrass (6% to 8%) were the other dominant grasses. Cover of both these species increased in 1997 compared to 1996.

The forb component was 1% to 3% higher at all treatments in 1997. Pussytoes and tiny penstemon were found to be between 1% and 2%, and 1% and 3%, respectively of ground cover at all treatments. Most other forbs were recorded at less than 1%.

Shrub cover was unchanged from 1996 at all sites except the Control. Cover of bearberry and saskatoon both increased such that total shrub cover was nearly 17% (Table 2).

Overall, 1997 tree and shrub cover decreased from 1996, ranging between 38% at the Control and 52% at the Burn (Table 2). Forest cover at the Harvest and Harvest/Burn

**Table 2. Cover and frequency of plant species at Cherry/TaTa Range Unit in 1997.**

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%								
<b>Grass and Grasslike</b>								
Bluebunch wheatgrass	1.4	17.0	0.7	12.0	0.6	9.0	0.1	2.0
Bearded wheatgrass	0.0	0.0	0.2	3.0	0.3	4.0	0.6	4.0
Canada bluegrass	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Columbia needlegrass	0.0	0.0	0.0	0.0	0.2	1.0	0.0	0.0
Idaho fescue	3.3	32.0	1.3	18.0	1.1	13.0	6.7	48.0
Kentucky bluegrass	0.0	0.0	0.0	0.0	0.8	4.0	2.3	12.0
Northwest sedge	3.4	28.0	3.0	23.0	0.9	12.0	0.6	7.0
Pinegrass	5.9	49.0	5.8	55.0	6.2	49.0	7.8	54.0
Prairie junegrass	0.4	7.0	0.5	14.0	0.6	7.0	0.3	5.0
Richardson's needlegrass	3.3	13.0	3.6	20.0	10.3	40.0	9.4	40.0
Rough fescue	11.9	69.0	12.9	62.0	11.6	59.0	8.6	50.0
Sand dropseed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Slender wheatgrass	0.0	1.0	0.0	0.0	0.0	1.0	0.5	2.0
Western needlegrass	0.4	3.0	0.0	0.0	0.5	2.0	0.0	0.0
Total Grass and Grasslike	30.0		28.0		33.1		36.9	
<b>Forbs</b>								
Black medic	0.9	13.0	0.5	5.0	0.3	8.0	0.2	7.0
Dandelion	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0
Dune goldenrod	0.2	6.0	0.0	0.0	0.2	3.0	0.0	0.0
Early blue violet	0.2	7.0	0.1	2.0	0.1	3.0	0.2	3.0
Hairy goldaster	0.0	0.0	0.2	2.0	0.0	0.0	0.0	0.0
Leafy aster	0.2	2.0	0.0	1.0	0.4	5.0	0.1	2.0
Old man's whiskers	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0
Prairie crocus	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Rosy pussytoes	2.1	21.0	0.9	14.0	1.5	30.0	0.5	11.0
Silky lupine	0.0	0.0	0.0	0.0	0.0	0.0	0.8	12.0
Small-flowered penstemon	0.0	0.0	0.3	3.0	0.0	0.0	0.0	0.0
Spiny phlox	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Stoneseed	0.1	2.0	0.0	1.0	0.3	3.0	0.4	3.0
Timber milkvetch	0.1	3.0	0.1	2.0	0.0	0.0	0.2	3.0
Tiny penstemon	2.8	33.0	1.3	22.0	1.8	27.0	0.8	17.0
Western yarrow	0.6	11.0	0.4	7.0	0.4	15.0	0.4	21.0
Wild strawberry	0.3	6.0	0.0	0.0	0.1	2.0	0.0	1.0
Total Forbs	7.7		3.8		5.1		3.8	

Table 2. (cont'd)

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%								
<b>Shrubs</b>								
Bearberry	26.7	81.0	26.2	72.0	18.0	78.0	13.6	46.0
Birch-leafed spirea	0.0	0.0	0.0	0.0	0.1	4.0	0.2	8.0
Bitterbrush	4.3	31.0	5.6	49.0	8.4	67.0	0.3	10.0
Low Oregongrape	0.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Rose	0.2	4.0	0.0	0.0	0.1	2.0	0.1	2.0
Saskatoon	5.2	48.0	2.9	42.0	4.8	64.0	2.7	29.0
Snowberry	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Soopolallie	0.1	3.0	0.2	3.0	0.0	1.0	0.0	0.0
Total Shrubs	36.7		34.9		31.4		16.9	
<b>Trees</b>								
Douglas-fir	2.2	5.0	0.2	1.0	1.0	2.0	6.1	12.0
Douglas-fir r/g	3.0	25.0	4.0	43.0	4.2	33.0	3.2	36.0
Douglas-fir u/s	1.3	4.0	0.0	0.0	0.0	0.0	1.0	2.0
Lodgepole pine	0.0	0.0	0.0	0.0	0.1	2.0	0.4	2.0
Ponderosa pine	4.0	10.0	4.7	9.0	12.0	21.0	9.3	21.0
Ponderosa pine r/g	0.3	6.0	0.3	10.0	1.6	22.0	0.1	5.0
Ponderosa pine u/s	0.2	3.0	0.5	2.0	0.8	7.0	0.4	2.0
Western larch	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.0
Total Trees	11.0		9.7		19.7		21.3	
Total Trees and Shrubs	47.7		44.6		51.1		38.2	
<b>Others</b>								
Bryophytes	3.9	35.0	7.9	49.0	9.5	64.0	9.6	60.0
Cattle feces	0.4	3.0	0.0	0.0	0.0	0.0	0.2	2.0
Deer feces	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Elk feces	0.0	0.0	0.2	4.0	0.1	2.0	0.3	6.0
Litter	66.0	99.0	64.3	100.0	68.0	100.0	73.0	100.0
Rock	0.4	5.0	0.0	0.0	0.2	2.0	0.1	2.0
Soil	3.5	30.0	4.2	43.0	3.1	41.0	1.5	25.0

sites was reduced to 11% and 10%, respectively. Ponderosa pine and Douglas-fir had decreased to about less than 1% to 5%. In contrast, in the Burn and Control, ponderosa pine (9% to 12%) and Douglas-fir (1% to 6%) cover remained similar to 1996. Ponderosa pine regeneration was slightly lower at the Harvest and more than 2% lower at the Harvest/Burn. It was slightly lower at the Burn also, but this was accompanied by an increase in the understory class. Douglas-fir decreased slightly in the Harvest and Harvest/Burn and increased in the Burn and Control. Lodgepole pine, larch and trembling aspen were also found.

In 1997, bryophytes decreased somewhat from 1996 at all treatments, ranging from 4% to 10%, while litter increased (64% to 73%). Bare soil was virtually unchanged (1% to 4%) from 1996.

## 1998

Total grass and grasslike cover ranged between approximately 31% and 43% at all sites in 1998 (Table 3). Species composition was similar to 1996 and 1997 with rough fescue, Richardson's needlegrass, Idaho fescue and pinegrass as the leading species. No species has exhibited meaningful change in frequency or cover. Overall, total grass cover was similar to 1996. Rough fescue cover ranged from 10% to 15%, while Idaho fescue and bluebunch wheatgrass cover ranged between 1% and 6%, and less than 1% to 2%, respectively. Richardson's needlegrass and pinegrass ranged between 3% and 12%.

Forb cover ranged between 10% and 14% at the Harvest, Harvest/Burn and Burn, while it was 5% at the Control (Table 3). Although a greater number of forb species were recorded in 1998 than in the two previous years, pussytoes, black medic, timber milkvetch, goldenrod and tiny penstemon were the only forbs whose cover exceeded 1%.

Shrub cover in 1998 was higher at the Harvest than in 1996 and 1997. At the Harvest/Burn and Burn, cover was lower (Table 3). At the Harvest site the main increase in cover came from bearberry and bitterbrush, which increased by approximately 7% and 2%, respectively, from post-treatment levels in 1997. At the Harvest/Burn and Burn, post-treatment shrub cover in 1998 was less than 27% at both sites (Table 3). The most notable response to prescribed burning in these two treatments was the decrease in bearberry and bitterbrush. Saskatoon and bitterbrush showed small decreases at the Control.

The Douglas-fir regeneration layer at the Harvest/Burn and Burn sites decreased by 4% to 5%. Cover of other tree species were similar to 1997 levels. Ponderosa pine and Douglas-fir cover all increased slightly at the Control (Table 3).

Bryophyte cover was lower at all sites in 1998 compared to 1996 or 1997 (Table 1, 2 and 3). Litter cover in 1998 was similar at the Harvest and Harvest/Burn, and higher at the Burn and Control. Bare soil was lower at the Harvest and Control in 1998, than in 1996 or 1997. Conversely, bare soil was higher in the Harvest/Burn and Burn. Elk feces

**Table 3. Cover and frequency of plant species at Cherry/TaTa Range Unit in 1998.**

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%-----								
<b>Grass and Grasslike</b>								
Bluebunch wheatgrass	0.7	7.0	0.9	4.0	2.3	11.0	0.6	9.0
Bearded wheatgrass	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Columbia needlegrass	0.0	0.0	0.2	2.0	0.0	0.0	0.3	2.0
Idaho fescue	2.5	22.0	0.6	6.0	0.8	8.0	6.2	42.0
Kentucky bluegrass	0.8	6.0	0.2	1.0	1.1	3.0	2.5	10.0
Northwest sedge	2.7	25.0	1.0	12.0	0.8	13.0	0.7	5.0
Pinegrass	3.6	51.0	9.1	66.0	6.5	50.0	7.1	48.0
Prairie junegrass	0.9	10.0	0.7	17.0	1.0	11.0	0.3	6.0
Richardson's needlegrass	7.7	38.0	4.9	26.0	10.6	40.0	12.6	44.0
Rough fescue	14.8	60.0	13.6	61.0	14.9	57.0	10.4	50.0
Sand dropseed	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Slender wheatgrass	0.2	1.0	0.5	4.0	0.6	7.0	1.2	9.0
Western needlegrass	0.0	0.0	0.1	2.0	0.0	0.0	0.8	4.0
Total Grass and Grasslike	34.1		31.8		38.6		42.7	
<b>Forbs</b>								
American vetch	0.1	2.0	0.2	1.0	0.2	3.0	0.1	2.0
Black medic	2.6	31.0	2.0	20.0	1.1	15.0	1.3	15.0
Chickweed	0.0	0.0	0.3	4.0	0.0	0.0	0.0	0.0
Compound fleabane	0.0	0.0	0.0	0.0	0.2	1.0	0.0	0.0
Dandelion	0.0	0.0	0.5	9.0	0.5	20.0	0.1	4.0
Dune goldenrod	0.3	3.0	1.9	17.0	1.3	11.0	0.0	1.0
Early blue violet	0.3	8.0	0.5	10.0	0.5	11.0	0.2	4.0
Hairy goldaster	0.0	0.0	0.0	0.0	0.2	1.0	0.0	0.0
Leafy aster	0.2	2.0	0.5	4.0	0.2	2.0	0.0	0.0
Locoweed	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0
Nuttall's pussytoes	0.0	0.0	0.0	0.0	0.2	3.0	0.0	0.0
Old man's whiskers	0.0	1.0	0.0	0.0	0.0	0.0	0.2	1.0
Prairie crocus	0.0	1.0	0.5	5.0	0.0	1.0	0.0	1.0
Rosy pussytoes	2.8	33.0	1.5	27.0	1.3	21.0	0.8	22.0
Shaggy fleabane	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0
Showy aster	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Silky lupine	0.0	0.0	0.0	0.0	0.0	0.0	0.3	5.0
Small-flowered penstemon	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0
Smooth agoseris	0.0	0.0	0.2	4.0	0.0	0.0	0.0	0.0
Spiny phlox	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0
Stoneseed	0.1	2.0	0.0	1.0	0.0	1.0	0.4	5.0
Timber milkvetch	0.7	8.0	1.4	17.0	1.0	15.0	0.0	0.0
Tiny penstemon	3.6	39.0	2.1	31.0	2.8	43.0	1.0	17.0
Western yarrow	0.5	15.0	0.6	10.0	1.0	27.0	0.5	9.0
White sweetclover	0.0	0.0	0.9	1.0	0.0	0.0	0.0	0.0
Wild strawberry	0.4	11.0	0.1	4.0	0.1	4.0	0.0	0.0

Total Forbs 11.6 13.8 10.6 5.0  
**Table 3. (cont'd)**

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%								
<b>Shrubs</b>								
Bearberry	34.5	81.0	17.3	72.0	9.5	62.0	13.8	50.0
Birch-leafed spirea	0.1	3.0	0.3	6.0	0.6	14.0	0.3	12.0
Bitterbrush	6.3	40.0	3.3	43.0	2.5	35.0	0.5	11.0
Low Oregongrape	0.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Rose	0.0	1.0	0.0	1.0	0.1	3.0	0.0	1.0
Saskatoon	2.6	41.0	4.7	60.0	6.4	66.0	1.3	20.0
Snowberry	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0
Soopolallie	0.1	5.0	0.0	0.0	0.1	2.0	0.0	0.0
Total Shrubs	44.0		25.6		19.2		15.9	
<b>Trees</b>								
Douglas-fir	2.2	3.0	0.0	0.0	0.7	3.0	6.0	12.0
Douglas-fir r/g	3.8	31.0	1.1	12.0	0.4	8.0	3.8	35.0
Douglas-fir u/s	0.7	3.0	0.0	1.0	0.4	1.0	2.3	5.0
Lodgepole pine	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.0
Ponderosa pine	2.5	6.0	4.7	8.0	6.6	11.0	5.9	12.0
Ponderosa pine r/g	0.2	9.0	0.2	3.0	2.7	10.0	0.1	4.0
Ponderosa pine u/s	1.6	7.0	0.2	2.0	4.2	11.0	6.1	15.0
Trembling aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0
Western larch	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.0
Total Trees	11.0		6.2		15.0		26.2	
Total Trees and Shrubs	55.0		31.8		34.2		42.1	
<b>Others</b>								
Bryophytes	4.3	47.0	5.7	41.0	8.3	58.0	7.9	50.0
Cattle feces	0.0	1.0	0.2	10.0	0.0	0.0	0.0	0.0
Deer feces	0.0	0.0	0.2	1.0	0.0	1.0	0.0	0.0
Elk feces	0.0	0.0	0.2	1.0	0.0	0.0	0.2	1.0
Litter	63.0	100.0	53.4	100.0	66.2	100.0	79.6	100.0
Rock	0.3	6.0	0.1	2.0	0.2	3.0	0.2	2.0
Soil	1.7	34.0	8.9	60.0	8.8	65.0	1.2	15.0

frequency was lower at all sites in 1998 than in 1996 or 1997. Cattle and deer feces frequency, while minor, were similar among years, although distribution changed.

## 1999

In 1999 grass and grasslike cover increased slightly in all treatments from 1998 levels, except for the Burn treatment (Table 4). Cover ranged between 33% and 47%. Species composition was similar to 1996-1998. Rough fescue (9% to 16%), Richardson's needlegrass (4% to 11%), pinegrass (8% to 12%) and Idaho fescue (1% to 6%) are the leading species.

Forb cover was higher in 1999 than in 1998. Cover ranged between 13% and 20%. Also, forb species were more numerous than in previous years. However, only western yarrow, rosy pussytoes, timber milkvetch, black medic and tiny penstemon consistently exceeded 1% cover among treatments (Table 4).

Shrub cover was within a similar range to that in 1998. However, some differences were noted by species. Bearberry cover was down in all treatments except the Control. This may be a delayed response to the 1998 prescribed burn. Additionally, increased light conditions in the treated areas may have further depressed bearberry cover. In contrast, saskatoon cover was 2% to 4% higher in the Harvest, Harvest/Burn and Burn treatments, and lower in the Control (Table 4).

Changes in forest cover occurred mostly with ponderosa pine. Douglas-fir cover was similar to 1998 levels. Ponderosa pine overstory increased in all treatments (Table 4). The regeneration layer cover was higher in the Harvest and Control treatments and lower in both the Harvest/Burn and the Burn treatments than in 1998. This may be a delayed response to the April, 1998 prescribed burn in the Harvest/Burn and Burn.

## 2000

Grass and grasslike cover was lower at all sites in 2000 than in 1999 (Table 5). Cover in the Harvest and in the Burn treatments is actually similar to cover in 1996. In contrast, grass cover in the Harvest/Burn and Control treatments is lower than in 1996. The principal difference is in the reduced cover of rough fescue and Idaho fescue in those treatments. The fescue species, along with Richardson's needlegrass and pinegrass are the leading species.

Forb cover was lower in 2000 than in 1999, but higher than in 1996. Cover ranged between 11% and 13%. Recorded forb species were more numerous than in the baseline year, having nearly doubled in that time. However, only western yarrow, rosy pussytoes, timber milkvetch and tiny penstemon consistently exceeded 1% cover across treatments (Table 5).

### **Table 4. Cover and frequency of plant species at Cherry/TaTa Range Unit in 1999.**

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%-----								
<b>Grass and Grasslike</b>								
Bluebunch wheatgrass	0.6	3.0	0.7	4.0	0.3	6.0	0.0	1.0
Bearded wheatgrass	0.0	0.0	0.0	0.0	0.3	4.0	0.0	0.0
Columbia needlegrass	0.0	0.0	0.0	0.0	0.2	1.0	0.5	5.0
Idaho fescue	4.3	23.0	1.4	12.0	1.1	11.0	5.6	40.0
Kentucky bluegrass	0.8	6.0	0.2	2.0	0.4	1.0	1.5	11.0
Northwest sedge	2.0	19.0	4.0	25.0	0.4	5.0	0.4	6.0
Pinegrass	8.3	67.0	9.1	58.0	7.7	59.0	12.0	66.0
Prairie junegrass	1.1	14.0	1.5	16.0	1.1	9.0	1.1	9.0
Richardson's needlegrass	10.9	39.0	3.9	24.0	10.1	46.0	11.3	45.0
Rough fescue	16.0	58.0	10.7	62.0	11.1	54.0	9.3	47.0
Slender wheatgrass	0.0	1.0	0.3	2.0	0.9	7.0	0.9	9.0
Western needlegrass	0.2	2.0	1.2	13.0	0.6	5.0	3.3	23.0
Total Grass and Grasslike	44.2		33.0		34.2		45.9	
<b>Forbs</b>								
American vetch	0.2	1.0	0.1	2.0	0.0	0.0	0.0	1.0
Baker's mariposa lily	0.3	10.0	0.3	12.0	0.2	4.0	1.1	5.0
Bastard toadflax	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Black medic	1.9	19.0	1.2	14.0	0.2	8.0	0.2	7.0
Brown-eyed susan	0.0	0.0	0.0	0.0	0.1	3.0	0.0	0.0
Dandelion	0.1	5.0	0.5	10.0	0.5	19.0	0.2	9.0
Dune goldenrod	0.9	8.0	1.2	10.0	0.7	4.0	0.0	0.0
Early blue violet	0.6	8.0	0.8	10.0	0.2	4.0	0.8	6.0
Goatsbeard	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Hairy goldaster	0.0	0.0	0.0	1.0	0.2	1.0	0.0	0.0
Indian paintbrush	0.2	1.0	0.2	3.0	0.0	1.0	0.6	3.0
Leafy aster	0.2	2.0	0.0	1.0	0.2	1.0	0.4	3.0
Locoweed	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0
Nuttall's pussytoes	0.0	0.0	0.0	0.0	0.7	12.0	0.3	2.0
Old man's whiskers	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0
Prairie crocus	1.0	7.0	0.5	5.0	0.0	0.0	0.0	0.0
Rosy pussytoes	3.3	34.0	1.4	24.0	0.9	20.0	1.1	20.0
Shaggy fleabane	0.0	1.0	0.0	0.0	0.2	1.0	0.2	2.0
Showy daisy	0.0	0.0	0.3	3.0	0.0	0.0	0.1	4.0
Silky lupine	0.0	0.0	0.0	0.0	0.0	0.0	7.4	38.0
Slender hawkweed	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0
Smooth agoseris	0.1	3.0	0.6	7.0	0.3	7.0	1.3	16.0
Spiny phlox	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0
Spreading dogbane	0.0	1.0	0.0	0.0	0.0	0.0	0.3	4.0
Star-f false Solomans seal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Stoneseed	0.3	3.0	0.2	1.0	0.3	3.0	1.3	13.0
Timber milkvetch	2.7	32.0	2.8	33.0	3.7	29.0	1.5	22.0

Tiny penstemon 2.7 33.0 3.1 22.0 2.4 36.0 1.8 22.0

**Table 4. (cont'd)**

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%								
Western yarrow	0.8	17.0	1.5	19.0	1.3	25.0	0.9	17.0
White sweetclover	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Wild strawberry	0.8	11.0	0.3	7.0	0.4	5.0	0.0	1.0
Yellow hedysarum	1.4	8.0	0.7	5.0	0.3	4.0	0.0	0.0
Total Forbs	17.5		16.1		12.8		19.8	
<b>Shrubs</b>								
Bearberry	19.9	78.0	15.6	69.0	5.9	49.0	9.0	37.0
Birch-leafed spirea	0.2	7.0	0.4	11.0	0.7	22.0	1.6	25.0
Bitterbrush	7.5	38.0	5.6	49.0	2.5	35.0	1.4	13.0
Low Oregongrape	0.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Rose	0.1	2.0	0.1	2.0	0.2	8.0	0.0	1.0
Saskatoon	6.2	48.0	6.8	61.0	7.8	66.0	2.8	23.0
Snowberry	0.0	0.0	0.0	0.0	0.2	1.0	0.0	0.0
Soopolallie	0.8	6.0	0.0	1.0	0.0	1.0	0.0	0.0
Total Shrubs	35.1		28.5		17.3		14.8	
<b>Trees</b>								
Douglas-fir	1.5	3.0	0.0	1.0	1.1	3.0	4.8	9.0
Douglas-fir r/g	4.0	26.0	1.3	12.0	0.4	8.0	3.9	35.0
Douglas-fir u/s	1.1	3.0	0.0	0.0	0.4	1.0	3.0	4.0
Lodgepole pine	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.0
Ponderosa pine	3.2	4.0	6.7	11.0	11.0	18.0	7.3	15.0
Ponderosa pine r/g	1.4	9.0	0.2	3.0	0.6	6.0	0.4	5.0
Ponderosa pine u/s	2.1	8.0	0.3	4.0	3.7	19.0	5.3	13.0
Trembling aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0
Western larch	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.0
Total Trees	13.3		8.5		17.2		26.7	
Total Trees and Shrubs	48.4		37.0		34.5		41.5	
<b>Others</b>								
Bryophytes	3.0	39.0	6.3	56.0	7.4	64.0	7.8	50.0
Cattle feces	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Deer feces	0.0	0.0	0.1	2.0	0.0	0.0	0.0	0.0
Elk feces	0.4	7.0	0.2	6.0	0.3	6.0	0.1	3.0
Litter	76.0	99.0	59.3	100.0	68.6	89.0	78.2	99.0
Rock	0.1	3.0	0.0	0.0	0.2	4.0	0.1	4.0
Soil	1.9	27.0	12.5	74.0	6.3	64.0	1.8	24.0

**Table 5. Cover and frequency of plant species at Cherry/TaTa Range Unit in 2000.**

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%								
<b>Grass and Grasslike</b>								
Bluebunch wheatgrass	0.4	7.0	0.8	6.0	0.2	2.0	0.0	1.0
Bearded wheatgrass	0.0	0.0	0.0	0.0	0.0	0.0	0.3	5.0
Columbia needlegrass	0.0	0.0	0.5	5.0	0.1	4.0	0.2	3.0
Idaho fescue	4.5	24.0	0.9	8.0	0.3	5.0	2.5	27.0
Kentucky bluegrass	0.8	11.0	0.2	2.0	0.4	1.0	1.2	9.0
Northwest sedge	3.4	21.0	1.6	16.0	0.8	15.0	0.5	6.0
Pinegrass	5.3	51.0	9.4	70.0	8.2	60.0	9.4	61.0
Prairie junegrass	0.5	11.0	0.7	13.0	0.8	13.0	0.3	6.0
Richardson's needlegrass	9.5	39.0	7.1	49.0	11.1	46.0	15.3	61.0
Rough fescue	10.9	55.0	7.7	51.0	9.9	58.0	5.8	39.0
Sandberg bluegrass	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Slender wheatgrass	0.3	2.0	0.4	3.0	0.7	4.0	0.3	3.0
Western needlegrass	0.0	0.0	0.0	0.0	0.0	0.0	0.2	3.0
Total Grass and Grasslike	35.6		29.3		32.5		36.0	
<b>Forbs</b>								
American vetch	0.0	1.0	0.1	2.0	0.0	0.0	0.0	0.0
Baker's mariposa lily	0.1	4.0	0.0	1.0	0.0	0.0	0.1	2.0
Bastard toadflax	0.0	0.0	0.1	2.0	0.0	1.0	0.0	0.0
Black medic	0.1	2.0	0.8	12.0	0.2	9.0	0.0	1.0
Compound fleabane	0.1	2.0	0.0	1.0	0.0	1.0	0.0	0.0
Creamy peavine	0.5	6.0	0.5	5.0	0.2	4.0	0.0	0.0
Dandelion	0.0	1.0	0.2	6.0	0.3	7.0	0.1	4.0
Dune goldenrod	0.7	8.0	1.5	15.0	0.6	14.0	0.3	3.0
Early blue violet	0.4	12.0	0.4	6.0	0.6	7.0	0.2	4.0
Goatsbeard	0.0	0.0	0.2	3.0	0.1	2.0	0.0	1.0
Graceful cinquefoil	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0
Hairy goldaster	0.0	0.0	0.3	3.0	0.2	3.0	0.0	0.0
Heart-leaved arnica	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Indian paintbrush	0.2	1.0	0.1	2.0	0.0	1.0	0.2	3.0
Leafy aster	0.0	0.0	0.2	1.0	0.2	1.0	0.0	0.0
Locoweed	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Long-leaved fleabane	0.0	0.0	0.0	0.0	0.6	7.0	0.0	0.0
Nine-leaved lomatium	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Nodding onion	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Old man's whiskers	0.0	0.0	0.1	5.0	0.0	0.0	0.0	0.0
Pacific anemone	0.4	8.0	0.0	0.0	0.2	6.0	0.3	3.0
Prairie crocus	0.5	2.0	0.3	3.0	0.2	2.0	0.3	2.0
Rosy pussytoes	2.2	31.0	1.5	26.0	1.5	24.0	1.5	22.0
Scouler's hawkweed	0.1	2.0	0.0	0.0	0.0	1.0	0.1	3.0
Shaggy fleabane	0.0	1.0	0.1	2.0	0.0	0.0	0.1	2.0

Showy daisy	0.0	0.0	0.0	0.0	0.2	1.0	0.0	0.0
Silky lupine	0.0	0.0	0.0	0.0	0.0	0.0	2.6	24.0

**Table 5. (cont'd)**

Species	Harvest		Harv/Burn		Burn		Control	
	Cover	Freq	Cover	Freq	Cover	Freq	Cover	Freq
-----%								
Slender hawkweed	0.0	0.0	0.0	0.0	0.0	0.0	0.2	3.0
Smooth agoseris	0.2	3.0	0.5	9.0	0.1	2.0	0.1	2.0
Spreading dogbane	0.4	2.0	0.0	0.0	0.0	0.0	0.2	2.0
Stoneseed	0.4	3.0	0.2	2.0	0.7	4.0	1.4	16.0
Thin-leaved owlclover	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0
Timber milkvetch	2.0	24.0	1.1	19.0	3.3	27.0	1.2	18.0
Tiny penstemon	2.5	32.0	1.8	30.0	3.1	43.0	1.6	28.0
Western yarrow	0.7	17.0	0.5	11.0	0.8	16.0	0.4	12.0
White sweetclover	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Wild strawberry	1.1	13.0	0.6	7.0	0.2	3.0	0.0	1.0
Total Forbs	12.6		11.1		13.3		11.2	
<b>Shrubs</b>								
Bearberry	25.1	78.0	18.4	75.0	10.1	63.0	7.1	40.0
Birch-leaved spirea	0.4	10.0	0.2	8.0	0.3	13.0	0.6	14.0
Bitterbrush	7.3	39.0	7.7	51.0	4.5	46.0	1.0	12.0
Low Oregongrape	0.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Rose	0.0	1.0	0.0	1.0	0.2	6.0	0.1	2.0
Saskatoon	5.2	49.0	4.9	59.0	6.8	72.0	1.4	21.0
Soopolallie	0.4	5.0	0.0	1.0	0.0	1.0	0.0	0.0
Total Shrubs	38.8		31.2		21.9		10.2	
<b>Trees</b>								
Douglas-fir	1.6	2.0	0.0	0.0	2.3	5.0	5.6	11.0
Douglas-fir r/g	5.2	32.0	1.6	13.0	0.4	8.0	4.0	38.0
Douglas-fir u/s	1.5	4.0	0.0	0.0	0.0	0.0	2.5	4.0
Lodgepole pine	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.0
Lodgepole pine r/g	0.2	2.0	0.0	0.0	0.0	0.0	0.0	1.0
Ponderosa pine	3.0	4.0	6.7	8.0	8.5	15.0	5.9	10.0
Ponderosa pine r/g	0.2	6.0	0.2	2.0	0.8	5.0	0.6	6.0
Ponderosa pine u/s	2.1	8.0	0.4	3.0	5.6	14.0	5.4	16.0
Western larch	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.0
Total Trees	13.8		8.9		17.6		26.2	
Total Trees and Shrubs	52.6		40.1		39.5		36.4	
<b>Others</b>								
Bryophytes	2.2	38.0	2.6	55.0	5.3	62.0	10.0	72.0
Cattle feces	0.0	0.0	0.6	5.0	0.2	1.0	0.0	1.0
Elk feces	0.2	7.0	0.4	5.0	0.1	3.0	0.1	2.0
Litter	76.9	100.0	63.2	100.0	70.1	100.0	75.9	100.0
Rock	0.4	5.0	0.1	2.0	0.3	3.0	0.2	4.0

Soil	3.1	38.0	13.8	86.0	8.3	59.0	1.6	21.0
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Shrub cover showed slight increases between 1999 and 2000 in all treatments except the Control. However, the Harvest treatment was the only site where cover has increased between 1996 and 2000. Shrub cover is dominated by bearberry at all sites, so to examine treatment response simply by totaling cover may be misleading. However, a trend of decreased cover of bearberry and increases in saskatoon and bitterbrush is noticeable in the treated sites.

Forest cover in 2000 was very similar to 1999 (Table 5). The only noticeable difference in cover was in the Harvest treatment. Douglas-fir regeneration layer cover was higher there in 2000 than in 1999, and it was similar in the other treatments.

Bryophytes decreased across all treatments in 2000, while litter increased. Bare soil increased in the Harvest/Burn and Burn treatments. Cattle feces increased in the Harvest/Burn and Burn treatments and was unchanged at the other sites. Deer feces was unchanged during the study. Elk feces was the same as pre-treatment in the Harvest and Burn sites, but decreased slightly in the Harvest/Burn and Control sites.

### 3.11 Plant Community Similarity

In 1996 plant communities in the four treatments were similar ( $p < 0.05$ ), except for the comparison between the Burn and Control (Table 6). Possible explanations for these differences can be found in the tree and shrub cover. The Burn is dominated by ponderosa pine, while the Control, although ponderosa pine leading, has a substantial Douglas-fir component (Table 1). Also, there were low amounts of bitterbrush and saskatoon in the Control, in contrast to the Burn where these species combined for 13% cover. Additionally, bearberry was the leading species in the Burn, while it was less prevalent in the Control. Other important differences lie in the absence of Idaho fescue in the Burn, while it reached approximately 6% in the Control. Silky lupine exceeded 3% cover in the Control but was less than 1% in the Burn.

Following forest harvest in 1997, all comparisons were similar ( $p < 0.05$ ), except for the Harvest/Burn and the Control (Table 7). The Harvest/Burn and the Control were likely not similar due to changes in the forest canopy at the Harvest/Burn. Douglas-fir overstory and understory, and ponderosa pine understory in particular, underwent decreases in cover from 3% to less than 1%, 3% to less than 1%, and nearly 5% to less than 1%, respectively (Table 1 and 2). Additionally, there was more Idaho fescue and Richardson's needlegrass at the Control, and more rough fescue at the Harvest/Burn.

The Burn and Control were similar in 1997 ( $p < 0.05$ ). Changes from 1996 in the herbaceous and shrub layers may be the reason (Table 1, 2, 6 and 7). Bearberry was the most prevalent plant at both sites in 1997, and rough fescue and Richardson's needlegrass were still ranked as second and third most prevalent. The sites grew more similar as Idaho fescue was recorded at the Burn in 1997, and more saskatoon and less silky lupine was recorded at the Control.

**Table 6. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 1996.**

	Harvest	Harvest/Burn	Burn	Control
Harvest	1.000	0.826*	0.493*	0.515*
Harvest/Burn		1.000	0.761*	0.466*
Burn			1.000	0.259
Control				1.000

**Table 7. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 1997.**

	Harvest	Harvest/Burn	Burn	Control
Harvest	1.000	0.837*	0.724*	0.496*
Harvest/Burn		1.000	0.805*	0.394
Burn			1.000	0.510*
Control				1.000

**Table 8. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 1998.**

	Harvest	Harvest/Burn	Burn	Control
Harvest	1.000	0.643***	0.598**	0.543*
Harvest/Burn		1.000	0.561*	0.270
Burn			1.000	0.502*
Control				1.000

**Table 9. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 1999.**

	Harvest	Harvest/Burn	Burn	Control
Harvest	1.000	0.585***	0.575***	0.491*
Harvest/Burn		1.000	0.507*	0.263
Burn			1.000	0.485*
Control				1.000

**Table 10. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 2000.**

	Harvest	Harvest/Burn	Burn	Control
Harvest	1.000	0.712***	0.586*	0.624***
Harvest/Burn		1.000	0.561*	0.342
Burn			1.000	0.462*
Control				1.000

\* p<0.05  
\*\* p<0.002  
\*\*\* p<0.001

The relationships between sites shown in 1997 were repeated in 1998, 1999 and 2000 (Table 8, 9 and 10). Although changes occurred in tree and shrub cover in the treated areas, Spearman's rank correlation comparisons indicated species composition remained similar among sites. As in 1997, the only non-significant ( $p>0.05$ ) relationship was between the Harvest/Burn and Control.

When the plant communities from 1996 and 1997 were compared (Table 11) all treatments were shown to be similar ( $p<0.05$ ) between years. This indicates species change has not occurred on any of the treatments as a result of forest canopy removal or the burn treatment. Plant communities were similar in each of the 4 treatments between 1996 and 1997, 1996 and 1998, 1996 and 1999 and between 1996 and 2000 (Table 12, 13 and 14).

### **3.2 Forage Production**

Forage production in 1996 ranged from approximately 500 kg/ha at the Harvest to 750 kg/ha at the Control (Table 15). Rough fescue was the dominant contributor to forage production at the Harvest and Harvest/Burn; approximately 240 kg/ha and 250 kg/ha, respectively. Other grasses, comprised principally of Richardson's needlegrass, pinegrass and northwest sedge, were dominant at the Control (more than 520 kg/ha). Rough fescue and other grasses contributed approximately 285 kg/ha and 320 kg/ha, respectively, to forage production in the Burn. Idaho fescue production was approximately 20 kg/ha at all sites, except the Burn where it was slightly less than 7 kg/ha. Bluebunch wheatgrass ranged from less than 3 kg/ha at the Control to nearly 50 kg/ha at the Burn treatment. Forb production ranged between 35 and 60 kg/ha at the 4 sites.

Post-treatment monitoring of the 4 treatment areas following harvest in 1997 revealed the range of production was similar to 1996 (Table 15). Production was still the lowest in the Harvest, but forage production was 37% higher in the Harvest/Burn. The rough fescue, other grasses and forb classes all produced more forage in this treatment in 1997, while Idaho fescue remained constant and bluebunch wheatgrass production decreased. Rough fescue production increased by approximately 50% from 1996 levels in the Harvest/Burn, but only by about 5% in the Harvest following forest harvest in 1997. Other grasses increased by approximately 16% and 28%, respectively, in the Harvest and Harvest/Burn.

Forage production was slightly lower in 1997 than in 1996 in both the Burn and Control (Table 15). Production by all bunchgrass species was lower in both treatments in 1997 than in 1996, except for Idaho fescue at the Control. Rough fescue production decreased by 15% and 23% in the Burn and Control, respectively (Table 15).

Other grasses production was more than 25% lower in the Control in 1997 than in 1996. Forb production was higher at all treatments in 1997, especially at the Harvest/Burn and Control where it increased by more than 2 times.

**Table 11. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 1996 and 1997.**

	Harvest96	Harvest/Burn96	Burn96	Control96
Harvest97	0.495*			
Harvest/Burn97		0.739**		
Burn97			0.855***	
Control97				0.769***

**Table 12. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 1996 and 1998.**

	Harvest96	Harvest/Burn96	Burn96	Control96
Harvest98	0.694**			
Harvest/Burn98		0.511*		
Burn98			0.629**	
Control98				0.764***

**Table 13. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 1996 and 1999.**

	Harvest96	Harvest/Burn96	Burn96	Control96
Harvest99	0.771***			
Harvest/Burn99		0.404*		
Burn99			0.568*	
Control99				0.804*

**Table 14. Spearman's rank correlation statistic at Cherry/TaTa Range Unit in 1996 and 2000.**

	Harvest96	Harvest/Burn96	Burn96	Control96
Harvest00	0.722***			
Harvest/Burn00		0.597*		
Burn00			0.629**	
Control00				0.661***

\* p<0.05  
 \*\* p<0.002  
 \*\*\* p<0.001

**Table 15. Distribution of forage production among key species at the Cherry/TaTa Range Unit between 1996 and 2000.**

<b>1996</b>						
Treatment	Rough Fescue (kg/ha)	Idaho Fescue (kg/ha)	Bluebunch Wheatgrass (kg/ha)	Other Grasses (kg/ha)	Forbs (kg/ha)	Total (kg/ha)
Harvest	241.3	21.5	2.8	188.5	48.4	502.4
Harvest & Burn	254.4	22.5	17.7	192.9	40.9	524.9
Burn	284.7	6.8	49.6	322.0	35.4	698.4
Control	132.1	21.6	16.1	522.4	59.5	751.8

<b>1997</b>						
Treatment	Rough Fescue (kg/ha)	Idaho Fescue (kg/ha)	Bluebunch Wheatgrass (kg/ha)	Other Grasses (kg/ha)	Forbs (kg/ha)	Total (kg/ha)
Harvest	253.7	2.8	7.9	218.6	77.1	560.1
Harvest & Burn	384.8	9.0	0.0	246.0	107.2	716.6
Burn	241.8	6.5	6.5	333.4	55.0	647.1
Control	101.6	31.0	0.0	390.2	144.5	667.4

<b>1998</b>						
Treatment	Rough Fescue (kg/ha)	Idaho Fescue (kg/ha)	Bluebunch Wheatgrass (kg/ha)	Other Grasses (kg/ha)	Forbs (kg/ha)	Total (kg/ha)
Harvest	410.6	62.6	6.9	393.9	111.6	985.6
Harvest & Burn	257.8	32.1	5.1	218.5	226.5	740.1
Burn	278.2	4.8	3.3	260.5	71.5	617.7
Control	251.7	27.0	0.0	402.8	71.4	753.0

<b>1999</b>						
Treatment	Rough Fescue (kg/ha)	Idaho Fescue (kg/ha)	Bluebunch Wheatgrass (kg/ha)	Other Grasses (kg/ha)	Forbs (kg/ha)	Total (kg/ha)
Harvest	677.2	50.9	23.6	252.8	99.5	1104.0
Harvest & Burn	449.4	24.5	49.5	422.3	54.7	1000.4
Burn	548.7	1.7	17.5	249.7	50.9	868.5
Control	413.4	59.0	1.7	339.0	67.1	880.2

<b>2000</b>						
Treatment	Rough Fescue (kg/ha)	Idaho Fescue (kg/ha)	Bluebunch Wheatgrass (kg/ha)	Other Grasses (kg/ha)	Forbs (kg/ha)	Total (kg/ha)
Harvest	443.6	29.1	0.0	312.6	30.2	815.4
Harvest & Burn	343.3	7.8	21.2	315.7	46.2	734.3
Burn	397.2	1.2	3.4	324.2	42.8	768.8
Control	296.9	1.6	0.0	344.6	36.8	680.0

The most notable difference in forage production in 1998 was the increased production in the Harvest. Total production was more than 985 kg/ha, nearly 100% higher than in 1996 (Table 15). Production increased in all forage classes. In particular, rough fescue and other grasses, increased by 62% and 80%, respectively. Production totals were very similar to 1997 levels in the Harvest/Burn. Rough fescue production was 33% lower than in 1997, but forb production increased by more than 110%. In the Burn, production decreased in 1997 and 1998 from 1996 levels. Other grasses accounted for the largest portion of this decline. Forage production in the Control was virtually identical to the baseline year.

In 1999, forage production was higher in all classes in the Harvest and Harvest/Burn (Table 15). Rough fescue production was 180% and 77% higher, respectively than in 1996. Rough fescue production increased in the Burn, but production was lower in all other classes. In the Control, rough fescue and Idaho fescue were higher, but bluebunch wheatgrass, other grasses and forbs were lower.

Forage production was lower at all sites in 2000 than it was in 1999 (Table 15). Decreased contributions from rough fescue, Idaho fescue, bluebunch wheatgrass and forbs were responsible. However, rough fescue production increased 80%, 35% and 40% from 1996 levels in the Harvest, Harvest/Burn and Burn treatments. Other grass production increased by more than 60% at the Harvest and Harvest/Burn treatments.

### **3.21 Treatment Effects**

Significant forage production differences were noted in the baseline year. In 1996, production was higher ( $p < 0.10$ ) in the Harvest/Burn and Control compared to the Harvest and Burn (Table 16). No significant differences were calculated between treatments in 1997. In 1998, after harvesting and prescribed burning treatments had been applied, production in the Harvest was higher ( $p < 0.10$ ) than in the Burn and Harvest/Burn. Production remained higher ( $p < 0.10$ ) in the Control than in the Burn (Table 16).

Harvest has had a more immediate effect on forage production than the Burn treatment. In 1999, significant forage production differences were found between the Harvest and Harvest/Burn treatments and the Burn and Control treatments (Table 16).

Forage production in 2000 exhibited a similar relationship among sites as in 1997. Although a range of 135 kg/ha existed between the highest producing site (Harvest) and the lowest producing site (Control) no significant differences ( $p > 0.10$ ) were detected among treatments in the final monitoring year. This indicates forage production was more variable within sites in 2000.

**Table 16. Forage production at Cherry/TaTa Range Unit between 1996 and 2000.**

## 1996

Treatment	Forage Production (kg/ha)
Harvest	502.4 b
Harvest/Burn	698.4 ab
Burn	524.9 b
Control	751.8 a

## 1997

Treatment	Forage Production (kg/ha)
Harvest	560.1 a
Harvest/Burn	716.6 a
Burn	647.1 a
Control	667.4 a

## 1998

Treatment	Forage Production (kg/ha)
Harvest	985.6 a
Harvest/Burn	740.1 b
Burn	617.7 b
Control	753.0 ab

## 1999

Treatment	Forage Production (kg/ha)
Harvest	1104.0 a
Harvest/Burn	1000.4 a
Burn	868.5 b
Control	880.2 b

## 2000

Treatment	Forage Production (kg/ha)
Harvest	815.4 a
Harvest/Burn	734.2 a
Burn	768.8 a
Control	680.0 a

Means within the same column followed by a different letter are significantly different ( $p < 0.10$ ).

### 3.22 Treatment and Year Interactions

1997

As the prescribed burn treatment was not scheduled until April, 1998, there was essentially one treatment applied in 1997, harvest. Accordingly, the forage production data for the Harvest and Harvest/Burn were combined, as were the data for the Burn and Control. The ANOVA procedure examined Treatment and Year as effects, and the Treatment by Year interaction.

Forage production at the Control was slightly more than 690 kg/ha, nearly 20% higher than the Harvest (Table 17). There was no significant ( $p < 0.05$ ) effect for Year. This confirms that forage production was similar between years, independent of forest harvesting. The significant Treatment by Year interaction indicates that changes in forage production within Treatments were not independent of the Year effect (Table 17). The principle difference in the Treatments between years was the forest harvest which took place in January to March, 1997.

In 1996 forage production in the Control was 725 kg/ha, approximately 40% larger ( $p < 0.05$ ) than in the Harvest. Following the harvest treatment in 1997 this relationship was not maintained. Production increased in the Harvest and decreased in the Control in 1997.

Forest harvest in 1997 has resulted in forage production increases of nearly 25% ( $p < 0.05$ ) in the Harvest between 1996 and 1997 (Table 17). Conversely, forage production was approximately equal in the Control, in 1996 and 1997.

1998

Following the prescribed burn in April, 1998, all treatments had been applied. The effects were Treatment and Year. The Treatment effect, where 1996 and 1998 data were combined (eg. Harvest 1996 and Harvest 1998) was not significant ( $p > 0.20$ ) (Table 18). This indicates forage production differences between treatments are not influenced by site differences.

The Year effect was significant ( $p < 0.002$ ). Averaged by treatment, forage production in 1998 was higher than in 1996 (Table 18). Forest harvest in 1997 and the prescribed burn in 1998 are the principal differences in conditions between years.

A significant ( $p < 0.05$ ) interaction indicates forage production in 1998 increased as a result of the forest harvest and prescribed burn treatments, when compared to 1996 (Table 18). Two years after forest harvest, forage production in the Harvest was approximately 986 kg/ha, nearly 100% higher than in 1996. In 1998, after both treatments had been applied to the Harvest/Burn, forage production was 740 kg/ha, more than 40% higher than in 1996.

**Table 17. The effect of forest harvest on forage production at Cherry/TaTa Range Unit in 1996 and 1997.**

Comparison	Forage Production (kg/ha)	
Main Effects		
Treatment	Harvest	Control
	576.0 a	691.1 b
Year	1996	1997
	619.4 a	647.7 a

Means within the same row followed by a different letter are significantly different ( $p < 0.05$ ).

Interactions		
Treatment*Year	Harvest 1996	513.7 b
	Harvest 1997	638.8 a
	Control 1996	725.5 a
	Control 1997	657.2 a

Means within the same column followed by a different letter are significantly different ( $p < 0.05$ ).

**Table 18. The effect of forest harvest and prescribed burning on forage production at Cherry/TaTa Range Unit in 1996 and 1998.**

Comparison	Forage Production (kg/ha)	
Main Effects		
Year	1996	1998
	619.4 a	774.1 b

Means within the same row followed by a different letter are significantly different ( $p < 0.05$ ).

Interactions	Forage Production (kg/ha)	
Treatment*Year	Harvest 1996	Harvest 1998
	502.4 a	985.6 b
	Harvest/Burn 1996	Harvest/Burn 1998
	524.9 a	740.1 b
	Burn 1996	Burn 1998
	698.4 a	617.7 a
	Control 1996	Control 1998
	751.8 a	753.0 a

Means within the same row followed by a different letter are significantly different ( $p < 0.05$ ).

There was no difference ( $p>0.05$ ) in forage production in the Burn between 1996 and 1998 (Table 18). It may be that more than one growing season is required to demonstrate the effects of prescribed burning on forage production. Forage production was virtually identical between Control 1996 and Control 1998 (Table 18). This signifies differences in forage production between 1996 and 1998 resulted from the forest harvest and prescribed burning treatments.

1999

Forage production was significantly higher in 1999 than in 1996 (Table 19). Although production was higher in all treatments, this is primarily due to the increases in the Harvest and Harvest/Burn treatments. Treatment by Year interactions were significant for all treatments except the Control. This indicates forage production has increased as a result of all forest treatments. Forage production in the Burn treatment may have required two seasons to experience a significant increase.

2000

Forage production in 2000 was significantly higher than in 1996 (Table 20). When all sites are averaged by year, the production was approximately 130 kg/ha higher in 2000.

Significant differences in forage production were realized between 1996 and 2000 in the Harvest and the Harvest/Burn treatments. Unlike 1999, there was no significant difference in production in the Burn treatment. The principal difference is due to forest harvest. Forage production in the Control was not significantly different ( $p>0.10$ ) from production in 1996.

### **3.3 Forage Production and Forest Cover**

In the pre-treatment relationship between forest cover and forage production in 1996, forest cover ranged from approximately 20% at the Burn and Control to nearly 30% at the Harvest (Table 21). The treatments appeared in the inverse order when ranked for forage production, with the highest production being recorded in the Control (approximately 750 kg/ha) and the lowest in the Harvest (slightly more than 502 kg/ha). Grass cover was similar among the Harvest, Harvest/Burn and Burn treatments, ranging from 33% to 37%, but was more than 50% at the Control site.

In 1997, following the forest harvest treatment, forest cover was reduced to approximately 10% in the Harvest and Harvest/Burn treatments (Table 21). Tree cover remained at approximately 20% for the Burn and Control. Forage production increased by about 10% and nearly 40%, in the Harvest and Harvest/Burn to approximately 560 kg/ha and 720 kg/ha, respectively (Table 21). Conversely, forage production decreased in both the Burn and Control.

**Table 19. The effect of forest harvest and prescribed burning on forage production at Cherry/TaTa Range Unit in 1996 and 1999.**

Comparison	Forage Production (kg/ha)	
Main Effects		
Year	1996	1999 *
	619.4 a	963.3 b

Means within the same row followed by a different letter are significantly different ( $p < 0.05$ ).

\*  $p < 0.05$ ; \*\*  $p < 0.10$ ; NS = not significantly different

Interactions	Forage Production (kg/ha)	
	1996	1999
Treatment*Year	Harvest	Harvest *
	502.4 a	1104.0 b
	Harvest/Burn	Harvest/Burn *
	524.9 a	1000.4 b
	Burn	Burn **
	698.4 a	868.5 b
	Control	Control NS
	751.8 a	880.2 a

Means within the same row followed by a different letter are significantly different ( $p < 0.05$ ).

\*  $p < 0.05$ ; \*\*  $p < 0.10$ ; NS = not significantly different

**Table 20. The effect of forest harvest and prescribed burning on forage production at Cherry/TaTa Range Unit in 1996 and 2000.**

Comparison	Forage Production (kg/ha)	
Main Effects		
Year	1996	2000 *
	619.4 a	749.6 b

Means within the same row followed by a different letter are significantly different ( $p < 0.05$ ).

\*  $p < 0.05$ ; \*\*  $p < 0.10$ ; NS = not significantly different

Interactions	Forage Production (kg/ha)	
	1996	2000
Treatment*Year	Harvest	Harvest *
	502.4 a	815.4 b
	Harvest/Burn	Harvest/Burn *
	524.9 a	734.3 b
	Burn	Burn NS
	698.4 a	768.8 a
	Control	Control NS
	751.8 a	680.0 a

Means within the same row followed by a different letter are significantly different ( $p < 0.05$ ).

\*  $p < 0.05$ ; \*\*  $p < 0.10$ ; NS = not significantly different

**Table 21. Forest cover and forage production at Cherry/TaTa Range Unit between 1996 and 2000.**

<b>1996</b> Treatment	Forest Cover (%)	Grass Cover (%)	Production (kg/ha)
Harvest	29.8	36.8	502.4
Harvest & Burn	24.4	33.5	524.9
Burn	19.3	34.5	698.4
Control	20.9	52.8	751.8

<b>1997</b> Treatment	Forest Cover (%)	Grass Cover (%)	Production (kg/ha)
Harvest	11.1	30.0	560.1
Harvest & Burn	9.7	28.0	716.6
Burn	20.6	33.1	647.1
Control	20.1	36.9	667.4

<b>1998</b> Treatment	Forest Cover (%)	Grass Cover (%)	Production (kg/ha)
Harvest	10.4	34.1	985.6
Harvest & Burn	6.2	31.8	740.1
Burn	15.0	38.6	617.7
Control	26.2	42.7	753.0

<b>1999</b> Treatment	Forest Cover (%)	Grass Cover (%)	Production (kg/ha)
Harvest	13.3	44.2	1104.0
Harvest & Burn	8.5	33.0	1000.4
Burn	16.8	33.7	868.5
Control	26.7	46.8	880.2

<b>2000</b> Treatment	Forest Cover (%)	Grass Cover (%)	Production (kg/ha)
Harvest	13.8	35.6	815.4
Harvest & Burn	8.9	29.3	734.2
Burn	17.6	32.5	768.8
Control	26.2	36.0	680.0

Greater increases in forage production in the Harvest/Burn, as compared to the Harvest may be in response to a more complete removal of the understory. Douglas-fir understory was reduced from 3.5% cover to 0% in the Harvest/Burn (Table 1, 2). In contrast, at the Harvest, 1.5% Douglas-fir understory cover remained from the original 4%. It is uncertain whether this is related to smaller increases in rough fescue production at the Harvest in 1997.

Forest cover in 1998 was reduced to approximately 10% at the Harvest. The prescribed burning treatment resulted in a further reduction of 3.5%, mostly in the regeneration layer, in the Harvest/Burn. Forest canopy removal in the Harvest and Harvest/Burn has resulted in significant increases ( $p < 0.05$ ) in forage production (Table 21).

Application of the prescribed burning treatment resulted in further reductions in tree and shrub cover in the Burn also (Table 21). Tree cover decreased nearly 5%, while shrub cover was approximately 10% lower (Table 3, 21). Tree cover totaled 15% in 1998, but forage production also decreased (Table 21). While decreases in cover of the ponderosa pine and Douglas-fir regeneration layers was evident, there was actually little change in the amount of overstory and understory cover in the Burn following the prescribed burn (Table 1, 3, 21). In contrast, forest cover was more than 5% higher in the Control in 1998, when compared to 1996.

These treatments resulted in increased grass cover in all treatment areas in 1998 as compared to 1997. However, 1998 grass cover was only higher in the Burn when compared to 1996 (Table 21).

Forest and grass cover were slightly higher in 1999 than in 1998 (Table 21). Forage production was higher in all of these treatments. In the Burn tree cover was higher and grass cover was lower. However, forage production was higher in the Burn than in 1998.

The trend in 2000 mirrors that of 1998 and 1999. The Harvest and Harvest/Burn treatments consistently produced more forage than the Burn and Control sites. However, forest cover has increased by nearly 4% at the Harvest treatment and by approximately 3% at the Harvest/Burn and Burn treatments.

Canopy removal by harvest treatment appears to promote a more immediate forage production response than removal by burning. The effect of forest harvest on forage production took two years to show a significant response in the Harvest (Table 17 to 21). Similarly, forage production was significantly higher in the Burn treatment in 1999, but not in 1998. The prescribed burning treatment required two years for significant differences to emerge.

Overall, between 1996 and 2000, significant ( $p < 0.05$ ) treatment effects were only observed at the Harvest and Harvest/Burn treatments (Table 22). It is uncertain whether differences in the treatment effect between 1999 and 2000 are due to increases in forest cover, lower precipitation or a combination of factors. While a numeric increase was

**Table 22. Summary of forest cover and forage production at Cherry/TaTa Range Unit in 1996 and 2000.**

	Forest Cover (%)	Forage Production (kg/ha)
Harvest 1996	29.8	502.4 a
Harvest 2000	13.8	815.4 b
Harvest/Burn 1996	24.4	524.9 a
Harvest/Burn 2000	8.9	734.2 b
Burn 1996	19.3	698.4 a
Burn 2000	17.6	768.8 a
Control 1996	20.9	751.8 a
Control 2000	26.2	680.0 a

Pairs of means within the same column (eg. Harvest 1996 and Harvest 1999) followed by a different letter are significantly different ( $p < 0.05$ ).

shown in production at the Burn treatment between 1996 and 2000, this difference was not significant. Differences in production between the two dates at the Burn site may have been masked by weather effects. Production was not significantly different at the Control site between 1996 and 2000.

### **3.4 Weather Effects**

Variable precipitation patterns were observed during the duration of the study. Total precipitation at the Cranbrook Airport in 1996 was approximately 140% of the long-term normal (Table 23). In contrast, in 1997 total precipitation was 75% of the long-term normal. Precipitation records from 1998 reveal that 124% of the long-term normal fell that year. In 1999 precipitation equaled the long-term normal. In 2000, recorded precipitation was the lowest of all years, less than 71% of the long-term normal.

Although there was no year effect on forage production between 1996 and 1997 (Table 17), lower precipitation in 1997 may account for some of the production differences between species. For example the forb class produced more forage and more cover in 1997 than in 1996 at all treatments (Table 15). Grass cover decreased at all treatments in 1997, likely as a result of decreased precipitation in July and August, 1997. Also, bryophyte cover decreased for all sites between 1996 and 1997.

Precipitation was above the long-term normal in 1996 and 1998 (Table 23). While the Year effect was significant ( $p < 0.05$ ) between 1996 and 1998 when the data for all treatments was combined, this forage response was primarily due to the harvest and prescribed burning treatments. There was no difference ( $p > 0.05$ ) between forage production at the Control and Burn, while production was higher ( $p < 0.05$ ) at the Harvest and Harvest/Burn (Table 18). Grasses and forbs may have had increased response to precipitation which exceeded the long-term normal in May, June and July, but this would affect all treatments equally. It is unlikely that precipitation unduly influenced differences in forage production among treatments.

In 1999, precipitation was equal to the long-term normal and well distributed throughout the growing season. Higher than average rainfall in July may have contributed to higher 1999 forage production overall.

In 2000, precipitation was similar to that in 1997, more than 25% below the long-term normal. Monthly precipitation was below average in April through August (Table 23). Forage production, grass cover and forb cover were lower at all sites than in 1999. The most noticeable difference was in decreased cover and production of rough fescue, Idaho fescue and bluebunch wheatgrass (Table 5 and 15). The latter two species are not large contributors to the forage base. As rough fescue produces nearly one-half of the total forage, differences are readily apparent. Forage production was between 100 kg/ha to nearly 300 kg/ha lower in 2000 than in 1999, when precipitation was at the long-term normal.

**Table 23. Precipitation at the Cranbrook Airport in from 1996 to 2000.**

Month	1996	1997	1998	1999	2000	Long-Term Normal
			(in)			
January	1.29	1.36	1.80	0.94	1.45	0.99
February	1.19	0.19	0.22	1.41	0.79	0.85
March	0.61	1.38	1.65	0.36	1.31	0.83
April	1.43	0.98	0.37	0.73	0.76	1.12
May	2.94	2.50	4.16	1.72	0.76	1.80
June	1.82	1.31	3.07	2.31	0.87	2.00
July	1.25	0.55	1.59	2.22	0.91	1.34
August	0.28	0.69	0.37	1.09	0.43	1.15
September	1.07	0.89	1.24	0.07	1.05	1.21
October	1.50	0.77	0.44	0.99	0.20	0.72
November	3.49	0.12	1.90	2.19	0.62	1.42
December	3.67	0.26	1.35	0.59	1.20	1.18
Total	20.54	11.00	18.16	14.62	10.35	14.61
			(cm)			
January	3.28	3.45	4.57	2.39	3.68	2.51
February	3.02	0.48	0.56	3.58	2.01	2.16
March	1.55	3.51	4.19	0.91	3.33	2.11
April	3.63	2.49	0.94	1.85	1.93	2.84
May	7.47	6.35	10.57	4.37	1.93	4.57
June	4.62	3.33	7.80	5.87	2.21	5.08
July	3.18	1.40	4.04	5.64	2.31	3.40
August	0.71	1.75	0.94	2.77	1.09	2.92
September	2.72	2.26	3.15	0.18	2.67	3.07
October	3.81	1.96	1.12	2.51	0.51	1.83
November	8.86	0.30	4.83	5.56	1.57	3.61
December	9.32	0.66	3.43	1.50	3.05	3.00
Total	52.17	27.94	46.13	37.13	26.29	37.11

#### 4.0 Summary and Discussion

Partial-cutting and slashing in the Harvest and Harvest/Burn treatment sites has opened the forest canopy considerably, reducing tree cover from 30% and 24%, respectively to approximately 10% in both treatments (Table 21, 22). A further reduction of 3.5% tree cover was achieved in 1998 through prescribed burning in the Harvest/Burn. The Burn had 5% less tree cover in 1998 following treatment. An additional 2% of ponderosa pine and Douglas-fir regeneration layer trees died in the Burn between 1998 and 1999 (Table 3, 4). The trend in the Control appears to be toward increased forest cover. Between 1996 and 2000 forest cover increased at this site by approximately 5%.

Forest overstory cover has increased in the Harvest, Harvest/Burn and Burn areas since treatments were applied. Although significant ponderosa pine and Douglas-fir canopy removal occurred in the overstory and understory, the percent cover of the regeneration layer, particularly of Douglas-fir, has increased in all treatments (Table 1, 5). This points to the importance of including prescribed fire at repeated stages, in conjunction with harvest and slashing, in the Site Prescription in ecosystem restoration programs.

Grazing management and ecosystem restoration treatments must be managed concurrently. Sufficient litter must be accumulated in order to create a hot enough fire to kill tree seedlings. If the fire is not hot enough only the bottom branches will be killed. The bark and upper growing points will not be injured and the tree will merely be “fire-proofed” for the next burn. Hall (1976) found ponderosa pine develops a fire-resistant bark at 5 cm outer diameter at ground level. In contrast, Douglas-fir bark remains photosynthetically active at up to 10 cm outer diameter at ground level.

Grass and grasslike cover was dominated by rough fescue, pinegrass, Richardson’s needlegrass, Idaho fescue, northwest sedge and bluebunch wheatgrass. Cover fluctuated throughout the study, more likely in response to precipitation than to immediate treatment effects. Rough fescue, Richardson’s needlegrass, Idaho fescue, northwest sedge and bluebunch wheatgrass have been shown to be important components of cattle and wildlife diets throughout the year in other studies in the East Kootenay region (Ross 1997), and are most common in open grassland and open forest communities.

Except for western yarrow, rosy pussytoes, black medic and tiny penstemon most forbs represented less than 1% cover. Bearberry was the dominant shrub at all sites. Other important shrubs are saskatoon and bitterbrush. These shrubs are important in wildlife diets throughout the year (Ross 1997).

Significant increases in forage production ( $p < 0.05$ ) were calculated between 1996 and 1999 in the Harvest, Harvest/Burn and Burn treatments (Table 15, 21, 22). Forage production increased in all classes in the Harvest and Harvest/Burn between 1996 and 1999, and was more than 100% higher in both treatments. In the Burn, forage production was 25% higher. No difference was found at the Control between 1996 and 1999.

Treatment differences were likely masked somewhat in 2000 due to precipitation being nearly 30% below average. However, the relationship between reduced forest cover and increased forage production, established as a result of the harvest treatments, has been reaffirmed. Despite lower precipitation in 2000, the harvest treatment has resulted in production increases in the order of 40% to 60% at the Harvest and Harvest/Burn sites (Table 21 and 22). Differences in production resulting from the burn treatment were not significant ( $p > 0.10$ ) in 2000. No difference was found at the Control between 1996 and 2000.

Production by all bunchgrass species was higher in 1999 than 1996 in all treated areas. Although lower production was noted post-treatment, particularly in the Burn, production and cover appear to be slowly increasing. Rough fescue produced more in all treatments in 2000 than in 1996, but trends in Idaho fescue and bluebunch wheatgrass production were less consistent.

Removal of forest cover seems to favour immediate increases in rough fescue production. Rough fescue forage production increased in 2000, as compared to 1996, in all treatments (Table 15). Rough fescue production increased by between 77% and 180% in the Harvest, Harvest/Burn and Burn in 1999, compared to 1996 (Table 15). Increases varied between 40% and 80% in 2000 as compared to 1996. A recent study (Ross *et al* 1998) measured available light as a more direct measure of forest canopy. Results indicate the frequency of rough fescue increased by 20% for each 5% increase in available light when available light exceeded 75%. Conversely, pinegrass was found to have its maximum frequency when available light was less than 25%.

It may be that timing of the prescribed burn (April 3, 1998) inhibited growth somewhat. Stout *et al* (1981) report that rough fescue initiates leaf growth between April 1 and April 15. Rough fescue production is generally inhibited by spring defoliation. Destruction of new growth by fire is another form of defoliation. Willms (1991) found rough fescue to be highly susceptible to defoliation during the grazing season, regardless of the frequency or height. McLean and Wikeem (1985) found rough fescue clipped weekly during May yielded 60% less than unclipped plants.

Idaho fescue production more than doubled in the Harvest, was equal in the Harvest/Burn and lower in the Burn in 1999 when compared to pre-treatment levels (Table 15). However, production was lower in 2000. It may also be affected by fire, but is recovering slower than rough fescue. If burning is delayed too long, so that excessive litter has built up, fire intensity can kill the crown of the plant, particularly if growth has been initiated. Idaho fescue will be killed or severely set back if fire is introduced while there is new growth visible in the crown because the budding areas are at or above the soil surface (Conrad and Poulton 1966). Vallentine (1980) reports that burning in late summer will also damage Idaho fescue stands.

Bluebunch wheatgrass production was two to eight times higher in the Harvest and Harvest/Burn in 1999, but 65% lower in the Burn treatments relative to 1996. In 2000, bluebunch wheatgrass was higher at the Harvest/Burn site, lower at the Burn site and not

collected at the Harvest and Control sites. Bluebunch wheatgrass is a minor portion of the plant community at these sites. Conrad and Poulton (1966) found the primary effect of excessive fire on bluebunch wheatgrass is the reduction in plant size, not plant density. This was attributed to bluebunch wheatgrass producing buds below the soil surface.

In 1999, production of other grasses was higher in the Harvest, Harvest/Burn and similar in the Burn when compared to 1996 (Table 15). Production of other grasses was 35% higher in the Harvest and more than 200% higher in the Harvest/Burn. In 2000, production was approximately 60% higher at both sites than in 1996, similar at the Burn and lower at the Control. Richardson's needlegrass often had large accumulations of litter in the crown before the prescribed burn. Wright and Klemmedson (1965) found needle-and-thread burned in June suffered high mortality. Oswald and Covington (1983) noted that forage and browse production on moderately burned areas was larger than production on severely burned areas 6 years after a fire.

Forb production has increased in the Harvest/Burn and Burn treatments (Table 15). Although cover was higher in all treatments in 1999, and more species were recorded in 1998, 1999 and 2000 than pre-treatment, forb cover has fluctuated throughout the study (Table 1, 2, 3, 4 and 5). Variable precipitation has likely influenced forb growth patterns more than the treatments to this point in the study.

Increases in forage production are more immediate than changes in cover. Species change ( $p < 0.05$ ) in the herbaceous plant community was not calculated at any treatment between 1996 and 2000 (Table 6 to 14 inclusive). However, treatment responses were noted in some species. Rough fescue cover was higher in the Harvest and lower at the other sites in 1999 than in 1996, and it was lower in all treatments in 2000. Idaho fescue cover was higher in all treatments in 1999 and 2000 than in 1996. In contrast, bluebunch wheatgrass was lower at all sites in 1999 and 2000 than in 1996. Richardson's needlegrass increased at all treatments between 1996 and 2000. Pinegrass decreased at the Harvest treatment and increased at the other sites.

Bearberry cover decreased in the order of 3% to 10% as a result of harvest and burning treatments. Saskatoon cover increased in the Harvest and Burn treatments while remaining constant in the Harvest/Burn and Control. Bitterbrush increased in the Harvest treatment in 1999 and decreased in the Harvest/Burn and Burn treatments. However, in 2000 bitterbrush cover was higher in the Harvest/Burn, as well as in the Harvest, than it was in 1996.

Four years are not sufficient to differentiate significant individual species response to the forest harvest and prescribed burning treatments. At a site on Skookumchuck Prairie, approximately 20 km. north of the Cherry/TaTa Range Unit, significant plant community species change, in the absence of any disturbance, took approximately 10 years (McLean and Tisdale 1972, Ross 1997).

Further monitoring will be required to more accurately assess the long-term effect of prescribed burning on individual species and the cumulative effect on forage production.

Wikeem and Strang (1983), in a review on prescribed burning in BC, state a pattern of most perennial grasses decreasing in cover the first year after a fire and then slowly increasing over a number of years has been well established by numerous authors. Weaver (1974) contends that rough fescue, bluebunch wheatgrass, needlegrass species and pinegrass all increase in cover following fire in the ponderosa pine zone.

In the short- to medium-term the release potential of a site depends on the composition of the herbaceous and shrub layer. For ecosystem restoration at an operational scale, sites should be prioritized based on the proportion of bunchgrasses and desirable shrubs in the plant community.

Where there appears to be excellent potential for “release” of the herbaceous and shrub layers with partial-cutting harvest systems, the amount of forest canopy cover remaining after treatment is likely the most important factor governing forage production. Ross et al (1997) investigated the suitability of 15-20 year old stand-tending operations, where ponderosa pine stands were thinned to 400 stems per hectare (sph) and 700 sph, as ecosystem rehabilitation techniques. Available light was found to be the most important factor governing the composition of the understory vegetation. The amount of light penetrating to the understory is influenced by the percentage canopy cover, the size of the basal area of the stems and by stem density. Understory plant cover increased with increasing light penetration. Available light averaged 41% at the 700 sph sites while at the 400 sph sites it was 50%. No difference ( $p>0.05$ ) was found between understory vegetation at the 400 sph and 700 sph sites. Even at the lowest stem density treatment (400 sph) the maximum light penetration did not exceed 60%. Ross et al (1997) concluded that forage release in the 15 to 20 year span since these treatments, is mainly dependent on the pre-treatment nature of the herbaceous and shrub layer, and that thinning forest stands to 400 sph is probably insufficient for forage release in an ecosystem restoration program.

Canopy removal through forest harvest is clearly the most effective treatment in increasing forage production. However, failure to remove the regeneration layer will eventually negate any forage-derived benefits received from partial-cutting of the overstory and understory.

It is difficult to assess the long-term benefits of this dry forest ecosystem restoration program based on 4 years data. Additional monitoring is required, particularly on the effects of prescribed burning. However, the post-harvest stand structure should result in increased benefits for all resource sectors.

## **5.0 Technical and Extension Activities**

On August 22, 1996 I conducted a tour of the site for FRBC and Science Council personnel.

On March 27, 1997 I attended a Trench Restoration Workshop sponsored by the East Kootenay Trench Natural Resources Society entitled “Breaking Through the Operational Barriers”. At this workshop I presented some of our baseline results to an assembled group of approximately 45 people. These people represented various sectors interested in natural resource value enhancement in the East Kootenay Trench. Those present included; Ministry of Agriculture, Environment, and Forests staff members, timber, ranching, and guiding industry representatives, naturalists and environmental groups, consulting professionals, FRBC representatives, and community interests.

On September 30, 1997, data from this site was presented in a talk given by Denis Petryshen, Silviculture Officer for the Cranbrook Forest District, at the “Fire and Ecosystem Restoration in Dry Interior Forests in Southern BC” conference held at Fort Steele, B.C. (BC Forestry Continuing Studies Network) The talk was entitled “Opportunities for Pre-Burn Stand Utilization”.

On November 7, 1998 I conducted a tour of the TaTa Creek research site for the Minister of Forests the Honorable David Zirnheldt, Cranbrook Forest District Manager Tony Wideski, District Planner Tom Hadin and Rocky Mountain Trench Natural Resources Society representatives. Data and preliminary conclusions were presented.

The Pacific Northwest Chapter of the Society for Range Management held their fall meeting and field tour in Cranbrook during October 21 to 23, 1999. The theme of the event was “Ecosystem Restoration: Back to the Grassroots”. The study site was a major stop on the Friday field tour and was attended by more than 150 people. I presented a summary of the data and conclusions to this point. An overview of the entire project, and preliminary results from forest stand characteristics and bird community studies were also presented.

Final results were discussed in a presentation given at the Southern Interior Silviculture Committee’s Winter Workshop in Penticton, BC on March 13, 2001. More than 200 people attended this event. The presentation was included in a session entitled “Douglas-fir Range Management Issues”.

## 6.0 Literature Cited

- Braumandl, T. F. and M. P. Curran. 1992. A field guide for site identification and interpretation for the Nelson Forest Region. B.C. Ministry of Forests, Nelson, B.C., 311 p.
- BC Ministry of Forests/BC Environment. 1995. Biodiversity guidebook. Forest Practices Code of British Columbia. 99 p.
- Canada Land Inventory. 1973. 1:250,000 wildlife capability maps. Wildlife Section of the Environment and Land Use Committee Secretariat.
- Conrad, C.E. and C.E. Poulton. 1966. Effect of a wildfire on Idaho fescue and bluebunch wheatgrass. *J. Range Manage.* 19:138-141.
- Daubenmire, R.F. 1959. A canopy coverage method of vegetation analysis. *Northwest Sci.* 33: 43-64.
- Environment Canada 1999. Cranbrook Airport (49°32'N, 115°46'W) Year-month matrix for precipitation.
- Gayton, D. 1997. Preliminary calculation of excess forest ingrowth and resulting forage impact in the Rocky Mountain Trench. unpubl. mimeo, BC Ministry of Forests, Nelson, B.C.
- Hall, F.C. 1976. Fire and vegetation in the Blue Mountains - implications for land managers. *Proc. Tall Timbers Fire Ecology Conf.* 15:155-170.
- Hitchcock, C.L. and A. Cronquist. 1973. *Flora of the Pacific northwest.* University of Washington Press, Seattle, Wa., 730 p.
- Holland, S.S. 1976. Landforms of British Columbia, a physiographic outline. *Bulletin 48.* British Columbia Department of Mines and Petroleum Resources. Victoria, B.C., 138 pp.
- Jamieson, R. and K. Hebert. 1993. Elk capture and monitoring in the East Kootenay Trench: 1991-1993. *East Kootenay Trench Agric. Wild. Com. Mimeo.* 33p.
- Lacelle, L.E.H. 1990. Biophysical resources of the East Kootenay area: Soils. *Wildlife Technical Monograph TM-1.* Report No. 20 B.C. Soil Survey. B.C. Ministry of Environment, Victoria, B.C., 359 p.
- McLean, A. and E.W. Tisdale. 1972. Recovery rate of depleted range sites under protection from grazing. *J. Range. Manage.* 25:178-181.
- McLean, A. and S. Wikeem. 1985. Rough fescue response to season and intensity of defoliation. *J. Range Manage.* 38(2):100-103.

- Oswald, B.P. and W.W. Covington. 1983. Changes in understory production following a wildfire in southwestern ponderosa pine. *J. Range Manage.* 36(4):507-509.
- Ross, T.J. 1997. Vegetation monitoring program final report. East Kootenay Trench Agriculture/Wildlife Committee, Cranbrook, BC. BC Ministry of Forests, Research Branch, Kamloops, B.C. Mimeo. 347 p.
- Ross, T.J., G. Powell and C. DeMaere. 1997. The effect of thinning and burning on PPdh2 understory plant cover. B.C. Ministry of Forests, Research Branch, Kamloops, BC, Internal Report, 43 pp.
- SAS Institute Inc. 1988. *SAS/STAT User's Guide*, Release 6.03. SAS Institute., Cary, N.C.
- Stout, D.G., McLean, A. and D.A. Quinton. 1981. Growth and phenological development of rough fescue in interior British Columbia. *J. Range Manage.* 34(6):455-459.
- Trench Integrated Resource Management Plan. 1993. B.C. Ministry of Forests, unpublished mimeo, Cranbrook Forest District, Cranbrook, B.C.
- Vallentine, J.F. 1980. Range developments and improvements. 2nd edition. Brigham Young University Press, Provo, Utah. 545 pp.
- Weaver, H. 1974. Effects of fire on temperate forests; Western United States. *In: Fire and Ecosystems*. Ed. T.T Kozlowski and C.E. Ahlgren. Academic Press, New York. p. 289-319.
- Wikeem, B.W. and R.M. Strang. 1983. Prescribed burning on B.C. rangelands: the state of the art. *J. Range Manage.* 36(1):3-7.
- Willms, W.D. 1991. Cutting frequency and cutting height effects on rough fescue and Parry oat grass yields. *J. Range Manage.* 44(1):82-86.
- Wright, H.E. and J.O. Klemmedson. 1965. Effect of fire on bunchgrasses of the sagebrush-grass region of southern Idaho. *Ecology* 46(5):680-688.
- Zar, J.H. 1984. *Biostatistical analysis*. Prentise-Hall Inc., Englewood Cliffs, N.J. 718 p.

## 7.0 Appendices

## Appendix 1. Plant Species. <sup>1</sup>

Latin Name	Common Name
<i>Acer glabrum</i> ,ACGL, 3	Douglas maple
<i>Achillea millefolium</i> ,ACMI, 2	Western yarrow
<i>Agrostis alba</i> ,AGAL, 1	Redtop
<i>Agropyron cristatum</i> ,AGCR, 1	Crested wheatgrass
<i>Agropyron dasytachyum</i> ,AGDA, 1	Western wheatgrass
<i>Agropyron riparium</i> ,AGRI, 1	Streambank wheatgrass
<i>Agropyron spicatum</i> ,AGSP, 1	Bluebunch wheatgrass
<i>Agrostis scabra</i> ,AGSC, 1	Hair bentgrass
<i>Agropyron subsecundum</i> ,AGSU, 1	Bearded wheatgrass
<i>Agropyron trachycaulum</i> ,AGTR, 1	Slender wheatgrass
<i>Alisma plantago-aquatica</i> ,ALPL, 2	Waterplantain
<i>Allium cernuum</i> ,ALCE, 2	Nodding onion
<i>Alnus sinuate</i> ,ANSI, 3	Sitka alder
<i>Alnus tenuifolia</i> ,ALTE, 3	Mountain alder
<i>Amelanchier alnifolia</i> ,AMAL, 3	Saskatoon
<i>Antennaria dimorpha</i> ,ANDI, 2	Pussytoes
<i>Antennaria microphylla</i> ,ANMI, 2	Pussytoes
<i>Anemone multifida</i> ,ANMU, 2	Pacific anemone
<i>Antennaria parvifolia</i> ,ANPA, 2	Pussytoes
<i>Anemone patens</i> ,ANPT, 2	Prairie crocus
<i>Androsace septentrionalis</i> ,ANSE, 2	Fairy candelabra
<i>Apocynum androsaemifolium</i> ,APAN, 2	Spreading dogbane
<i>Artemesia frigida</i> ,ARFR,2	Pasture sage
<i>Arnica fulgens</i> ,ARFU, 2	Orange arnica
<i>Arabis holboellii</i> ,ARHO, 2	Hoelboel's rockcress
<i>Artemesia spp.</i> ,ARSP, 3	Sage
<i>Arctostaphylos uva-ursi</i> ,ARUV, 3	Bearberry
<i>Aster campestris</i> ,ASCA, 2	Western meadow aster
<i>Aster ciliolatus</i> ,ASCI, 2	Lindley's aster
<i>Aster conspicuous</i> ,ASCO, 2	Showy aster
<i>Aster foliaceus</i> ,ASFO, 2	Leafy aster
<i>Aster pansies</i> ,ASPA, 2	Tufted white prairie aster
<i>Astragalus miser</i> ,ASMI, 2	Timber milkvetch
<i>Balsamorhiza sagittata</i> ,BASA, 2	Balsamroot
<i>Betula glandulosa</i> , BEGL, 3	Bog-birch
<i>Berberis repens</i> ,BERE, 3	Low Oregongrape
<i>Beckmannia syzigachne</i> ,BESY, 1	Beckmannia
<i>Bromus inermis</i> ,BRIN, 1	Smooth brome grass

<sup>1</sup> Plant species list represents common PPdh2 and IDFd2 species.

### Appendix 1. (cont'd)

Latin Name

Common Name

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Bromus tectorum, BRTE, 1	Cheatgrass
Bryophytes, BRYO, 4	Mosses and Lichens
Calochortus apiculatus, CAAP, 2	Baker's mariposa lily
Calamagrostis canadensis, CACA, 1	Bluejoint
Carex douglasii, CADO, 1	Douglas sedge
Calochortus macrocarpum, CAMA, 2	Mariposa lily
Campanula rotundifolia, CARO, 2	Scottish bells
Calamagrostis rubescens, CARU, 1	Pinegrass
Carex spp., CARX, 1	Sedge
Castilleja thompsonii, CATH, 2	Thompsons paintbrush
Cerastium arvense, CEAR, 2	Chickweed
Centaurea diffusa, CEDI, 2	Diffuse knapweed
Centaurea maculosa, CEMA, 2	Spotted Knapweed
Ceanothus velutinus, CEVE, 3	Buckbrush
Chenopodium capitatum, CHCA, 2	Alkali goosefoot
Chrysanthemum leucanthemum, CHLE, 2	Oxeye daisy
Cirsium hookerianum, CIHO, 2	Hooker's thistle
Chrysothamnus nauseosus, CHNA, 3	Rabbitbrush
Chrysopsis villosa, CHVI, 2	Hairy goldaster
Cirsium arvense., CIAR, 2	Canada thistle
Cirsium vulgare, CIVU, 2	Bull thistle
Collinsia parviflora, COPA, 2	Blue-eyed Mary
Commandra umbellata, COUM, 2	Bastard toadflax
Crepis atrabarba, CRAT, 2	Slender hawksbeard
Cynoglossum officianale, CYOF, 2	Houndstongue
Danthonia intermedia, DAIN, 1	Timber oatgrass
Dactylis glomerata, DAGL, 1	Orchardgrass
Delphinium nuttallianum, DENU, 2	Upland larkspur
Distichlis stricta, DIST, 1	Inland saltgrass
Dodecatheon pauciflorum, DOPA, 2	Shooting star
Echium vulgare, ECVU, 2	Viper's bugloss
Elaeagnus commutata, ELCO, 3	Wolf-willow
Elymus cinereus, ELCI, 1	Giant wildrye
Elymus glauca, ELGL, 1	Blue wildrye
Epilobium angustifolium, EPAN, 2	Fireweed
Erigeron compositus, ERCO, 2	Compound fleabane
Erigeron pumilis, ERPU, 2	Shaggy fleabane
Eriogonum umbellatum, ERUM, 2	Sulphur buckwheat
Festuca idahoensis, FEID, 1	Idaho fescue
Festuca scabrella, FESC, 1	Rough fescue

**Appendix 1. (cont'd)**

Latin Name

Common Name

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Fragaria virginiana,FRVI, 2	Wild strawberry
Gaillardia aristata,GAAR, 2	Brown-eyed susan
Gallium boreale,GABO, 2	Northern bedstaw
Geum triflorum,GETR, 2	Old man's whiskers
Grindellia squarosa,GRSQ, 2	Curly-cup gumweed
Heuchra cylindrica,HECY, 2	Alum root
Hieracium albiflorum,HIAL, 2	White hawkweed
Hieracium gracile,HIGR, 2	Slender hawkweed
Hieracium scouleri,HISC, 2	Scouler's hawkweed
Hypericum perforatum,HYPE, 2	St. John's-wort
Juniper communis,JUCO, 3	Common juniper
Juncus spp.,JUNC, 1	Rush species
Juniper scopulorum,JUSC, 3	Rocky Mountain juniper
Koeleria cristata,KOCR, 1	Prairie junegrass
Lappula echinata,LAEC, 2	Stickseed
Larix occidentalis,LAOC, 3	Western larch
Lathyrus occidentalis,LAOI, 2	Creamy peavine
Lepidium densiflorum,LEDE, 2	Field peppergrass
Lewisia rediviva,LERE, 2	Bitterroot
Linnaea borealis,LIBO, 2	Twinflower
Linum perenne,LIPE, 2	False flax
Lithospermum ruderales,LIRU, 2	Stoneseed
Lotus corniculatus,LOCO, 2	Birdsfoot trefoil
Lolium perenne,LOPE, 1	Perennial ryegrass
Lomatium macrocarpum,LOMA, 2	Large-leafed desert parsley
Lomatium triternatum,LOTR, 2	Nine-leafed lomatium
Medicago lupulina,MELU, 2	Black medic
Medicago sativa,MESA, 2	Alfalfa
Melilotus alba,MEAL, 2	White sweet-clover
Monarda fistulosa,MOFI, 2	Wild bergamo
Oryzopsis asperifolia,ORAS, 1	Rough-leaved ricegrass
Orthocarpus luteus,ORLU, 2	Thin-leafed owl-clover
Oxytropis campestris,OXCA, 2	Locoweed
Penstemon confertus,PECO, 2	Tiny penstemon
Penstemon procerus,PEPR, 2	Small-flowered penstemon
Philadelphus lewisii,PHLE, 3	Mock-orange
Phalaris arundinacea, PHAR, 1	Reed canarygrass
Phleum pratense,PHPR, 1	Timothy
Phlox rigida,PHRI, 2	Spiny phlox
Pinus contorta,PICO, 3	Lodgepole pine

**Appendix 1. (cont'd)**

Latin Name

Common Name

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*Picea* spp.,PISP, 3  
*Pinus ponderosa*,PIPO, 3  
*Plantago patigonica*,PLPA, 2  
*Potentilla anserina*,POAN, 2  
*Populus balsamifera*,POBA, 3  
*Poa compressa*,POCO, 1  
*Potentilla gracilis*,POGR, 2  
*Potentilla hippiana*,POHI, 2  
*Poa junctifolia*, POJU, 1  
*Poa pratensis*,POPR, 1  
*Potentilla recta*,PORE, 2  
*Poa sandbergii*,POSA, 1  
*Poa* spp.,POSP, 1  
*Populus tremuloides*,POTR, 3  
*Prunus virginiana*,PRVI, 3  
*Pseudotsuga menziesii*,PSME, 3  
*Puccinellia nuttallianum*, PUNU, 1  
*Purshia tridentata*,PUTR, 3  
*Ranunculus acris*,RAAC, 2  
*Rhianthus minor*,RHMI, 2  
*Ratibida columnifera*,RACO, 2  
*Ranunculus glaberrimus*,RAGL, 2  
*Ribes* spp.,RISP, 3  
*Rosa* spp.,ROSA, 3  
*Rubus* spp.,RUSP, 3  
*Senecio canus*,SECA, 2  
*Shepherdia canadensis*,SHCA, 3  
*Sonchas arvense*,SOAR, 2  
*Solidago spathulata*,SOSP, 2  
*Spirea betulifolia*,SPBE, 3  
*Spartina gracilis*,SPGR, 1  
*Spirea pyramidata*,SPPY, 3  
*Stellaria longifolia*,STLO, 2  
*Stipa columbiana*,STCL, 1  
*Stipa comata*,STCO, 1  
*Stipa occidentalis*,STOC, 1  
*Stipa richardsonii*,STRI, 1  
*Symphoricarpus albus*,SYAL, 3  
*Taraxacum officinale*,TAOF, 2  
*Trisetum cernuum*,TRCE, 1

**Appendix 1. (cont'd)**

Spruce  
 Ponderosa pine  
 Narrow-leafed plantain  
 Silverweed  
 Cottonwood  
 Canada bluegrass  
 Graceful cinquefoil  
 Woolly cinquefoil  
 Alkali blugrass  
 Kentucky bluegrass  
 Sulphur cinquefoil  
 Sandberg bluegrass  
 Bluegrass  
 Trembling aspen  
 Chokecherry  
 Douglas-fir  
 Alkaligrass  
 Bitterbrush  
 Meadow buttercup  
 Yellow rattle  
 Coneflower  
 Sagebrush buttercup  
 Currant  
 Rose  
 Raspberry  
 Prairie groundsel  
 Soopolallie  
 Prickly sow-thistle  
 Dune goldenrod  
 Birch-leafed spirea  
 Alkali cordgrass  
 Pyramid spirea  
 Long-leaved chickweed  
 Columbia needlegrass  
 Needle-and-thread  
 Western needlegrass  
 Richardson's needlegrass  
 Snowberry  
 Dandelion  
 Nodding trisetum

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Latin Name

Common Name

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Trifolium hybridum,TRHY, 2  
Trifolium pratense,TRPA, 2  
Tragopogon pratense,TRPR, 2  
Trifolium repens,TRRE, 2  
Verbascum thapsis,VETH, 2  
Viola adunca,VIAD, 2  
Vicia americana,VIAM, 2  
Zygadenus venenosus,ZYVE, 2

Alsike clover  
Red clover  
Goatsbeard  
White clover  
Common mullein  
Early blue violet  
American vetch  
Death camas

## Appendix 2. Sampling Methodology.

### Sampling Layout

Plot/ Transect	1	2	3	4	5	6	7	8	9	10
1	4	8	14	19	25	28	33	42	44	50
2	6	12	17	22	24	28	33	41	46	49
3	2	9	15	22	28	30	35	40	44	50
4	4	7	18	22	25	28	34	42	47	49
5	2	10	17	18	21	26	31	38	46	48
6	4	8	14	19	25	28	33	42	44	50
7	6	12	17	22	24	28	33	41	46	49
8	2	9	15	22	28	30	35	40	44	50
9	4	7	18	22	25	28	34	42	47	49
10	2	10	17	18	21	26	31	38	46	48

### Daubenmire Cover Classes

Cover Class	Percent Cover
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

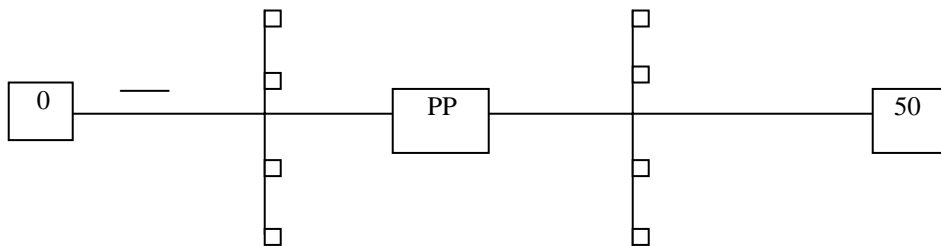
### Photo-points

A permanent photo-point was installed at 25 m on each 50 m transect and marked with a 7 cm. X 10 cm. metal tag. Two photos were taken at each transect;

1) From T + 25 m to T + 0 m and 2) from T + 25 m to T + 50 m.

### Forage Production

Each 50 m transect has two 40 m sub-transects laid out at right angles at 10 m and 30 m (odd #'d transects), or 20 m and 40 m (even #'d transects). Four random plot locations are located on each of these sub-transects at 0 m, 10 m, 30 m and 40 m. Two caged plots accompanied each transect for a total of 20 plots per treatment.



### Appendix 3. Plot Layout.

#### Harvest

	Transect	Transect	Tie-point	Tie-Point	
Transect	Bearing (°)	Length (m)	Bearing (°)	Distance (m)	Location
1	205	50	105	27	west fence
2	195	50	105	35	west fence
3	200	50	111	33	west fence
4	210	50	300	38	west fence
5	210	50	340	52	thicket
6	205	50	205	23	flagged Py
7	190	50	305	32	flagged Py
8	200	50	210	51	Stn. 14
9	109	50	285	39	boundary
10	015	50	010	21	NE boundary

#### Harvest and Burn

	Transect	Transect	Tie-point	Tie-Point	
Transect	Bearing (°)	Length (m)	Bearing (°)	Distance (m)	Location
1	360	50	325	60	SE corner
2	005	50	110	60	west fence
3	360	50	110	25	west fence
4	025	50	225	95	west fence
5	360	50	005	90	S border
6	010	50	190	210	S border
7	360	50	090	37	Stn. 97
8	360	50	090	17	E. border
9	350	50	120	27	E. border
10	360	50	275	85	Stn. 92

### Appendix 3. Plot Layout (cont'd).

## Burn

	Transect	Transect	Tie-point	Tie-Point	
Transect	Bearing (°)	Length (m)	Bearing (°)	Distance (m)	Location
1	015	50	350	80	Stn. 100
2	020	50	020	35	flagged Py
3	205	50	205	37	N fence
4	190	50	190	60	N fence
5	190	50	190	5	flagged Py
6	195	50	240	5	flagged Fd
7	005	50	010	31	S border
8	005	50	275	55	E border
9	010	50	275	82	E border
10	010	50	280	110	Stn. 96

## Control

	Transect	Transect	Tie-point	Tie-Point	
Transect	Bearing (°)	Length (m)	Bearing (°)	Distance (m)	Location
1	020	50	075	90	SE corner
2	020	50	030	30	SW corner
3	020	50	360	15	flagged Fd
4	030	50	065	73	flagged Py
5	015	50	145	10	edge of gully
6	015	50	280	57	flagged Fd
7	360	50	220	37	NE corner
8	040	50	200	28	NW corner
9	015	50	090	23	W border
10	020	50	120	68	W border

## Appendix 4

## **Appendix 5. Permanent Photopoints.**



