

**East Kootenay Wildlife-Cattle Vegetation Monitoring:
Implications of Long-term Results for Agriculture,
Wildlife and Forest Management**

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Executive Summary

In 1990, the East Kootenay Trench Agriculture/Wildlife Committee (EKTAW) was formed to mitigate long-standing conflicts concerning forage allocation among cattle, elk and deer in the Rocky Mountain Trench in southeastern British Columbia. A habitat monitoring program was initiated in 1991 on four wildlife winter ranges. Vegetation data were collected between 1991 and 1994 and a report was completed in 1997 summarizing results. This project extends that report by re-sampling the original sites and evaluating the effects of 18 years of wildlife and cattle grazing.

The Skookumchuck Historical Exclosure was constructed in 1951 and sampled at about 10 intervals from 1960 to 2009. Both the grazed and ungrazed areas were in Poor range condition in 1951 and were dominated by Sandberg's bluegrass, low pussytoes, prairie Junegrass and needle-and-thread. Over the 60 years of protection inside the exclosure, bluebunch wheatgrass and needle-and-thread initially increased and then declined while rough fescue and Idaho fescue increased. Since 1970, rough fescue and Idaho fescue have jointly dominated the plant community. By 1982, range condition inside the exclosure was rated as Good and it has remained unchanged to 2009. On the grazed site, range condition has remained Poor for nearly 60 years with no sign of improvement.

The Skookumchuck Prairie "Three-way Exclosure" was divided into three grazing treatment areas to allow differential access to cattle, wildlife, and cattle and wildlife together. An exclosure was also constructed to prevent all ungulate grazing. In 1991, all four sites were rated in Poor range condition and little change was apparent in any of treatment areas until 2003. By 2003, range condition in the Ungulate Exclosure had advanced from Poor to Fair but range condition has not improved since. Range condition on the Cattle Only Area also improved from Poor to Fair between 1991 and 2009 mostly because of an increase in rough fescue. There were no changes in range condition in the Wildlife Only and Combined Use Areas from 1991 and 2009. Except for sulphur cinquefoil, noxious weeds such as spotted and diffuse knapweed, hound's-tongue and Dalmatian toadflax were absent.

Range condition at Premier Ridge and Pickering Hills was assessed as Poor in 1991 and it remained Poor inside and outside the exclosures in 2009. No noxious weeds were found at Premier Ridge but sulphur cinquefoil, diffuse knapweed, and spotted knapweed were all found as trace species in the Grazed Area at Pickering Hills.

Evaluation of range condition on East Kootenay ranges can be challenging. Results from this study indicate that Idaho fescue and rough fescue are Decreaser species on the sites sampled, while bluebunch wheatgrass, needle-and-thread and Richardson's needlegrass act as Increasers. With mixed ungulate grazing, Saskatoon should also be regarded as a Decreaser species, while bitterbrush appears to increase under mixed ungulate grazing.

Plant community assessments conducted in this study revealed that range condition on some sites has not improved for up to 60 years. Continued heavy and/or sequential

forage use have stagnated these sites leaving them in a steady state that is not easily reversible and unlikely with grazing management alone.

The exclosures at the Skookumchuck Historical Site, and the Ungulate Exclosure and Cattle Only Area at the Three-way Exclosure Site, demonstrate that these rangelands are much more resilient than perhaps previously thought and they have a capacity to recover given proper management and sufficient time. The outcome of recovery, however, will likely be plant communities containing a mix of native dominant species and naturalized alien plants that have reached a new “steady state” (potential natural community).

While much can be done with improved livestock and wildlife management, external management inputs may be necessary to achieve desired plant communities. Fire, chemical, or mechanical treatments may be required to shift bitterbrush-dominated communities across the threshold from their current lower-seral steady state to a higher seral stage that has less bitterbrush and more desirable shrubs such as Saskatoon, low Oregongrape and buckbrush.

The most important objective for the sustainability of integrated resources is land management, and in particular, management of soils, herbaceous forage species, and browse. Instead of independent management of all ungulates the landscape unit should be managed holistically with livestock and wildlife considered as components of the system. Some of the main recommendations from this study include:

- Site-specific plant community objectives should be established based on obtainable ecological, production and social goals. Desired plant communities should represent realistic targets, which reflect these goals but may not always aim to achieve the climax ecological potential.
- Range management practices, such as modified herd sizes, shorter grazing periods, improved distribution of water, range riders, and salt should be used to obtain even livestock distribution.
- Cattle stocking rates should be set relative to the seasonal availability of preferred forages and known distribution patterns of cattle.
- Wildlife management planning must balance wildlife numbers and distribution with livestock numbers and distribution to ensure wildlife objectives do not negate benefits gained from livestock management.
- Livestock turn-out dates on key wildlife winter ranges should be adjusted to provide a rest period for forage plants between winter/spring wildlife use and cattle grazing.
- Monitoring should be conducted to evaluate the results of ecosystem restoration, and range and wildlife habitat management activities.
- Ecosystem restoration activities should be continued with an emphasis on reducing forest cover on traditional grassland and maintaining open forest sites.

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1.0 Introduction

Elk, mule deer, white-tailed deer, and cattle have shared grassland and open forest range in the Rocky Mountain Trench (Trench) for more than 150 years. Early explorers and settlers, however, found the landscape dominated by forest with few large ungulate species present. A large part of the contemporary open range in the Trench resulted from fires in the low-elevation forests during the 1920s and 1930s, which provided ideal habitat and range for wild ungulates and domestic livestock. Since the last major forest fires in 1931, forest encroachment has advanced into these open areas reducing forage capability for both wildlife and cattle.

In the mid-1950s, a number of wildlife, soil and range surveys were conducted to determine the status of ungulate populations, habitat and range resources in the Trench (Sugden 1953; Ashford et al. 1956). Collectively, these assessments concluded that grasslands were overgrazed, and the carrying capacity for wildlife and livestock was below its capability. The following issues were identified as significant problems:

- Livestock were being turned-out before range readiness;
- Ranges were overstocked with livestock;
- Bunchgrasses were being overused;
- Bluebunch wheatgrass and rough fescue were becoming scarce on the open range compared to areas protected from grazing;
- Livestock were reluctant to graze forest range and areas remote from water;
- Overuse was particularly high near water; and
- Weeds were invading grassland range.

Conflicts emerged during the 1960s and 1970s concerning dietary overlap and forage allocation among cattle, elk and deer. While most of the debate focused on large ungulate grazing, other factors such as fire, fire suppression, forest ingrowth and encroachment, logging, land alienation, and recreation, also contributed to declining range and wildlife habitat resources in the area.

Three interacting factors, however, have dominated resource management in the East Kootenay

since the 1960s: potential competition between native ungulates and domestic livestock, forest ingrowth and encroachment, and deterioration of range condition.

Coordinated Resource Management Planning was introduced into the East Kootenay in 1975 primarily to resolve forage allocation conflicts between cattle and elk, and to ensure the long-term sustainability of the range resource. Although most resource managers believed that forage availability had improved with coordinated planning, many still contended that grazing pressure, forest ingrowth, and land alienation were resulting in declining range condition, and that an equitable forage allocation process was necessary to mitigate conflicts (Pitt 1982).

The East Kootenay Trench Agriculture/Wildlife Committee (EKTAW) was formed in 1990 to mitigate long-standing wildlife/livestock conflicts on Crown and private land in the East Kootenay Trench. In 1991, the committee initiated a Vegetation Monitoring Program to compile local information on various issues related to the conflict and aimed to:

- promote stewardship of the range resource;
- maintain and enhance compatible use of forest and rangeland for grazing;
- encourage management practices that optimize distribution of livestock and wildlife on common range; and
- sustain biodiversity of rangeland and wildlife habitat.

This program collected data between 1991 and 1994 and a report was completed in 1997 summarizing the results (Ross 1997). From the onset, the EKTAW committee understood that continuing information was necessary to document and evaluate the long-term effects of livestock and ungulate grazing on Crown land in the Trench. Additional data, which were collected in 2003 on part of the original study area, demonstrated that changes were occurring among areas grazed by cattle only, wildlife only, cattle and wildlife together, and in an area that excluded all ungulate grazing (Rosentreter 2006). No further sampling has been conducted on any of the original sites since 2003, and there has been no communication with agriculture, wildlife and forest sectors on the results of the EKTAW program.

2.0 Objectives

This project was initiated to extend the previous EKTAW report that described results to 1994 (Ross 1997). The specific objectives of the project are to:

1. Re-sample vegetation plots at sites in the Rocky Mountain Trench that were established in 1991 by the EKTAW vegetation monitoring program;
2. Produce a report summarizing the results and the implications of 18 years of wildlife and cattle grazing on the sites to the agriculture industry, wildlife interest groups, and resource agency personnel; and
3. Conduct a demonstration field day to bring interested parties together under field conditions to discuss the results and implications of the long-term monitoring for enhancing range management policy and practices in the East Kootenay.

3.0 Description of the Study Areas

The study was conducted on three important winter ranges for elk and deer in the Rocky Mountain Trench within 60 km of Cranbrook, BC. Two sites, called the “Historical Exclosure” and the “Three-way Exclosure,” are located at Skookumchuck Prairie and the other two sites are situated at Pickering Hills and Premier Ridge (Figure 1). Each location is rotationally grazed by cattle and represents a significant area of conflict in the Trench.

3.1 Landforms and Soils

Skookumchuck Prairie occurs on flat river terrace deposits in the Ponderosa Pine Zone while Pickering Hills and Premier Ridge occupy morainal soils in the Interior Douglas-fir Zone above the flood plain. Topography at Skookumchuck Prairie is mostly flat. Both Premier Ridge and Pickering Hills are located on steep, undulating south and southwest facing slopes.

Virtually all soils in the Rocky Mountain Trench were derived from glacial deposits (Kelley and Sprout 1956; Lacelle 1990). Soils at all three locations are classified as Orthic Eutric Brunisols and range from 70 - 90 cm in depth. In a typical terrace soil, the upper part of the solum consists of gravelly or fine sandy loam while the lower profile is comprised of a matrix of stratified medium gravel and scattered stones (Kelley and Sprout 1956). Texture in morainal soils ranges between silt loam and gravelly silt loam. Coarse fragments vary between 20 and 60% and consist of subangular and subrounded gravels, cobbles and stones (Lacelle 1990). .

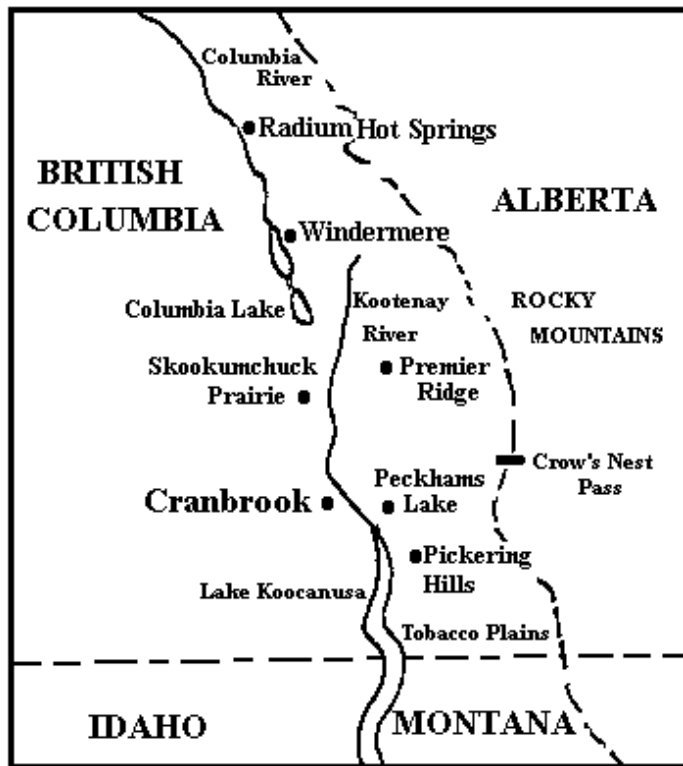


Figure 1. The Rocky Mountain Trench from Radium Hot Springs to Tobacco Plains.

3.2 Climate

The climate in the Rocky Mountain Trench is variable depending on elevation with upland areas receiving slightly more precipitation and cooler temperatures than on the floodplain. Kelley and Sprout (1956) characterized the climate near Cranbrook as semi-arid with weather patterns being influenced by cold continental air masses from the north in winter, and from heated air masses from the southern United States in summer.

Normal precipitation from 1990-2009 at Cranbrook Airport, which is approximately centrally located among the three study locations, averages slightly more than 37 cm annually (Table 1). Precipitation is bi-modally distributed with peaks in November-January (mostly snow) and in May-June (rain). Maximum precipitation falls in June and October is generally the driest month (Table 1).

Temperatures vary throughout the year with the warmest average readings occurring in July (25.6°C) and August (25.4°C) and coldest in December (-11.8°C) and January (-8.4°C). The absolute extremes on record are a high of 36.6°C in July 1985 and a low of -40.0 °C in December 1975. The Rocky Mountain Trench enjoys an average of 2205.3 hours of sunshine and approximately 110 frost-free days annually (Environment Canada 2010).

3.3 Vegetation

Skookumchuck Prairie occurs in the Ponderosa Pine dry, hot (PPdh2) biogeoclimatic sub-zone (Braumandl and Curran 1992). The site is predominantly open grassland interspersed with groves of ponderosa pine¹ and trembling aspen (see Appendix 1 for scientific names).

Herbaceous vegetation consists of Kentucky bluegrass, Canada bluegrass, Richardson's needlegrass, rough fescue, Idaho fescue, bluebunch wheatgrass, and a variety of forbs, while bitterbrush and Saskatoon are important browse species on the site.

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

Table 1. Precipitation at the Cranbrook Airport between 1990 and 2009.

| Month | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | Normal |
|-------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| January | 4.0 | 1.7 | 1.8 | 2.9 | 1.1 | 3.3 | 3.3 | 3.5 | 4.6 | 2.4 | 3.7 | 0.4 | 1.6 | 2.9 | 2.4 | 2.5 | 5.3 | 2.8 | 2.6 | 0.8 | 2.5 |
| February | 1.9 | 1.3 | 1.6 | 1.8 | 3.0 | 1.0 | 3.0 | 0.5 | 0.6 | 3.6 | 2.0 | 0.8 | 4.2 | 1.3 | 1.0 | 0.4 | 1.6 | 3.2 | 1.5 | 1.7 | 2.2 |
| March | 0.8 | 5.6 | 1.0 | 0.5 | 1.2 | 4.4 | 1.6 | 3.5 | 4.2 | 0.9 | 3.3 | 2.0 | 1.7 | 2.8 | 1.1 | 2.4 | 1.5 | 2.1 | 1.3 | 4.9 | 2.1 |
| April | 2.3 | 2.8 | 2.8 | 1.5 | 4.0 | 3.5 | 3.6 | 2.5 | 0.9 | 1.9 | 1.9 | 3.3 | 2.6 | 3.8 | 2.3 | 0.6 | 4.4 | 1.0 | 1.1 | 2.5 | 2.8 |
| May | 11.8 | 3.3 | 3.5 | 3.6 | 4.8 | 3.5 | 7.5 | 6.4 | 10.6 | 4.4 | 1.9 | 1.3 | 12.8 | 3.7 | 3.6 | 4.9 | 2.3 | 6.7 | 3.4 | 1.9 | 4.6 |
| June | 6.3 | 2.8 | 5.9 | 12.7 | 6.9 | 13.0 | 4.6 | 3.3 | 7.8 | 5.9 | 2.2 | 4.9 | 3.3 | 3.4 | 4.3 | 19.0 | 5.6 | 6.1 | 3.6 | 5.2 | 5.1 |
| July | 3.2 | 4.3 | 7.7 | 10.2 | 0.5 | 6.8 | 3.2 | 1.4 | 4.0 | 5.6 | 2.3 | 3.7 | 3.4 | 0.4 | 4.4 | 1.5 | 4.5 | 1.8 | 3.0 | 5.4 | 3.4 |
| August | 2.5 | 1.6 | 0.9 | 4.3 | 1.3 | 4.1 | 0.7 | 1.8 | 0.9 | 2.8 | 1.1 | 0.5 | 1.1 | 1.5 | 6.8 | 6.3 | 2.2 | 1.0 | 2.9 | 6.4 | 2.9 |
| September | 0.0 | 2.9 | 1.9 | 4.5 | 0.3 | 2.5 | 2.7 | 2.3 | 3.2 | 0.2 | 2.7 | 1.6 | 4.4 | 4.9 | 6.4 | 6.5 | 3.7 | 1.2 | 1.8 | 1.3 | 3.1 |
| October | 3.6 | 0.6 | 2.4 | 1.1 | 4.4 | 2.4 | 3.8 | 2.0 | 1.1 | 2.5 | 0.5 | 1.1 | 0.3 | 1.9 | 3.0 | 2.8 | 5.0 | 1.3 | 1.7 | 6.0 | 1.8 |
| November | 5.4 | 4.0 | 3.5 | 2.6 | 2.3 | 4.5 | 8.9 | 0.3 | 4.8 | 5.6 | 1.6 | 2.1 | 1.0 | 3.2 | 1.3 | 3.8 | 9.7 | 2.5 | 1.5 | 1.3 | 3.6 |
| December | 3.7 | 1.1 | 3.0 | 3.1 | 3.2 | 6.8 | 9.3 | 0.7 | 3.4 | 1.5 | 3.1 | 3.8 | 5.4 | 2.4 | 2.9 | 2.3 | 3.6 | 5.9 | 5.0 | 1.7 | 3.0 |
| Total | 45.4 | 32.0 | 36.0 | 48.7 | 32.8 | 55.7 | 52.2 | 27.9 | 46.1 | 37.1 | 26.3 | 25.3 | 42.0 | 32.2 | 39.3 | 53.1 | 49.3 | 35.5 | 29.5 | 39.2 | 37.1 |
| Normal (%) | 122.3 | 86.3 | 97.1 | 131.3 | 88.4 | 150.2 | 140.6 | 75.3 | 117.8 | 100.1 | 70.8 | 68.3 | 113.1 | 86.9 | 106.0 | 143.0 | 132.9 | 95.7 | 79.4 | 105.6 | 100.0 |
| Growing | | | | | | | | | | | | | | | | | | | | | |
| Season | 29.7 | 18.3 | 25.2 | 37.8 | 22.0 | 35.7 | 26.1 | 19.5 | 28.6 | 23.2 | 12.7 | 16.3 | 28.0 | 19.5 | 30.7 | 41.6 | 27.6 | 19.1 | 17.5 | 28.7 | 23.7 |
| (Apr-Oct) | | | | | | | | | | | | | | | | | | | | | |
| Normal (%) | 125 | 77 | 106 | 160 | 93 | 151 | 110 | 82 | 120 | 98 | 53 | 69 | 118 | 82 | 129 | 175 | 116 | 81 | 74 | 121 | 100 |

Premier Ridge and Pickering Hills are found in the Interior Douglas-fir dry, mild (IDFdm2) biogeoclimatic subzone (Braumandl and Curran 1992). Vegetation consists of open grass/shrub land intermingled with stands of Douglas-fir mixed with ponderosa pine and trembling aspen. Both sites are in a low seral stage dominated by Kentucky bluegrass and western needlegrass, although rough fescue and bluebunch wheatgrass can be found very infrequently. Again, bitterbrush and Saskatoon are the dominant shrubs on both sites.

3.4 Wildlife and Cattle

Coordinated Resource Management improved forage availability, forage quality and productivity for wild ungulates and domestic livestock in the East Kootenay (Pitt 1982). Between 1982 and 1986 the elk population in the East Kootenay increased from nearly 10,000 to more than 28,000 animals (Demarchi et al. 1987) and then declined to approximately 25,000 in 1991 (Simpson 1992). Wildlife managers concluded in a recent elk management plan, however, that “Current habitat condition on all potential winter range (gross suitability) is estimated to support 41,400 elk, while the net suitability (minus private land) has the potential to support 24,400 elk” (Bircher et al. 2001).

Livestock Animal Unit Months (AUMs) in the Trench peaked in 1964 (72,900 AUMs). By 1980, they were down to 41,200 AUMs (Pitt 1982). Actual AUMs varied between 35,000 and 45,000 between 1980 and 2006 (unpublished data, BC Min. Forests and Range).

4.0 Methods

4.1 Fence Construction and Layout

Enclosures were constructed at all four sites to provide “grazed” and “ungrazed” areas for sampling. The enclosures at Premier Ridge, Pickering Hills and the Historical Enclosure at Skookumchuck Prairie measured approximately 100 m x 70 m (0.7 ha) and were constructed with 2.8 m (9 ft) ungulate fence to exclude all ungulate grazing.

The Skookumchuck Prairie "Three-way Exclosure" was constructed in three compartments to allow differential access to cattle, wildlife, and cattle and wildlife together. A fourth compartment was constructed to prevent all ungulate grazing, which acts as an ungrazed control. The Cattle Only Area (65 ha) was fenced with 2.8 m (9 ft) ungulate fence and serves as an enclosure for cattle while excluding native ungulate grazing. The Wildlife Only Area (65 ha) was fenced with 1.2 m (4 ft) barbed wire to exclude cattle while permitting deer and elk access. This site is located immediately south of the Cattle Only Area.

An unfenced area of approximately 65 ha was defined east of the fenced areas to assess Combined Use by cattle and wildlife. The Ungulate Exclosure, which measures 100 m x 70 m (0.7 ha), is located adjacent to the Cattle Only Area and was also constructed with 2.8 m ungulate fence.

4.2 Livestock and Wildlife Grazing

The Skookumchuck Prairie "Three-way Exclosure" site and the Skookumchuck Historical Exclosure site are located in the TaTa/Skookumchuck Range Unit in Pulp and Plot pastures, respectively. The Premier Ridge site is located in Sheep Pasture in the Wolf/Sheep Range Unit, while the Pickering Hills site is found in Pickering Hills Pasture in the Pickering Hills Range Unit.

Cattle grazing at Pickering Hills, Premier Ridge and Skookumchuck Prairie followed the operational prescriptions set by the Ministry of Forests and Range for each site. Generally, each pasture was grazed for approximately one month annually on a spring/fall rotation, although the AUMs used, and season of use, varied during the study (Table 2).

Wild ungulates followed normal distribution patterns in all parts of the pastures they had access to during the study but the exact number of deer and elk using each pasture was not documented. Elk surveys were conducted throughout the study period at several polygons within the management units where the sites are located and population estimates were calculated for the management unit as a whole (Table 3). Similarly, other data collected between 1991 and 1993

Table 2. Cattle grazing rotations in the Rocky Mountain Forest District between 1991 and 2009.

| Site | Actual Number of AUM's | | | | | | | | | | | |
|----------------------|------------------------|---------------|------|---------------|------|---------------|------|---------------|------|---------------|------|---------------|
| | 1992 | Dates | 1993 | Dates | 1994 | Dates | 1995 | Dates | 1996 | Dates | 1997 | Dates |
| Skookumchuck Prairie | | | | | | | | | | | | |
| Cattle Only | 38 | Jun 15-Jul 15 | 38 | Sep 1-Sep 30 | 43 | Jul 10-Aug 10 | 0 | No use | 0 | No use | 40 | May 10-Jun 28 |
| Combined Use | 48 | Jun 15-Jul 15 | 38 | Sep 1-Sep 30 | 72 | Jul 10-Aug 10 | 99 | Oct 1-Oct 15 | 0 | No use | 200 | May 29-Jul 6 |
| Historical Exclosure | 0 | No Use | | Not available | | Not available | | Not available | 194 | May 7-Jun 15 | | |
| Premier Ridge | 104 | May 1-Jun 15 | 60 | Aug 1-Aug 30 | 91 | May 15-Jun 19 | 0 | No Use | | | | |
| Pickering Hills | 199 | Aug 11-Sep 4 | 270 | Jul 10-Aug 10 | 270 | Jul 26-Aug 25 | 270 | Sep 4-Sep 23 | 114 | Sep 24-Oct 15 | 285 | Aug 6-Sep 6 |

| Site | 1998 | Dates | 1999 | Dates | 2000 | Dates | 2001 | Dates | 2002 | Dates | 2003 | Dates |
|----------------------|------|---------------|------|---------------|------|--------------|------|--------------|------|---------------|------|---------------|
| Skookumchuck Prairie | | | | | | | | | | | | |
| Cattle Only | | N/A | | N/A | | N/A | 0 | No use | 39 | May 27-May 31 | 27 | May 22-Jul 5 |
| Combined Use | 255 | Sep 1-Oct 15 | | N/A | | N/A | 0 | No use | 79 | May 17-May 26 | 108 | May 30-Jun 11 |
| Historical Exclosure | | Not available | | Not available | | No use | | No use | 87 | May 6-May 16 | 125 | May 15-May 29 |
| Premier Ridge | | | 0 | No use | 50 | Sep 5-Sep 18 | 50 | Sep 1-Sep 14 | 92 | Sep 1-Sep 28 | 107 | Aug 23-Sep 22 |
| Pickering Hills | 290 | Aug 4-Aug 29 | 293 | Sep 20-Oct 10 | 350 | Jul 3-Aug 7 | 96 | Jul 15-Aug 1 | 239 | Aug 10-Sep 6 | 216 | Jul 10-Aug 2 |

East Kootenay Wildlife-Cattle Vegetation Monitoring

| Site | 2004 | Dates | 2005 | Dates | 2006 | Dates | 2007 | Dates | 2008 | Dates | 2009 | Dates |
|----------------------|------|---------------|------|---------------|------|---------------|------|---------------|------|---------------|------|--------------|
| Skookumchuck Prairie | | | | | | | | | | | | |
| Cattle Only | 71 | May 19-Sep 30 | 63 | May 6-Aug 1 | 31 | May 12-Jul 1 | 59 | May 12-May 20 | 60 | May 20-May 30 | 11 | May 15-Jun 7 |
| Combined Use | 103 | Jun 5-Jun 15 | 107 | Jun 18-Jul 2 | 94 | Jun 19-Jul 1 | 0 | No use | 72 | May 31-Jun 12 | 77 | Jun 8-Jul 7 |
| Historical Exlosure | 121 | May 23-Jun 4 | 100 | Jun 4-Jun 17 | 115 | Jun 3-Jun 18 | 0 | No use | 72 | Jun 13-Jun 24 | 121 | Jul 8-Jul 23 |
| Premier Ridge | 73 | Jul 25-Aug 17 | 92 | Aug 21-Sep 15 | 72 | Jul 15-Aug 5 | 0 | No use | 60 | Jun 25-Jul 10 | 0 | No Use |
| Pickering Hills | 320 | Jul 11-Jul 31 | 299 | Jul 21-Aug 12 | 259 | Jul 22-Aug 15 | 0 | No use | 177 | Jul 29-Aug 11 | 177 | Jul 11-Aug 2 |

Table 3. Elk population estimates in the Rocky Mountain Trench between 1992 and 2008.

| Management Unit (MU) / Site | Numbers | | | |
|--------------------------------|---------|------|-------|-------|
| | 1992 | 1997 | 2001 | 2008 |
| East Kootenay | 11038 | 7762 | 10733 | 14115 |
| | | | | |
| MU 4-20 (Skookumchuck Prairie) | 1000 | 850 | 1100 | 2526 |
| | | | | |
| MU 4-21 (Premier Ridge) | 1500 | 1200 | 1600 | 1902 |
| | | | | |
| MU 4-22 (Pickering Hills) | 2050 | 1900 | 2100 | 3417 |

Sample sizes relative to the study area overall.

Source: Phillips et al. 2008.

found that over-wintering elk spent between 185 and 222 days at Skookumchuck Prairie, 171 and 183 days at Premier Ridge, and slightly more than 160 days at Pickering Hills during these years (Jamieson and Hebert 1993).

4.3 Assessment of Plant Cover and Frequency

Plant species cover and frequency were assessed on all sites using a modification of the canopy coverage method (Daubenmire 1959) with nested plots. Cover of grasses, forbs and soil attributes was estimated using a 20 cm x 50 cm (0.1 m²) plot, which was nested in a 1 m x 2 m plot used to determine tree and shrub cover.

Cover, or the vertical projection of foliar material to the ground, was estimated for each species within six cover classes (Appendix 2). Cover of soil, litter, rock, bryophytes, and cattle, deer and elk feces was also recorded. Species that occurred within a three-metre band on each side of the transect, but not in the plots, were recorded as trace.

At Skookumchuck Prairie, ten plots were systematically located along each of ten 50 m transects in the Ungulate Exclosure, Wildlife Only, Cattle Only, and Combined Use Areas.

At Premier Ridge and Pickering Hills, five 50 m transects were installed systematically within exclosures and in the area grazed by elk, deer and cattle. Five paired transects were also installed inside the New Exclosure at the Skookumchuck Historical Exclosure site. Only a single transect was located in the Grazed Area and in the Old Exclosure at this site.

Transects were sampled at the beginning of August each year on all sites. All transects were permanently marked with steel pegs at each end and global positioning system (GPS) coordinates were taken at both ends for relocation (Appendix 2).

Percent cover for each species was determined by averaging the cover estimates over all plots at each location, while percent frequency was calculated using the following formula:

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

4.4 Photographic Record

Photographs were taken each year following sampling since 1991 (Ross 1997). In 2009, two photographs were taken at each site from opposite ends of a designated transect that had been previously photographed. The first photograph documented the transect from 0 m to the transect endpoint (50 m) with a stadia rod (range pole) located at the 5 m point. The second photo was taken from opposite end of the transect toward the 0 m point with the stadia rod located 5 m from the transect endpoint. All photos were taken at 5 m from either the start or endpoint using a tripod adjusted to approximately 1.5 m above ground level. Photographs in 2009 were taken in digital format, labelled with captions, and stored in computer files. Photographs are included in digital format on an accompanying CD.

4.5 Data Analysis

4.5.1 Cover Analysis

Changes in plant and soil substrate cover between 1991 and 2009 were determined at Pickering Hills, Premier Ridge and Skookumchuck Historic Exclosure with paired t-tests (Zar 1984). Separate t-tests were performed in the grazed and ungrazed areas at each site.

At the Skookumchuck Three-way Exclosure, a two-factor analysis of variance (ANOVA) was conducted to discern the differences in cover of individual species and soil substrates among grazing treatments (Ungulate Exclosure, Cattle Only, Wildlife Only and Combined Use) and years (1991, 1994, 2003 and 2009). Newman-Kuels multiple range test was applied to detect differences among means after a significant F-test in ANOVA (Zar 1984).

Simple linear regression was also used to evaluate trends in cover for bluebunch wheatgrass, rough fescue, Idaho fescue, cinquefoil species, Saskatoon, bitterbrush, litter, rock and soil, where cover was considered the dependent variable and year the independent variable (Zar 1984). Trends for each dependent variable were discerned for all four grazing treatments and graphically displayed.

4.5.2 Range Condition and Trend Analysis

Numerous approaches have been proposed to explain or evaluate floristic changes resulting from natural and human-caused disturbances including the effects of grazing by livestock (Sampson 1919; Dyksterhuis 1949; Heady 1973; Westoby et al. 1989; and Laycock 1991, among others). Sampson (1919) was among the first to propose “the most rational and reliable way to detect overgrazing is to recognize the replacement of one type of plant cover by another.” Dyksterhuis (1949) combined the principles of earlier researchers into a practical system for classifying the condition of rangeland based on quantitative ecology.

McLean and Marchand (1968) adapted the quantitative procedure developed by Dyksterhuis into a range condition model for grassland and dry forest range in British Columbia. They proposed that range plants can be classified according to their response to grazing as Decreasers, Increaseers and Invaders. Decreasers are perennial plants that dominate the climax community and decline under prolonged heavy grazing. Increaseers are commonly sub-dominant species in the climax community that increase initially and then decline with continued overuse. Invaders are often non-native plant species that enter plant communities as the range deteriorates but they may also be members of climax plant communities on other range sites in the same locality.

Range condition is the state of range in relation to its potential and is expressed as Excellent, Good, Fair, or Poor based on the proportion of Decreasers, Increaseers and Invaders in the plant community. A range site in Excellent condition contains at least 76% of the forage made up of Decreasers compared to Good (51 to 75%), Fair (26 to 50%) and Poor (25% or less) condition sites. Other factors, such as plant vigour, amount of litter on the ground, and the degree of erosion are also considered in assessments (McLean and Marchand 1968). Range trend, which assesses whether the range is improving, deteriorating or remaining static in range condition, should be determined along with range condition.

Decreaser species were based on those proposed for the Bluebunch Wheatgrass-Rough Fescue and the Ponderosa Pine Sites described by McLean and Marchand (1968). Decreasers for the Bluebunch Wheatgrass-Rough Fescue Site and the Ponderosa Pine Site in the southern interior include bluebunch wheatgrass, Idaho fescue, and rough fescue (McLean and Marchand 1968). Needle-and-thread is also considered a Decreaser on some soils in Ponderosa Pine communities.

Increaseers found in these zones are prairie Junegrass, needle-and-thread, Kentucky bluegrass, Columbia needlegrass, Sandberg's bluegrass, balsamroot, dwarf pussytoes, silky lupine, western yarrow, pasture sage, timber milkvetch and rabbitbrush (McLean and Marchand 1968). Common Invaders include annual phlox, cheatgrass, dandelion, woolly plantain, common mullein and compound fleabane.

Range condition on each site was determined by calculating the total Decreaser canopy cover (%) for each site as a proportion of total combined grass and forb cover (%). The resulting number was compared to the range condition class ranges described by McLean and Marchand (1968) above and each site was assigned a rating of Excellent, Good, Fair or Poor. Range trend was evaluated by comparing the calculated range condition classes in 1991 and 2009.

5.0 Results

5.1 Skookumchuck Historical Exclosure Site

The Skookumchuck Historical Exclosure was constructed by the BC Ministry of Forests in 1951 and sampled intermittently since 1960 at about 10 year intervals. Sandberg's bluegrass, low pussytoes, prairie Junegrass and needle-and-thread were the most common species in both the grazed and ungrazed areas when the Exclosure was constructed. According to McLean and Tisdale (1972) there appeared to be very little bluebunch wheatgrass and virtually no rough fescue on the site in 1951.

Plant Communities 1960 - In 1960, total grass cover exceeded 50% on the Grazed Area adjacent to the Exclosure and the site was dominated by Sandberg's bluegrass and prairie Junegrass, which together provided more than 40% canopy cover. Bluebunch wheatgrass and needle-and-thread were also present but collectively they accounted for only slightly more than 10% cover. No other perennial or annual grasses were found on the site (Appendix 3).

After nine years of protection, total grass cover inside the Exclosure was almost 35% higher than on the Grazed Area and bluebunch wheatgrass and prairie Junegrass contributed over 55% of the total grass cover (Appendix 3). Needle-and-thread and Sandberg's bluegrass continued to be prominent in the plant community while rough fescue cover was beginning to increase (Appendix 3).

Forb cover nearly tripled in the Grazed Area compared to the Exclosure with low pussytoes the dominant species on both sites. Nuttal's pussytoes, Holboell's rockcress, shaggy fleabane, sulphur buckwheat, spiny phlox, and dune goldenrod each contributed more than 1% cover on the Grazed Area. No tree or shrub cover was recorded in 1960 (Appendix 3).

Plant Communities 1970 - By 1970, grass cover had increased to more than 75% in the Grazed Area (Appendix 3). The principal grasses that increased included needle-and-

thread, bluebunch wheatgrass and prairie Junegrass, primarily at the expense of Sandberg's bluegrass. Inside the Exclosure, grass cover was similar to the Grazed Area but the relative cover among species differed from the Grazed Area. Both bluebunch wheatgrass and rough fescue more than doubled in cover between 1960 and 1970. In contrast, prairie Junegrass, Sandberg's bluegrass, and needle-and-thread all declined from a collective cover of nearly 60% in 1960 to 15% in 1970.

Forb cover decreased slightly in the Grazed Area, and increased slightly in the Exclosure in 1970 compared to 1960 (Appendix 3). The same species dominated except spiny phlox, which was not present on the site in 1960, provided 11% cover in 1970. Tree and shrub cover was unchanged except bearberry was encountered as a trace species in the Exclosure.

Plant Communities 1982 - Grass cover was lower in the Grazed Area in 1982 than in 1970 (Appendix 3). Compared to other grasses, prairie Junegrass and Sandberg's bluegrass declined the most from a combined cover of 30% in 1970 to 5% in 1982. In contrast, bluebunch wheatgrass maintained relatively the same frequency and cover between 1970 and 1982.

In the Exclosure, total grass cover also declined from 90% in 1970 to just over 75% in 1982 (Appendix 3). Bluebunch wheatgrass cover decreased to less than 13% in 1982 from 55% in 1970, and frequency was reduced from nearly 100% to less than 70%. Conversely, rough fescue almost tripled to nearly 60% cover, which was the peak cover and frequency for this species between 1960 and 2009.

Similar to grasses, total forb cover decreased in the Grazed Area in 1982 by more than 50% compared to 1960, primarily resulting from declines of low and Nuttal's pussytoes. Forb cover inside the Exclosure increased by nearly 50% in 1982 compared to 1970, mostly from western yarrow, timber milkvetch, and prairie groundsel (Appendix 3). Ponderosa pine occurred as a trace species on the Grazed Area.

Plant Communities 1991 - Total grass and forb cover declined in both the Grazed Area and Exclosure in 1991 compared to 1982 (Appendix 4) likely because of the dry spring in 1991 (Table 1). Needle-and-thread, bluebunch wheatgrass, and prairie Junegrass cover all declined in the Grazed Area with needle-and-thread alone reduced by 70%. Frequency and cover of bluebunch wheatgrass and prairie Junegrass also declined in the Exclosure.

Rough fescue cover, which peaked at nearly 60% in 1982, declined dramatically in the Exclosure in 1991 to under 25%. Idaho fescue cover, however, increased from 1% to nearly 8% and its frequency quadrupled during the period (Appendix 3; Appendix 4).

Forb cover was lower in 1991 than in all previous sampling periods in both the Grazed Area and the Exclosure (Appendix 4). Pussytoes, yellow owl-clover, spiny phlox, cinquefoil species, and prairie groundsel contributed more than 1% cover in the Grazed Area, whereas pussytoes, spiny phlox, and prairie groundsel were more prevalent in the Exclosure.

Tree and shrub cover in the grazed area was unchanged from 1982 to 1991. In contrast, ponderosa pine, which was not present in the Exclosure in 1982, occurred in 14% of the plots in 1991 and provided 2.5% canopy cover (Appendix 3; Appendix 4).

Plant Communities 2009 - In 2009, total grass cover inside the Exclosure was about half of the original cover in 1960, even though it was slightly higher than in 1991 (Appendix 3; Appendix 4). Both bluebunch wheatgrass and rough fescue cover had peaked in 1970 and 1982, respectively (Appendix 3). By 2009, bluebunch wheatgrass had decreased from over 50% canopy cover in 1970 to less than 3%, while rough fescue declined from nearly 60% to less than 25% cover (Appendix 4).

Compared to bluebunch wheatgrass and rough fescue, Idaho fescue cover more than doubled ($P < 0.05$) to nearly 19% inside the Exclosure between 1991 and 2009 (Table 4; Appendix 4). This species was absent in 1951 and first appeared in the Exclosure in 1982

Table 4. Cover of key species at the Skookumchuck Historical Old Exclosure 1991 to 2009.

| Species | Historic Old Exclosure | | | | | Grazed Area | | | | | |
|-------------------------|------------------------|------|------|------|-------|-------------|----------------|------|------|-------|--|
| | 1991 | ± SE | 2009 | ± SE | Prob. | 1991 | ± SE | 2009 | ± SE | Prob. | |
| | ------(%)----- | | | | | | ------(%)----- | | | | |
| Grasses | | | | | | | | | | | |
| Bluebunch wheatgrass | 5.5 | 1.26 | 2.2 | 1.72 | | 7.6 | 1.91 | 0.0 | 0.00 | ** | |
| Canada bluegrass | 0.0 | 0.00 | 0.0 | 0.00 | | 0.0 | 0.00 | 1.4 | 0.58 | ** | |
| Idaho fescue | 7.9 | 1.27 | 18.5 | 1.90 | ** | 0.5 | 0.14 | 0.0 | 0.00 | ** | |
| Needle-and-thread | 0.0 | 0.00 | 0.0 | 0.00 | | 14.0 | 1.47 | 18.3 | 1.35 | ** | |
| Prairie Junegrass | 1.0 | 0.43 | 0.0 | 0.00 | ** | 0.9 | 0.32 | 1.0 | 0.32 | | |
| Rough fescue | 23.8 | 2.34 | 23.5 | 3.00 | | 1.0 | 0.51 | 0.0 | 0.00 | | |
| Sandberg bluegrass | 0.3 | 0.12 | 0.0 | 0.00 | ** | 0.4 | 0.31 | 0.1 | 0.05 | | |
| Forbs | | | | | | | | | | | |
| Cinquefoil species | 0.0 | 0.00 | 0.0 | 0.00 | | 1.3 | 0.51 | 9.3 | 0.93 | ** | |
| Rosy pussytoes | 2.6 | 0.73 | 4.3 | 1.38 | | 3.6 | 0.92 | 6.0 | 0.97 | | |
| Spiny phlox | 4.8 | 1.07 | 2.9 | 0.72 | | 3.1 | 0.94 | 0.7 | 0.32 | ** | |
| Western yarrow | 0.6 | 0.15 | 1.9 | 0.50 | ** | 0.1 | 0.05 | 0.1 | 0.07 | | |
| Trees and Shrubs | | | | | | | | | | | |
| Ponderosa pine | 2.5 | 1.27 | 11.2 | 3.16 | ** | 0.1 | 0.05 | 0.0 | 0.00 | | |
| Soil Substrate | | | | | | | | | | | |
| Bryophytes | 37.7 | 2.81 | 31.5 | 3.87 | | 18.9 | 2.25 | 37.9 | 2.69 | ** | |
| Litter | 53.5 | 3.15 | 65.8 | 4.24 | ** | 24.3 | 2.12 | 11.7 | 1.13 | ** | |
| Rock | 0.5 | 0.31 | 0.2 | 0.08 | | 2.3 | 0.40 | 1.8 | 0.32 | | |
| Soil | 0.8 | 0.32 | 2.1 | 0.63 | | 32.9 | 2.25 | 28.9 | 2.02 | | |

Asterisks indicate significance at ** P< 0.05.

as only 1% canopy cover. Only minor changes in forb cover occurred in the Exclosure between 1991 and 2009 (Appendix 4).

After nearly 50 years of mixed ungulate grazing on the Grazed Area, total grass cover was less than half of its original cover in 1960 (Appendix 3; Appendix 4). Most of this response resulted from the decline ($P < 0.05$) in bluebunch wheatgrass between 1991 and 2009 (Table 4; Appendix 3; Appendix 4). In 1991, cover of bluebunch wheatgrass remained similar to the original cover in 1960 but this species was not found in any plots in 2009. The apparent collapse of bluebunch wheatgrass, however, could have resulted from the below normal precipitation in 2007 and 2008 (Table 1). Idaho fescue and rough fescue were also absent in 2009 although they only represented about 1% cover in 1991 (Appendix 4).

In contrast to bluebunch wheatgrass, needle-and-thread cover increased to nearly 18% between 1991 and 2009, which was more than quadruple the cover recorded in 1960 (Appendix 3; Appendix 4). Only minor differences were observed in forb cover in the Grazed Area between 1991 and 2009, with rosy pussytoes and cinquefoil species increasing to about 6 and 9%, respectively (Appendix 4).

Trees and shrubs continued to be poorly represented at the Skookumchuck Historical Exclosure site except for ponderosa pine inside the Old Exclosure. This species became established between 1982 and 1991 when it contributed 2.5% cover. By 2009 cover had increased ($P < 0.05$) to more than 11% (Table 4) but no corresponding change in cover was found on the Grazed Area.

Precipitation may have influenced cover at Skookumchuck Prairie. Interestingly, in all of the sampling years except 2009, growing season precipitation was below the long-term normal (Table 1). In 1991 and 2003 it was about 80%, where as in 1994 it was 93%. Total grass cover peaked in 1994 (Appendix 4), likely in response to the above normal precipitation in April, May and June 1994, which also followed the second wettest year during the study (Table 1).

5.2 Skookumchuck Historical New Exclosure

The New Exclosure at the Skookumchuck Historical site was built in 1991 as an attachment to the original exclosure. This site was sampled for the first time in 1991 and then in 1994 and 2009.

In 1991, total grass cover was 43% and the site was dominated by bluebunch wheatgrass and needle-and-thread with a combined cover exceeding 35% (Appendix 5; Table 5). Prairie Junegrass, rough fescue and Idaho fescue also occurred on the site as subordinates, collectively accounting for less than 10% of total grass cover.

Fifteen forbs were present in 1991, each contributing less than 1% cover except for prairie crocus, Wyeth's buckwheat and yellow owl-clover, which provided between 1 and 1.5% cover. No trees or shrubs were recorded on the transects in 1991. Soil substrates measurements in 1991 were similar to those in the Grazed Area. Litter and Bare Soil cover were approximately 36 and 30%, respectively, while Bryophyte cover was about 25% (Appendix 5). Rock cover was 2%.

After 18 years of ungulate exclusion, total grass cover was essentially the same as in 1991 (Appendix 5). However, bluebunch wheatgrass and needle-and-thread both declined significantly ($P < 0.05$) with their combined cover totaling 19.3% in 2009 (Table 5). Although rough fescue, prairie Junegrass and Canada bluegrass cover all increased ($P < 0.05$) between 1991 and 2009, these species only added about 12% to total cover.

By 2009, forb cover nearly tripled compared to 1991 with western yarrow, rosy pussytoes and cinquefoil species all becoming more prominent ($P < 0.05$) on the site (Table 5). Other species, such as dune goldenrod, dandelion, Holboell's rockcress, purple owl-clover, and sulphur buckwheat also contributed to forb cover but most of these species did not exceed 1% individually (Appendix 5). No trees or shrubs were present on the site in 2009.

Table 5. Cover of key species at Skookumchuck Historical New Exclosure 1991 to 2009.

| Species | 1991 | ± SE | 2009 | ± SE | Prob. |
|-------------------------|----------------|------|------|------|-------|
| | ------(%)----- | | | | |
| Grasses | | | | | |
| Bluebunch wheatgrass | 20.3 | 2.56 | 9.9 | 1.91 | ** |
| Canada bluegrass | 0.3 | 0.55 | 2.6 | 1.30 | ** |
| Idaho fescue | 1.6 | 0.51 | 0.6 | 0.42 | |
| Needle-and-thread | 15.5 | 2.00 | 9.4 | 1.53 | ** |
| Prairie Junegrass | 3.8 | 0.77 | 6.8 | 1.52 | * |
| Rough fescue | 1.0 | 0.51 | 8.3 | 2.32 | ** |
| Sandberg bluegrass | 0.7 | 0.32 | 0.0 | 0.00 | ** |
| Forbs | | | | | |
| Cinquefoil species | 0.1 | 0.05 | 4.8 | 0.92 | ** |
| Rosy pussytoes | 1.0 | 0.43 | 4.3 | 0.91 | ** |
| Spiny phlox | 0.7 | 0.42 | 0.5 | 0.14 | |
| Western yarrow | 0.0 | 0.08 | 1.9 | 0.64 | ** |
| Trees and Shrubs | | | | | |
| Ponderosa pine | 0.0 | 0.00 | 0.0 | 0.00 | |
| Soil Substrates | | | | | |
| Bryophytes | 25.1 | 2.53 | 72.6 | 2.41 | ** |
| Litter | 35.9 | 3.34 | 19.7 | 2.18 | ** |
| Rock | 2.0 | 0.80 | 0.1 | 0.05 | ** |
| Soil | 30.5 | 2.95 | 6.7 | 0.90 | ** |

Asterisks indicate significance at * P < 0.10 and ** P < 0.05.

Significant changes occurred in all soil substrate measurements between 1991 and 2009. Bryophyte cover increased to nearly 73% from about 25% (Table 5). In contrast, Litter, Rock and Bare Soil cover were all lower in 2009 compared to 1991 (Table 5).

5.3 Skookumchuck Prairie Three-Way Exclosure Site

Floristic changes among the four “grazing treatment” sites at the Skookumchuck Three-way Exclosure have been gradual and varied. After 18 years, differences are finally emerging in the plant communities, which are best expressed by the response of individual key species, species groups and soil attributes.

5.3.1 Grazing Treatment Response

Plant Communities 1991- Floristically the four sites at Skookumchuck Prairie were relatively similar in 1991. Total grass averaged about 30% in each area (Appendix 6). Bluebunch wheatgrass was the dominant species at all sites except the Ungulate Exclosure. Bluebunch wheatgrass cover varied between 9 and 13% in the Combined Use, Cattle Only, and Wildlife Only Areas, compared to nearly 5% of the Ungulate Exclosure. Kentucky bluegrass and Canada bluegrass were present on all sites and dominated the grass composition in the Ungulate Exclosure (Appendix 6).

Forb cover in August 1991 varied from about 9% in the Cattle Only Area to nearly 17% in the Ungulate Exclosure (Appendix 6). Relatively few forbs exceeded 1% of canopy cover. Western yarrow, timber milkvetch, and hairy golden-aster were prominent forbs on all sites at Skookumchuck Prairie.

Tree and shrub cover was highest in the Combined Use Area and in the Ungulate Exclosure, where it reached nearly 19%. Cover was slightly lower on the Cattle Only and Wildlife Only Areas. Bitterbrush was the dominant shrub on all sites at Skookumchuck Prairie, ranging from less than 5% in the Cattle Only Area to more than 11% in the Ungulate Exclosure.

Plant Communities 1994 - After four years of differential grazing, the plant communities on all sites remained statistically similar ($P < 0.05$) although some trends in individual species were beginning to emerge (Ross 1997). The greatest changes occurred in the Ungulate Exclosure where rough fescue, prairie Junegrass and common yarrow cover had all increased while cheatgrass decreased between 1991 and 1994 (Appendix 6; Appendix 7). Despite these changes, plant communities between the two sites were not statistically similar ($P > 0.05$) (Ross 1997). Grass and shrub cover was the highest ($P < 0.05$) in 1994 and was similar among the other years (Table 6).

Plant Communities 2009 - Grass cover at Skookumchuck Prairie ranged from 23% in the Wildlife Only Area to slightly over 50% in the Ungulate Exclosure (Appendix 8). Averaged over the four sampling years, grass cover was about 7% higher ($P < 0.10$) in the Ungulate Exclosure compared to the Cattle Only Area, which was higher than in the other areas. There was no difference in cover between the Wildlife Only and Combined Use areas (Table 6).

Forb cover ranged between 6 and 16% at Skookumchuck Prairie in 2009 but most forbs contributed less than 1% to total cover (Appendix 6; Appendix 8). Only western yarrow, low pussytoes, hairy golden-aster, spiny phlox, cinquefoil species, and dandelion exceeded 1% cover at one or more sites in 2009 (Appendix 8). Total forb cover was significantly higher ($P < 0.10$) in 1994 compared to all other years. Cover was similar in 1991, 2003 and 2009 (Table 6). There were no significant differences in total forb cover among treatments (Table 6).

Tree and shrub cover ranged from 15 and 23% at Skookumchuck Prairie in both 1991 and 2009 (Appendix 6; Appendix 8). Bitterbrush was the dominant shrub at all sites in 2009 with cover ranging from 5 and 15%, while other common shrubs included Saskatoon, bearberry, and rose. Ponderosa pine was the dominant tree species on all Three-way Exclosure sites except the Ungulate Exclosure although trembling aspen was found sparsely in the Combined Use Area. Average total shrub cover was higher ($P < 0.10$) inside the Ungulate Exclosure than on the Wildlife Only and Combined Use areas with bitterbrush providing most of the cover in all areas (Table 6; Appendix 6; Appendix 7; Appendix 8).

Table 6. Cover for grasses, forbs and shrubs at Skookumchuck Prairie Three-way Exclosure 1991 to 2009.

| Total Grasses (%) | | | | | | |
|------------------------------------|---------------------|--------------------|----------------------|------------------|-------------------------------|---------------------|
| Year | Combined Use | Cattle Only | Wildlife Only | Exclosure | Year Means¹ | Significance |
| 1991 | 30.1 | 28.8 | 28.2 | 26.2 | 28.3 | b |
| 1994 | 55.4 | 53.5 | 49.4 | 64.9 | 55.8 | a |
| 2003 | 21.8 | 37.2 | 31.5 | 37.5 | 32.0 | b |
| 2009 | 27.7 | 32.3 | 23.0 | 50.7 | 33.4 | b |
| Treatment Means² | 33.7 | 38.0 | 33.0 | 44.8 | | |
| Significance | b, c | b | b, c | a | | |

| Total Forbs (%) | | | | | | |
|------------------------------------|---------------------|--------------------|----------------------|------------------|-------------------------------|---------------------|
| Year | Combined Use | Cattle Only | Wildlife Only | Exclosure | Year Means¹ | Significance |
| 1991 | 11.9 | 9.2 | 12.2 | 16.8 | 12.5 | b |
| 1994 | 10.5 | 16.9 | 14.4 | 20.1 | 15.5 | a |
| 2003 | 14.6 | 12.1 | 14.3 | 8.3 | 12.3 | b |
| 2009 | 15.5 | 14.2 | 12.1 | 6.0 | 11.9 | b |
| Treatment Means² | 13.1 | 13.1 | 13.2 | 12.8 | | |
| Significance | a | a | a | a | | |

| Total Shrubs (%) | | | | | | |
|------------------------------------|---------------------|--------------------|----------------------|------------------|-------------------------------|---------------------|
| Year | Combined Use | Cattle Only | Wildlife Only | Exclosure | Year Means¹ | Significance |
| 1991 | 15.7 | 12.0 | 10.4 | 18.3 | 14.1 | b,c |
| 1994 | 27.9 | 24.0 | 21.8 | 28.5 | 25.5 | a |
| 2003 | 19.3 | 21.8 | 19.9 | 21.7 | 20.7 | b |
| 2009 | 11.5 | 11.3 | 21.2 | 15.5 | 14.8 | b,c |
| Treatment Means² | 18.6 | 17.3 | 18.3 | 21.0 | | |
| Significance | b,c | b,c | a,c | a | | |

¹ Year Means in Columns followed by the same letter are not significantly different (P>0.10)

² Treatment Means in Rows followed by the same letter are not significantly different (P>0.10)

5.3.2 Plant Species Response Among Treatment Areas

Although there were numerous changes in cover among individual plant species between 1991 and 2009, not all species responded in the same way, presumably due to the different grazing treatments.

Bluebunch wheatgrass - In 1991, bluebunch wheatgrass cover varied from approximately 5% in the Ungulate Exclosure to nearly 13% in the Wildlife Only Area (Table 7), but by 2009, it had declined ($P < 0.05$) on all sites (Table 7, Figure 2; Table 8). These declines likely resulted from a combination of ungulate grazing, plant competition, and annual weather patterns. Rough fescue ($P < 0.05$), Idaho fescue ($P < 0.05$) and Richardson's needlegrass ($P < 0.10$) all increased in the Ungulate Exclosure (Table 7), which probably contributed to bluebunch wheatgrass decline. In field trials, Muggler (1972) found that rough and Idaho fescue can compete with bluebunch wheatgrass in ungrazed conditions.

Idaho Fescue – In 1991 Idaho fescue cover ranged from less than 1% at the Exclosure to about 7% in the Wildlife Only Area. In 2009, Idaho fescue cover was highest ($P < 0.05$) in the Wildlife Only Area and lowest in the Combined Use Area (Table 7). Cover significantly increased ($P < 0.05$) inside the Ungulate Exclosure between 1991 and 2009 but no significant trends were observed on the other sites (Table 7; Figure 3; Table 8). There was no difference in Idaho fescue cover between the Combined Use Area and the Ungulate Exclosure between 1991 and 2009.

Rough Fescue - In 1991, rough fescue provided less than 3% canopy cover on all the treatment sites. By 2009 it dominated both the Ungulate Exclosure and the Cattle Only Area accounting for nearly 23% and 14% cover on each site, respectively (Table 7). There was no difference ($P > 0.10$) in cover between these sites (Table 9). In contrast, cover of this species was virtually unaltered in the Wildlife Only and Combined Use areas over the same period of time (Figure 4; Table 8; Table 9).

Table 7. Cover of key species at Skookumchuck Prairie Three-way Exclosure 1991 to 2009.

| Species | Exclosure | | | | | Cattle Only | | | | |
|--------------------------|----------------|------|------|------|-------|----------------|------|------|------|-------|
| | 1991 | ± SE | 2009 | ± SE | Prob. | 1991 | ± SE | 2009 | ± SE | Prob. |
| | ------(%)----- | | | | | ------(%)----- | | | | |
| Grasses | | | | | | | | | | |
| Bluebunch wheatgrass | 4.6 | 0.77 | 0.9 | 0.75 | * | 11.7 | 2.18 | 3.8 | 0.86 | ** |
| Canada bluegrass | 7.1 | 0.90 | 11.1 | 3.65 | | 2.7 | 1.13 | 0.8 | 0.45 | |
| Idaho fescue | 0.8 | 0.27 | 5.6 | 1.96 | * | 4.1 | 1.29 | 5.5 | 2.06 | |
| Kentucky bluegrass | 9.5 | 1.60 | 7.8 | 1.48 | | 1.8 | 1.28 | 4.7 | 2.93 | |
| Richardson's needlegrass | 0.0 | 0.03 | 2.1 | 0.96 | ** | 1.4 | 0.99 | 1.8 | 0.61 | |
| Rough fescue | 0.6 | 0.22 | 22.7 | 4.09 | * | 1.8 | 0.72 | 13.8 | 4.41 | ** |
| Sandberg bluegrass | 0.1 | 0.05 | 0.0 | 0.00 | | 0.6 | 0.22 | 0.8 | 0.42 | |
| Western needlegrass | 0.4 | 0.18 | 0.0 | 0.00 | | 1.9 | 0.76 | 0.0 | 0.00 | |
| Other grasses | 3.1 | 1.26 | 0.6 | 0.20 | ** | 2.9 | 0.95 | 1.1 | 0.52 | * |
| Forbs | | | | | | | | | | |
| Cinquefoil species | 4.7 | 1.18 | 3.3 | 0.88 | | 0.1 | 0.07 | 2.1 | 0.83 | ** |
| Western yarrow | 1.7 | 0.64 | 0.8 | 0.22 | | 1.1 | 0.24 | 2.1 | 0.49 | ** |
| Other forbs | 15.1 | 1.44 | 2.0 | 0.48 | * | 8.1 | 1.18 | 9.9 | 3.18 | |
| Shrubs | | | | | | | | | | |
| Bearberry | 1.1 | 0.72 | 0.7 | 0.40 | | 4.0 | 1.77 | 6.1 | 1.81 | * |
| Bitterbrush | 11.5 | 1.62 | 10.4 | 1.58 | | 4.6 | 1.39 | 4.8 | 2.78 | |
| Saskatoon | 2.1 | 1.10 | 2.6 | 1.13 | | 2.0 | 1.03 | 0.2 | 0.15 | |
| Other shrubs | 3.7 | 1.10 | 1.9 | 0.57 | * | 1.5 | 0.56 | 0.2 | 0.17 | ** |
| Soil Substrates | | | | | | | | | | |
| Bryophytes | 30.2 | 2.97 | 28.2 | 3.22 | | 24.6 | 3.01 | 14.1 | 2.77 | ** |
| Litter | 53.9 | 3.69 | 77.9 | 1.39 | * | 39.5 | 5.70 | 59.9 | 9.53 | ** |
| Rock | 3.6 | 0.55 | 0.3 | 0.20 | * | 8.2 | 1.81 | 4.6 | 1.38 | ** |
| Soil | 5.8 | 0.83 | 0.5 | 0.34 | * | 12.9 | 2.36 | 9.6 | 4.28 | |

East Kootenay Wildlife-Cattle Vegetation Monitoring

| Species | Wildlife Only | | | | | Combined Use | | | | |
|--------------------------|----------------|------|------|------|-------|----------------|------|------|------|-------|
| | 1991 | ± SE | 2009 | ± SE | Prob. | 1991 | ± SE | 2009 | ± SE | Prob. |
| | ------(%)----- | | | | | ------(%)----- | | | | |
| Grasses | | | | | | | | | | |
| Bluebunch wheatgrass | 12.6 | 1.85 | 5.1 | 1.84 | * | 9.7 | 1.52 | 2.4 | 0.97 | ** |
| Canada bluegrass | 0.6 | 0.24 | 1.0 | 0.57 | | 4.4 | 1.59 | 7.3 | 2.24 | |
| Idaho fescue | 7.2 | 1.53 | 7.2 | 1.37 | | 3.8 | 0.86 | 2.6 | 1.28 | |
| Kentucky bluegrass | 1.7 | 0.96 | 1.5 | 0.98 | | 2.8 | 1.21 | 1.6 | 0.92 | ** |
| Rough fescue | 1.1 | 0.81 | 1.6 | 1.25 | | 2.7 | 0.50 | 1.6 | 0.70 | |
| Sandberg's bluegrass | 0.5 | 0.15 | 0.9 | 0.41 | | 0.3 | 0.08 | 0.0 | 0.03 | ** |
| Richardson's needlegrass | 1.1 | 0.63 | 3.6 | 1.56 | ** | 1.9 | 0.87 | 10.4 | 3.21 | ** |
| Western needlegrass | 0.3 | 0.20 | 0.0 | 0.03 | | 1.7 | 1.44 | 0.2 | 0.18 | |
| Other grasses | 3.3 | 1.31 | 2.2 | 0.67 | | 8.6 | 0.94 | 2.4 | 0.49 | |
| Forbs | | | | | | | | | | |
| Cinquefoil species | 0.1 | 0.03 | 4.6 | 1.55 | * | 0.9 | 0.56 | 2.2 | 1.13 | |
| Western yarrow | 1.7 | 0.84 | 1.4 | 0.65 | | 1.1 | 0.23 | 0.3 | 0.11 | ** |
| Other forbs | 10.6 | 1.78 | 6.1 | 1.23 | * | 10.8 | 1.46 | 13.1 | 1.77 | |
| Shrubs | | | | | | | | | | |
| Bearberry | 0.4 | 0.84 | 1.4 | 0.27 | | 2.7 | 1.99 | 2.3 | 1.33 | |
| Bitterbrush | 8.6 | 0.49 | 15.2 | 0.43 | * | 9.1 | 2.04 | 8.0 | 1.57 | |
| Saskatoon | 1.0 | 0.62 | 0.5 | 0.32 | | 2.9 | 0.98 | 0.9 | 0.38 | * |
| Other shrubs | 0.4 | 0.22 | 4.2 | 3.05 | | 1.1 | 0.32 | 0.3 | 0.18 | ** |
| Soil Substrates | | | | | | | | | | |
| Bryophytes | 32.4 | 4.08 | 30.4 | 6.56 | | 20.0 | 3.36 | 25.4 | 6.56 | |
| Litter | 36.1 | 5.16 | 49.4 | 9.87 | ** | 49.3 | 6.29 | 51.7 | 9.25 | |
| Rock | 5.6 | 1.13 | 2.9 | 0.89 | * | 7.1 | 1.81 | 6.1 | 1.51 | |
| Soil | 9.9 | 2.10 | 4.5 | 1.89 | * | 9.4 | 2.88 | 3.1 | 1.16 | * |

Asterisks indicates significance at * P < 0.10 and ** P < 0.05.

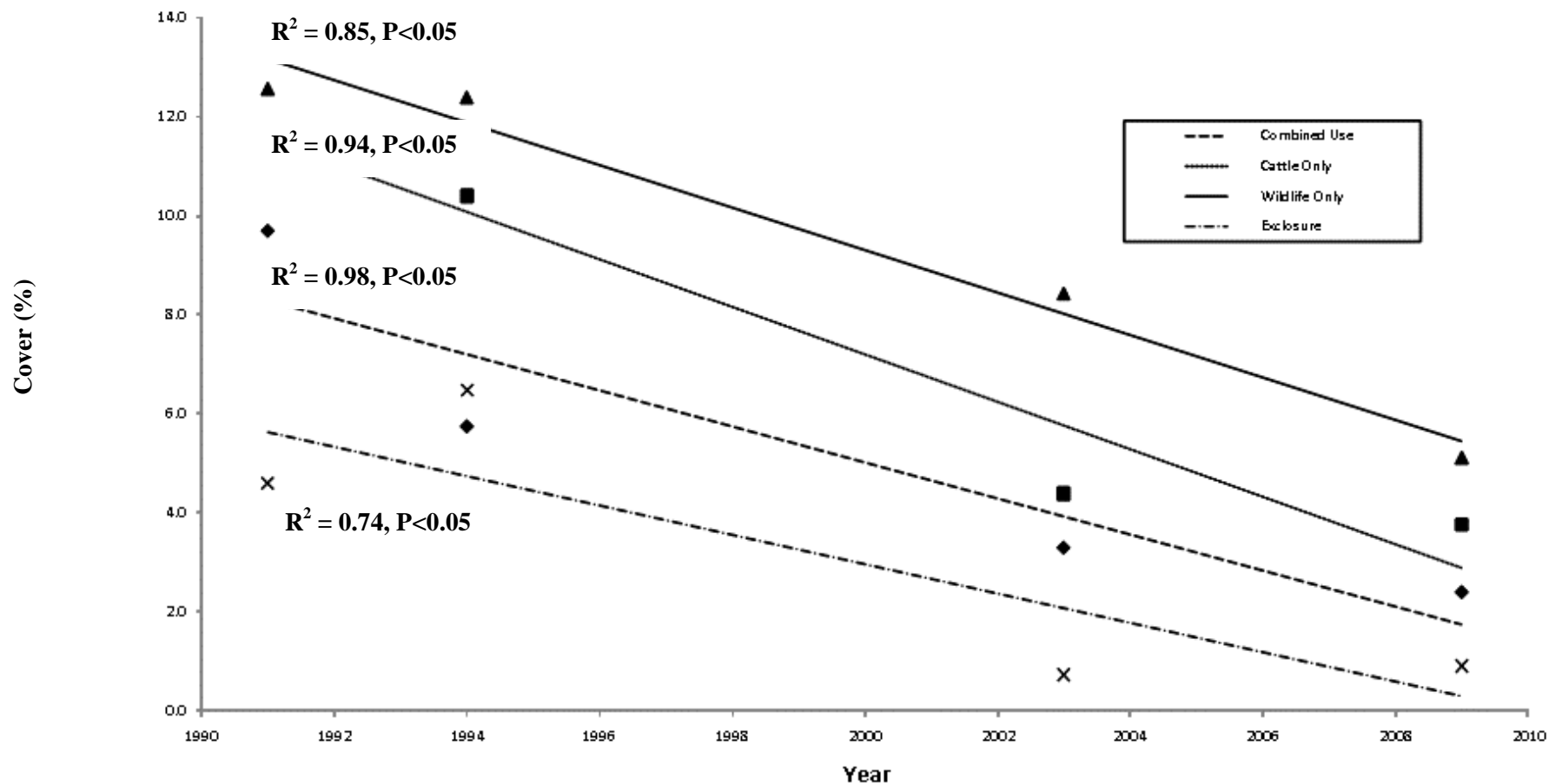


Figure 2. Trend in cover of bluebunch wheatgrass by grazing treatment at Skookumchuck Three-way Exclosure 1991-2009.

Table 8. Linear regression coefficients for selected key species and substrates at Skookumchuck Prairie Three-way Exclosure 1991 to 2009.

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|--------------------------|----------------|-------|----------------|-------|----------------|-------|----------------|-------|
| | R ² | Prob. | R ² | Prob. | R ² | Prob. | R ² | Prob. |
| Grasses | | | | | | | | |
| Bluebunch wheatgrass | 0.85 | * | 0.94 | ** | 0.98 | ** | 0.74 | |
| Canada bluegrass | 0.00 | | 0.82 | * | 0.03 | | 0.08 | |
| Idaho fescue | 0.59 | | 0.10 | | 0.01 | | 0.92 | ** |
| Kentucky bluegrass | 0.26 | | 0.01 | | 0.24 | | 0.30 | |
| Richardson's needlegrass | 0.14 | | 0.12 | | 0.00 | | 0.62 | |
| Rough fescue | 0.39 | | 0.88 | * | 0.04 | | 0.98 | ** |
| Sandberg's bluegrass | 0.38 | | 0.16 | | 0.26 | | 0.44 | |
| Western needlegrass | 0.41 | | 0.76 | | 0.01 | | 0.01 | |
| Other grasses | 0.51 | | 0.41 | | 0.21 | | 0.81 | * |
| Forbs | | | | | | | | |
| Cinquefoil species | 0.44 | | 0.89 | * | 0.82 | * | 0.41 | |
| Western yarrow | 0.11 | | 0.05 | | 0.64 | | 0.34 | |
| Other forbs | 0.21 | | 0.01 | | 0.48 | | 0.93 | ** |
| Shrubs | | | | | | | | |
| Bearberry | 0.18 | | 0.00 | | 0.00 | | 0.31 | |
| Bitterbrush | 0.09 | | 0.00 | | 0.23 | | 0.11 | |
| Saskatoon | 0.83 | * | 0.83 | * | 0.78 | | 0.21 | |
| Other shrubs | 0.99 | ** | 0.06 | | 0.57 | | 0.68 | |
| Soil Substrate | | | | | | | | |
| Bryophytes | 0.43 | | 0.59 | | 0.01 | | 0.00 | |
| Litter | 0.06 | | 0.83 | * | 0.63 | | 0.70 | |
| Rock | 0.56 | | 0.75 | | 0.97 | ** | 0.97 | ** |
| Soil | 0.81 | * | 0.20 | | 0.61 | | 0.54 | |

Astrisks indicates significance at * P < 0.10; ** P < 0.05.

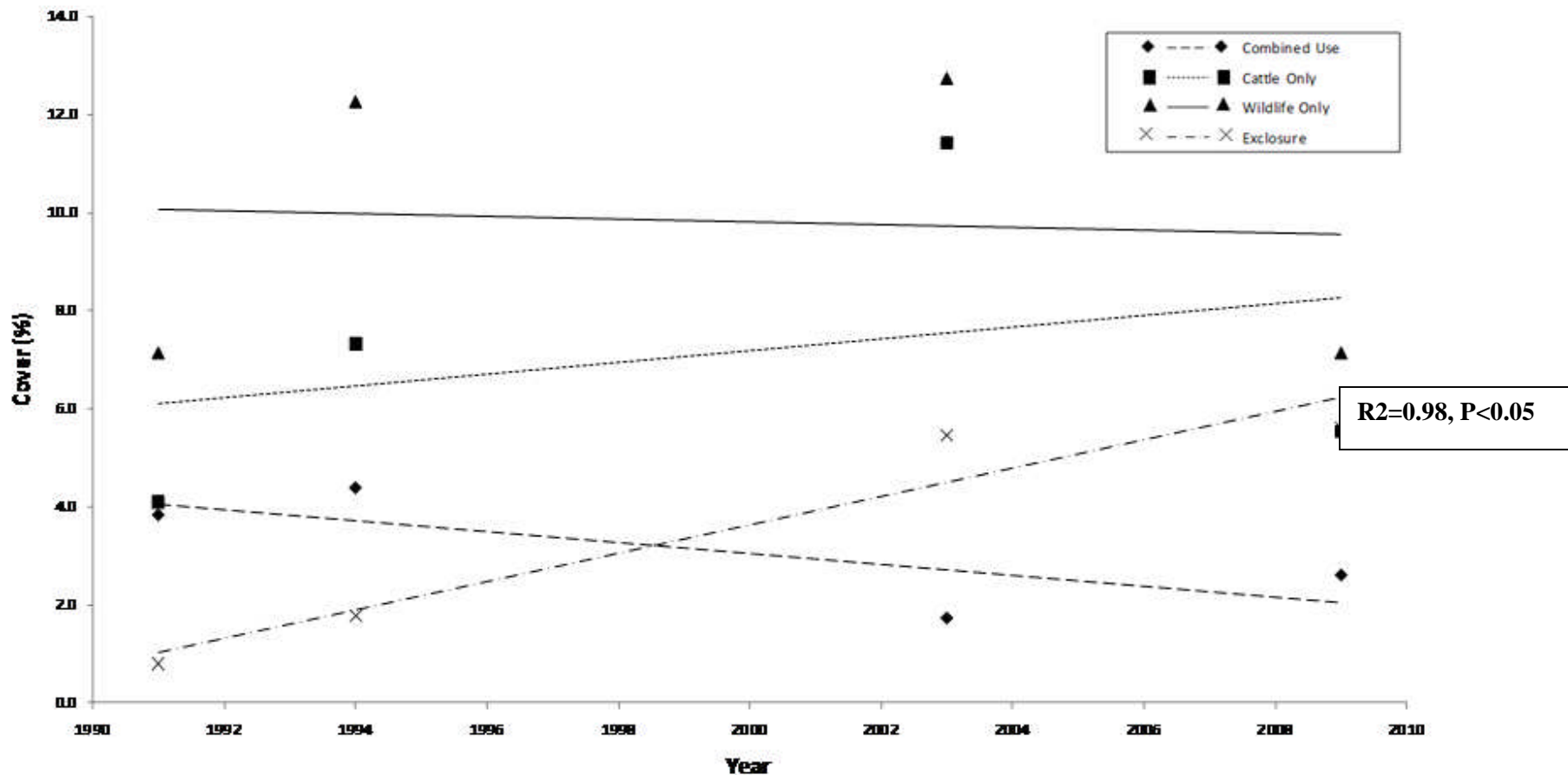


Figure 3. Trend in cover of Idaho fescue by grazing treatment at Skookumchuck Three-way Exclusion 1991-2009.

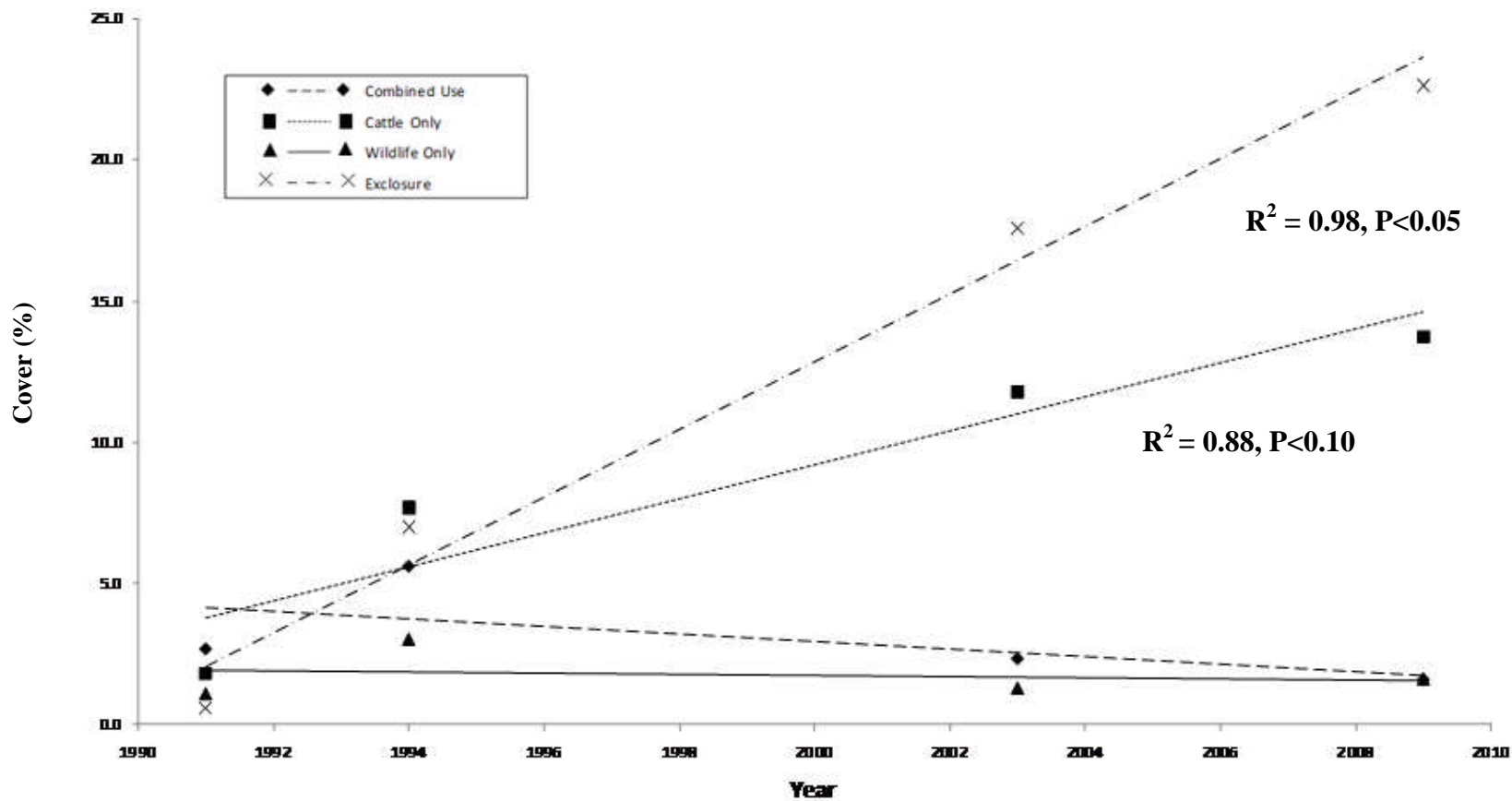


Figure 4. Trend in cover of rough fescue by grazing treatment at Skookumchuck Three-way Exclosure 1991-2009.

Table 9. Analysis of variance for cover of key species and substrates by treatment at Skookumchuck Prairie Three-way Exclosure.

| Species | Combined Use | ± SE | Cattle Only | ± SE | Wildlife Only | ± SE | Exclosure | ± SE | Probability |
|--------------------------|----------------|------|-------------|------|---------------|------|-----------|------|-------------|
| Grasses | ------(%)----- | | | | | | | | |
| Bluebunch wheatgrass | 5.3 c | 2.0 | 7.6 b | 1.6 | 9.6 a | 1.8 | 3.2 d | 1.4 | * |
| Idaho fescue | 3.1 b,c | 0.6 | 7.1 b | 1.6 | 9.8 a | 1.6 | 3.4 b,c | 1.2 | * |
| Richardson's needlegrass | 8.0 a | 2.4 | 3.7 b | 1.8 | 3.5 b,c | 1.3 | 1.5 b,c | 0.5 | * |
| Rough fescue | 3.1 b,c | 0.9 | 8.8 a | 2.6 | 1.8 b | 0.4 | 12.0 a | 5.0 | * |
| Forbs | | | | | | | | | |
| Cinquefoil species | 2.0 b | 0.8 | 0.8 b,c | 0.5 | 1.8 b | 1.0 | 4.0 a | 0.4 | * |
| Shrubs | | | | | | | | | |
| Bitterbrush | 11.7 b,c | 1.9 | 8.1 b,d | 2.0 | 14.9 a | 2.2 | 14.5 a | 2.2 | * |
| Saskatoon | 2.1 a | 0.6 | 1.0 b | 0.4 | 0.8 b | 0.1 | 2.3 a | 0.1 | * |
| Soil Substrates | | | | | | | | | |
| Bryophytes | 24.6 b | 3.3 | 21.4 b | 2.5 | 32.1 a | 1.3 | 25.4 b | 2.9 | * |
| Litter | 51.3 b | 2.2 | 52.1 b | 4.6 | 42.7 b,c | 2.8 | 69.1 a | 5.3 | * |
| Rock | 6.8 a | 0.6 | 6.0 b | 1.2 | 4.4 c | 0.7 | 2.0 d | 0.8 | * |
| Soil | 5.7 b | 1.3 | 10.3 a | 0.9 | 9.2 a | 1.7 | 1.9 b,c | 1.3 | * |

Astrisk indicates significance at* P<0.05; Means within rows followed by the same letter are not significantly different.

The prominence of rough fescue in the Ungulate Exclosure and Cattle Only Area likely relates to reduced grazing pressure. In 1991, virtually all rough fescue plants found at Skookumchuck Prairie site were in poor vigour (Ross and Wikeem, pers. observ. 1991). In 2009, plants found inside the Ungulate Exclosure and Cattle Only Area were robust while those in the Combined Use Area and Wildlife Only Area continued to lack vigour (Ross and Wikeem, pers. observ. 2009).

5.3.3 Non-Native Vascular Plants and Invasive Plants

Several non-native grasses and forbs, such as cheatgrass, Canada bluegrass, Kentucky bluegrass, stickseed, black medic, alfalfa, white sweet-clover, dandelion, yellow salsify, common mullein, and cinquefoils were present in the Skookumchuck Three-way Exclosure system in 1991. Except for Canada bluegrass and Kentucky bluegrass, most of these species occurred as trace and minor species with cover rarely exceeding 5% during the study period (Appendix 6; Appendix 7; Appendix 8).

Cinquefoils, and particularly sulphur cinquefoil, were identified at Skookumchuck Prairie in 1991 and persisted throughout the pastures in 2009. Although cinquefoil cover also was generally below 5% in both 1991 and 2009, statistically significant increases ($P < 0.10$) were observed in the Cattle Only and Wildlife Only areas over the study period (Table 7; Figure 5). Sulphur cinquefoil may require some attention in the future since this species is listed in the *Weed Control Act* as noxious and in the *Forest and Range Practices Act* as an invasive plant.

5.3.4 Shrubs

Trees and shrubs are an important part of plant communities on all sites in the Skookumchuck Three-way Exclosure. Combined tree and shrub cover varied from about 10 to 18% in 1991 to 15 to 23% in 2009. Except for the Wildlife Only Area where cover increased from about 11 to 21%, tree and shrub cover remained relatively constant in all treatment areas over the study period (Appendix 6; Appendix 8).

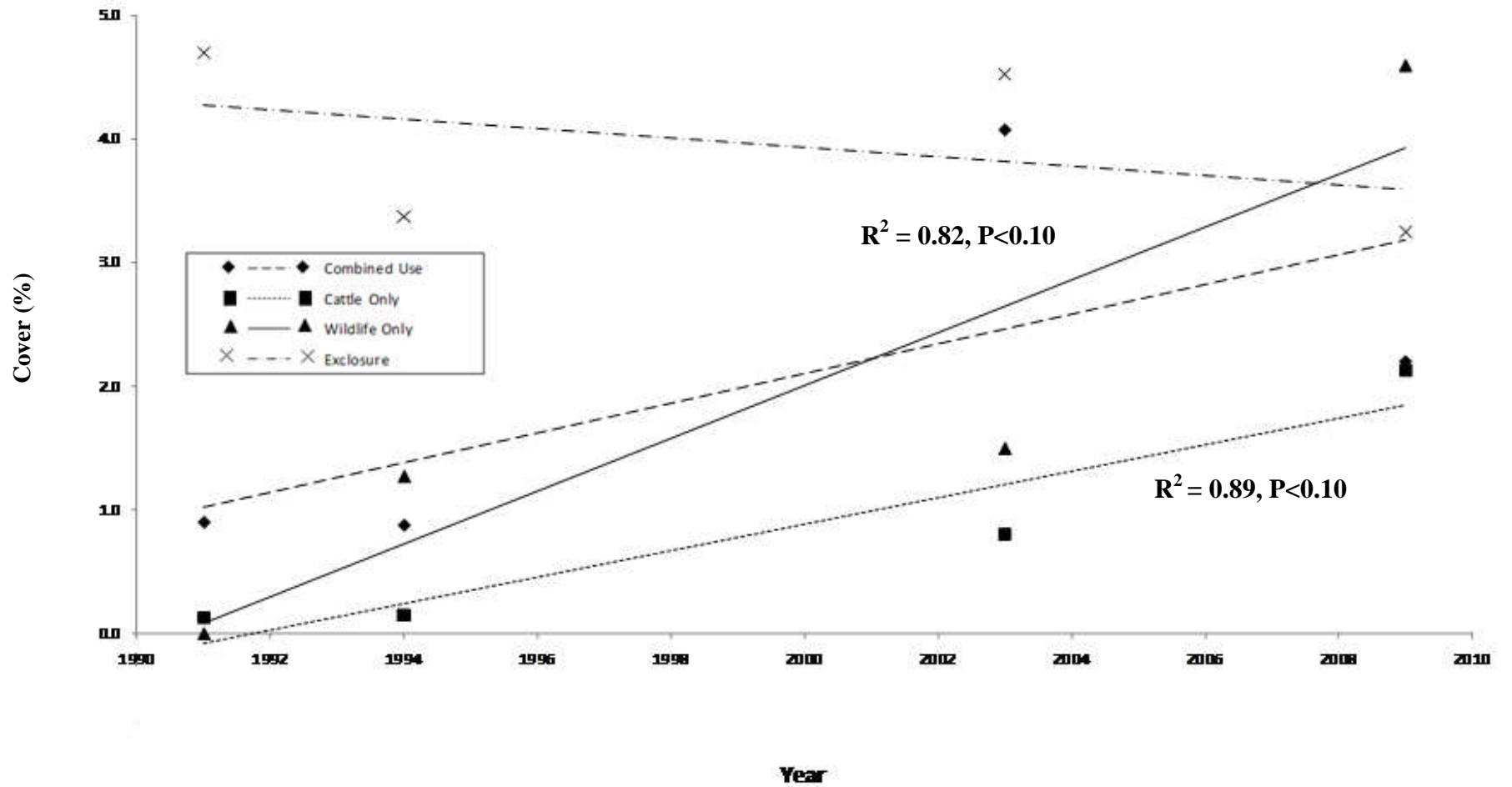


Figure 5. Trend in cover of cinquefoils by grazing treatment at Skookumchuck Three-way Exclosure 1991-2009.

Saskatoon - Diet studies at Skookumchuck Prairie from 1991 to 1993 revealed that Saskatoon provided important browse for deer, elk and cattle (Ross 1997). Saskatoon cover rarely exceeded 2% among grazing treatments and between 1991 and 2009 (Table 7). Despite its low cover, Saskatoon declined marginally ($P < 0.10$) between 1991 and 2009 in the Cattle Only and Combined Use areas (Table 9; Figure 6).

Bitterbrush- Although bitterbrush dominated shrub cover at all Skookumchuck Prairie sites (Table 7), and was eaten by cattle, deer and elk at various times of the year (Ross 1997), no significant trends in bitterbrush cover were established between 1991 and 2009 in any of the treatment areas (Figure 7). Nonetheless, bitterbrush cover nearly doubled at the Wildlife Only Area ($P < 0.05$) between 1991 and 2009 but there were no significant differences on other sites (Table 7).

Other Shrubs - Bearberry cover was higher at the Cattle Only Area between 1991 and 2009, where it increased from 4 to 6% (Table 7). Cover for Other Shrubs as a group also declined significantly between 1991 and 2009 on all sites except the Wildlife Only Area, although changes in cover were small (Table 7).

5.3.5 Other Species

Richardson's needlegrass was found on all sites at Skookumchuck Three-way Exclosure and increased on all sites except the Cattle Only Area between 1991 and 2009 (Table 7). Generally, changes were modest with cover never exceeding 5% except on the Combined Use Area, where it advanced from less than 2% to over 10% ($P < 0.05$) between 1991 and 2009 (Table 7). Other minor changes ($P < 0.05$) in cover were also found for Kentucky bluegrass and Sandberg's bluegrass (Table 7).

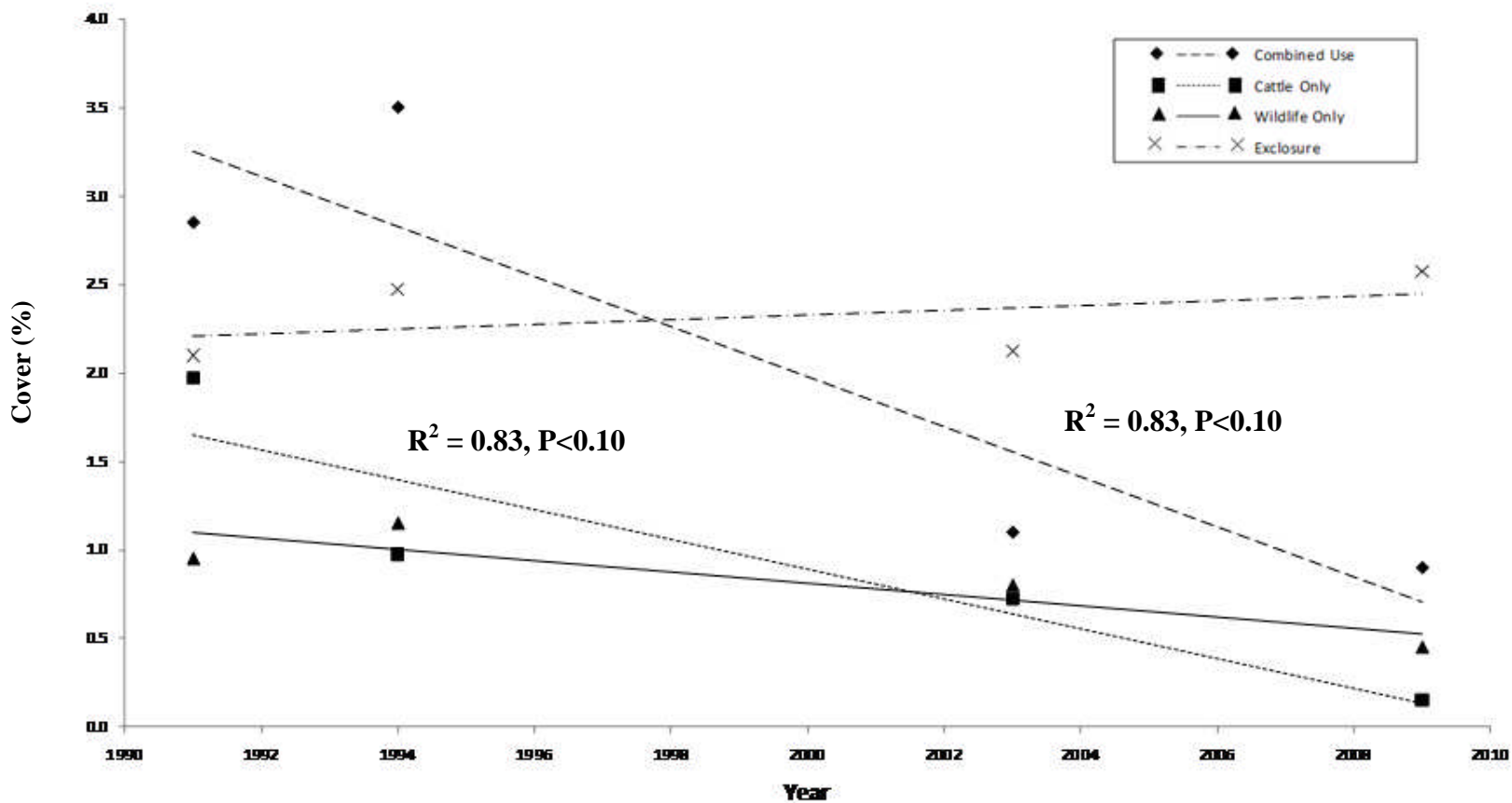


Figure 6. Trend in cover of Saskatoon by grazing treatment at Skookumchuck Three-way Exclosure 1991-2009.

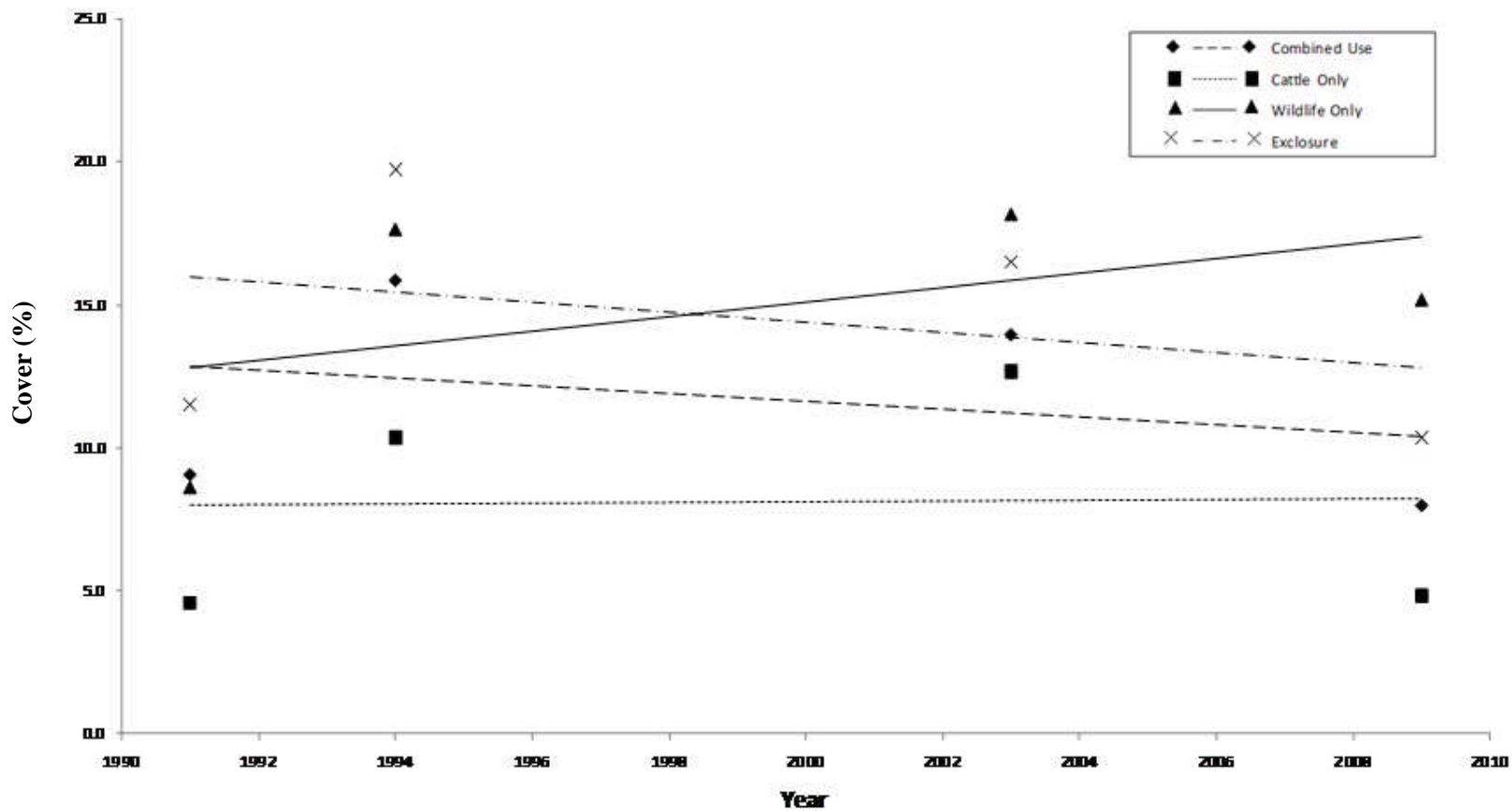


Figure 7. Trend in cover of bitterbrush by grazing treatment at Skookumchuck Three-way Exclosure 1991-2009.

5.3.6 Soil Substrates

Statistically significant differences in cover were found for Litter, Rock, Soil, and Bryophytes, (Table 7) although consistent trends were more difficult to establish (Figure 8, Figure 9, Figure 10). Although Litter cover increased between 1991 and 2009 in the Ungulate Exclosure ($P < 0.05$), Cattle Only Area ($P < 0.05$) and Wildlife Only Area ($P < 0.10$), a significant linear trend was only detected in the Cattle Only Area (Figure 8). After 18 years, Litter cover was highest in the Ungulate Exclosure compared to the other three sites (Table 9).

Both Rock and Soil cover were generally lower on all sites in 2009 compared to 1991 (Table 7). Significant declines ($P < 0.10$) in Rock cover were established in the Ungulate Exclosure and Wildlife Only Area but not on the other two sites (Table 8; Figure 9). Similarly, a significant decline in Soil cover ($P < 0.05$) was only detected on the Combined Use Area (Figure 10). Bryophytes cover did not change between 1991 and 2009 on all sites except the Cattle Only Area where they declined ($P < 0.10$) by nearly 43% (Table 7). Bryophyte cover was highest ($P < 0.05$) at the Wildlife Only Area compared to the other three sites (Table 9). There were no differences among the other sites.

Although the role of litter, bare soil and bryophytes has long been regarded as important for temperature and water relations on rangeland, few studies have been conducted that demonstrate their ecological importance. Dyksterhuis and Schmutz (1947) predicted that litter in particular was important for rainfall interception, prevention of soil erosion and for ameliorating soil temperatures. Similarly, bryophytes contribute to nitrogen fixation, soil stability, water infiltration and they provide nutrients for plants (Anderson et al. 1982).

5.4 Premier Ridge

Grazed Area 1991-2009 - Total Grass cover in 1991 was approximately 30% and by 2009 it had increased to nearly 46% (Appendix 9). Although nine grass species were found on the site in 1991, only three species provided most of the canopy cover. Rough fescue and Idaho fescue did

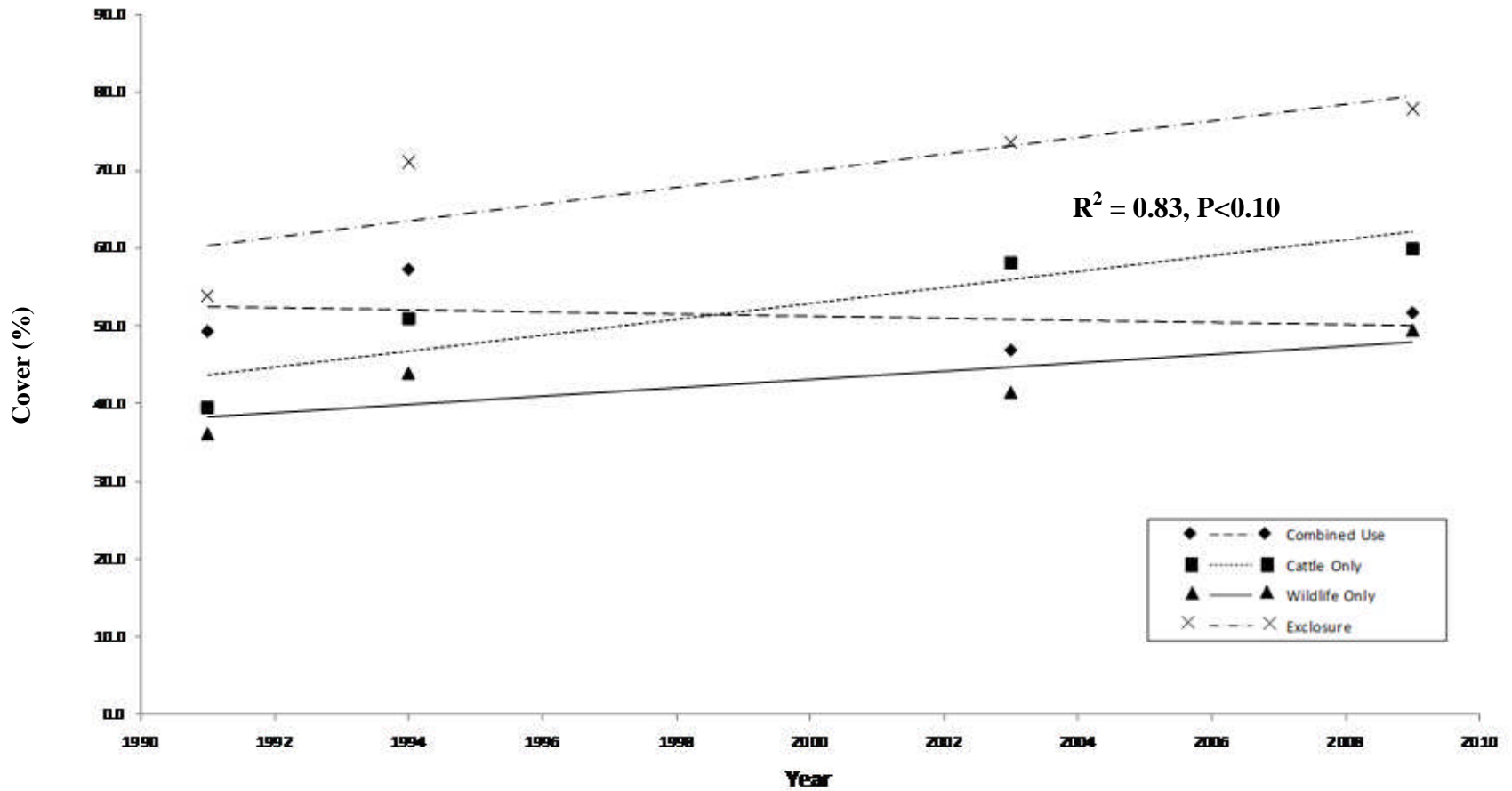


Figure 8. Trend in cover of litter by grazing treatment at Skookumchuck Three-way Exclosure 1991-2009.

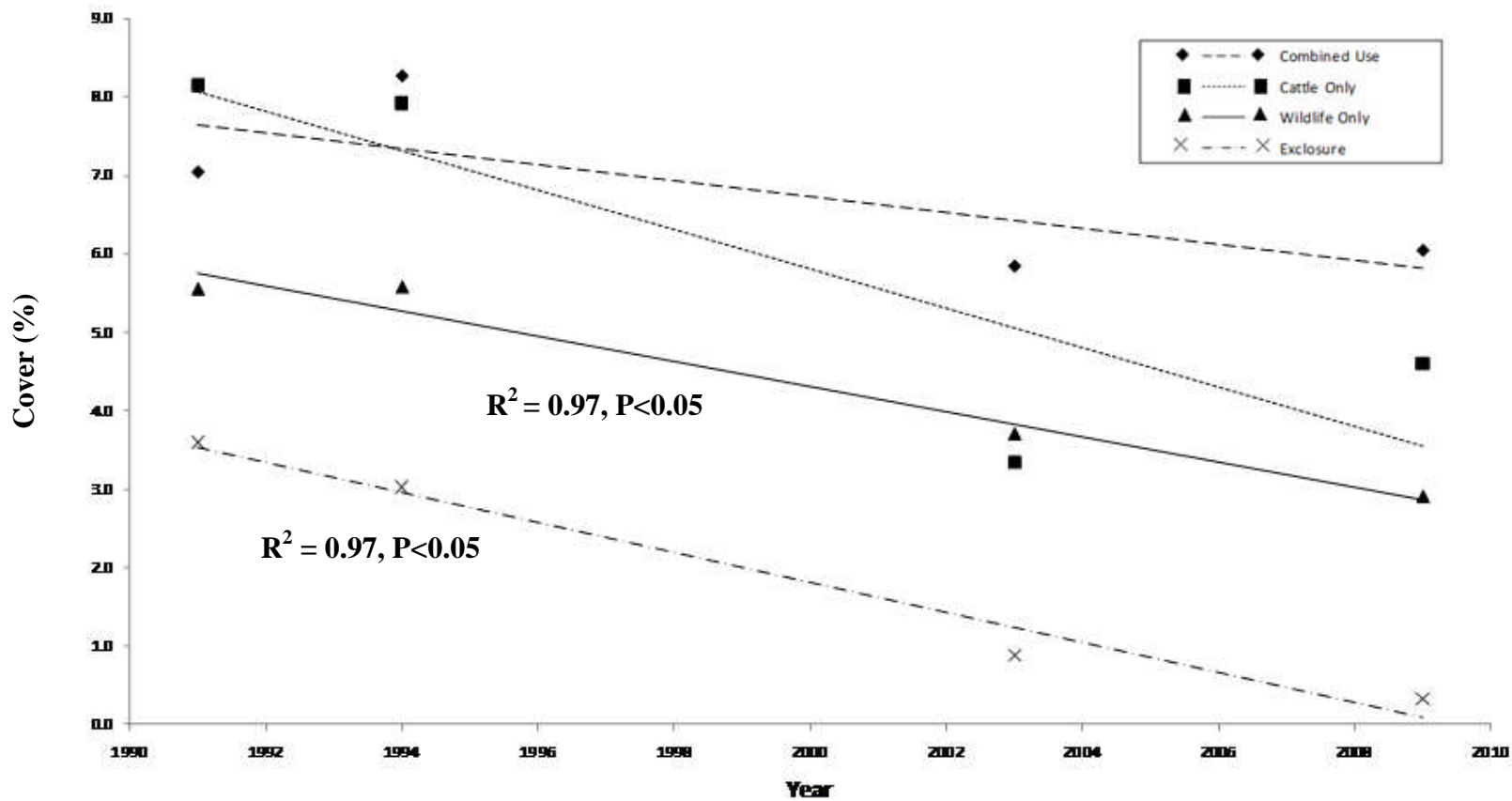


Figure 9. Trend in cover of rock by grazing treatment at Skookumchuck Three-way Exclosure 1991-2009.

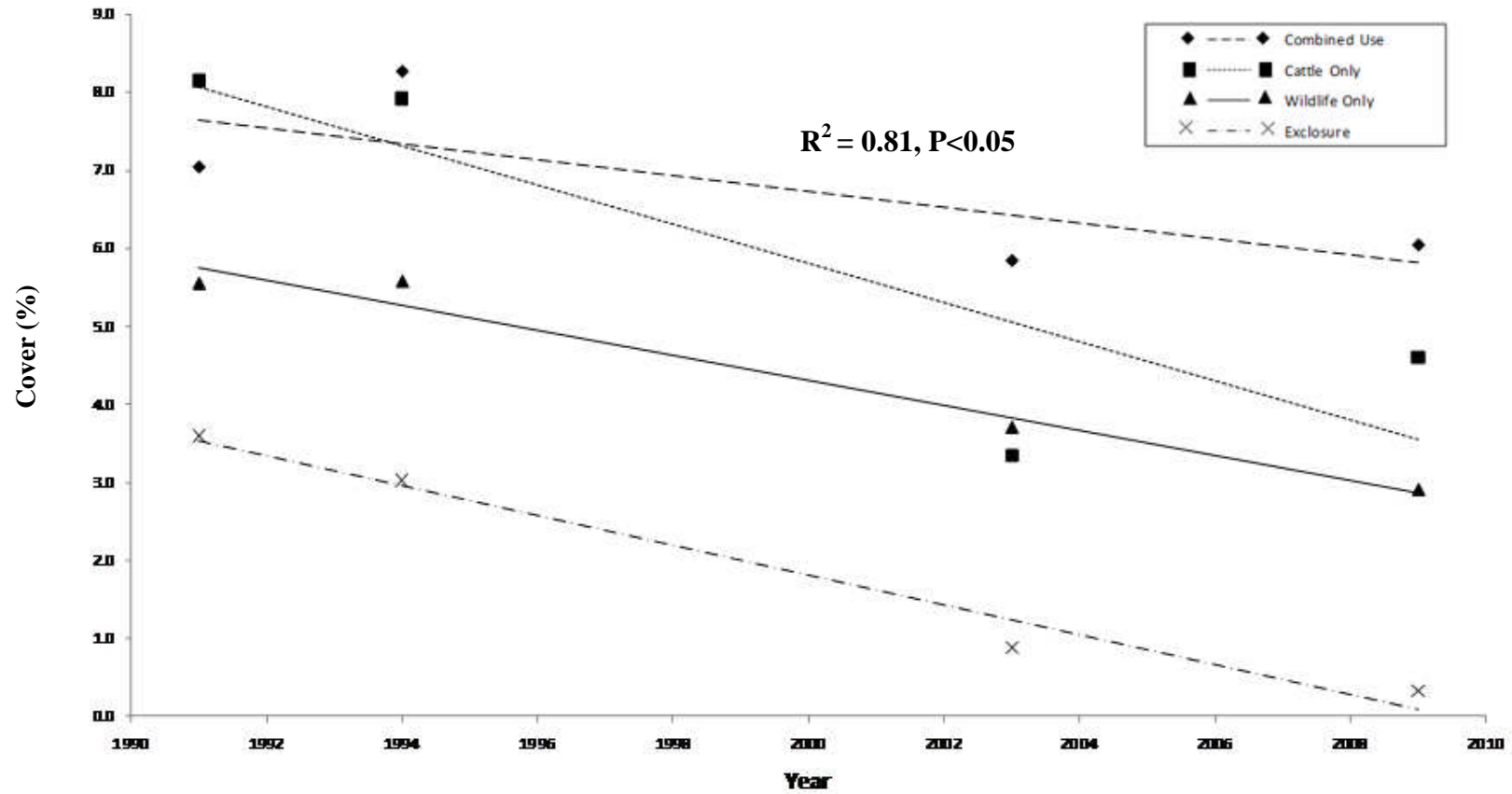


Figure 10. Trend in cover of soil by grazing treatment at Skookumchuck Three-way Exclosure 1991-2009.

not occur on transects in either year, and only a few scattered Idaho fescue plants were found on the site in 2009 (Wikeem and Ross, pers. observ. 2009).

Kentucky bluegrass dominated the grazed area in both years and virtually doubled in cover ($P < 0.05$) between 1991 and 2009 (Table 10). Western needlegrass was the sub-dominant species in 1991 providing nearly 8% cover but it declined ($P < 0.05$) to less than 4% cover in 2009 yielding to bluebunch wheatgrass (Table 10).

Collectively, 23 forbs were identified at Premier Ridge in 1991 but only 16 species were encountered in 2009. Forb cover ranged from about 8% in 1991 to over 12% in 2009 but only a few forb species, such as spreading dogbane, common mullein, hairy golden-aster, stoneseed, and western yarrow contributed more than 1% cover at any time (Appendix 9).

Tree and shrub cover remained relatively constant between 1991 and 2009 at about 30%. Bitterbrush was the dominant shrub in both years producing about 20% canopy cover in both the Grazed Area and the Exclosure (Appendix 9). Of the seven shrubs that were found on the Grazed Area, Saskatoon and snowberry were the only other species that provided more than 5% cover in either year.

Exclosure 1991-2009 - Total grass cover inside the Exclosure approached 35% in 1991 and increased to nearly 40% in 2009. Similar to the Grazed Area, Kentucky bluegrass dominated the site in both years but cover was constant at about 15% between 1991 and 2009. Kentucky bluegrass cover inside the Exclosure, however, was less than half of that in the Grazed Area in 2009 (Appendix 9).

Unlike in the Grazed Area, western needlegrass and Columbia needlegrass increased inside the Exclosure and collectively contributed about 10% to grass cover in 1991 and over 20% in 2009 (Table 10). By comparison, Canada bluegrass cover declined ($P < 0.05$) from slightly more than 3% and was absent on the site in 2009 (Table 10). Bluebunch

Table 10. Cover of key species and substrates at Premier Ridge 1991 to 2009.

| Species | Grazed | | | | | Exclosure | | | | |
|------------------------|----------------|------|------|------|-------|----------------|------|------|------|-------|
| | 1991 | ± SE | 2009 | ± SE | Prob. | 1991 | ± SE | 2009 | ± SE | Prob. |
| | ------(%)----- | | | | | ------(%)----- | | | | |
| Bluebunch wheatgrass | 0.9 | 0.43 | 3.6 | 1.80 | | 0.0 | 0.00 | 0.0 | 0.00 | |
| Canada bluegrass | 2.0 | 0.69 | 1.9 | 1.08 | | 3.1 | 0.76 | 0.0 | 0.00 | ** |
| Cheatgrass | 0.9 | 0.75 | 0.3 | 0.11 | | 0.0 | 0.00 | 0.0 | 0.00 | |
| Columbia needlegrass | 0.0 | 0.00 | 1.5 | 0.58 | ** | 0.1 | 0.07 | 5.2 | 1.42 | ** |
| Idaho fescue | 0.0 | 0.00 | 0.0 | 0.00 | | 0.0 | 0.00 | 0.0 | 0.00 | |
| Kentucky bluegrass | 15.9 | 1.98 | 32.3 | 3.48 | ** | 17.2 | 1.94 | 15.1 | 2.44 | |
| Prairie Junegrass | 1.6 | 0.58 | 3.4 | 0.89 | | 2.1 | 0.69 | 2.1 | 0.69 | |
| Rough fescue | 0.0 | 0.00 | 0.0 | 0.00 | | 0.0 | 0.00 | 0.0 | 0.00 | |
| Western needlegrass | 7.7 | 1.23 | 3.0 | 0.81 | ** | 9.8 | 1.49 | 15.1 | 2.09 | * |
| Forbs | | | | | | | | | | |
| Goatsbeard | 0.4 | 0.12 | 1.7 | 0.64 | ** | 0.2 | 0.08 | 0.4 | 0.31 | |
| Hairy goldaster | 0.4 | 0.31 | 1.5 | 0.64 | | 0.8 | 0.42 | 0.0 | 0.00 | |
| Spreading dogbane | 2.0 | 0.57 | 3.5 | 1.08 | | 1.6 | 0.43 | 1.9 | 1.08 | |
| Stoneseed | 0.8 | 0.80 | 1.7 | 1.28 | | 0.4 | 0.31 | 2.0 | 0.93 | * |
| Western yarrow | 0.5 | 0.31 | 1.3 | 0.58 | | 0.4 | 0.31 | 1.6 | 0.64 | * |
| Shrubs | | | | | | | | | | |
| Bitterbrush | 22.2 | 2.22 | 19.0 | 3.67 | | 22.1 | 2.39 | 3.9 | 1.53 | ** |
| Saskatoon | 4.9 | 0.83 | 0.9 | 0.51 | ** | 4.0 | 0.98 | 5.6 | 1.40 | |
| Soil Substrates | | | | | | | | | | |
| Bryophytes | 20.4 | 2.60 | 5.0 | 1.43 | ** | 14.2 | 1.64 | 15.1 | 3.08 | |
| Litter | 42.0 | 4.43 | 56.7 | 5.38 | ** | 37.8 | 4.48 | 46.9 | 4.10 | |
| Rock | 2.5 | 0.68 | 3.5 | 0.83 | | 2.0 | 0.64 | 1.7 | 0.58 | |
| Soil | 12.6 | 2.28 | 9.7 | 2.06 | | 23.0 | 2.75 | 25.4 | 4.04 | |

Asterisks indicate significance at * P < 0.10; ** P < 0.05.

wheatgrass, Idaho fescue, rough fescue, and prairie Junegrass were not recorded in the Exclosure in 2009.

A total of 25 forbs were found inside the Exclosure during the study but the number declined from 20 in 1991 to 13 in 2009. Forb cover was relatively constant between years at 12% despite the fewer species present in 2009 (Appendix 9). Except for common mullein, spreading dogbane, western yarrow, and yellow salsify, few forb species contributed more than 1% cover between 1991 and 2009 (Table 10; Appendix 9).

Similar to the Grazed Area, bitterbrush and Saskatoon were the dominant shrubs inside the Exclosure. Bitterbrush declined ($P < 0.05$) from over 22% cover in 1991 to less than 4% in 2009, whereas Saskatoon cover was relatively unchanged (Table 10). Snowberry provided most of the cover for the remaining four shrub species in the Exclosure.

Substrate cover was not significantly different between years except for litter, which increased in the Grazed Area from 42% in 1991 to nearly 57% in 2009 (Table 10).

5.5 Pickering Hills

Grazed Area 1991-2009 - Unlike Premier Ridge, total vascular plant cover at Pickering Hills decreased in 2009 compared to 1991 but most of the changes were minor (Table 11). Bluebunch wheatgrass, which was not found on the area in 1991, increased marginally to 2% cover, while cheatgrass, Idaho fescue and Columbia needlegrass all declined by less than 4% (Table 11).

Forbs contributed more species to plant community composition at Pickering Hills in 1991 (24) than in 2009 (15) (Appendix 10). Forb cover varied from about 19 to 23%, over 18 years with fairy candelabra, spreading dogbane and chickweed the most prevalent species in the Grazed Area (Appendix 8). Cinquefoil species and spreading dogbane cover was significantly ($P < 0.05$) higher in 2009 compared to 1991 but chickweed declined (Table 11). Sulphur cinquefoil, diffuse knapweed and spotted

Table 11. Cover of key species and substrates at Pickering Hills 1991 to 2009.

| Species | 1991 | ± SE | 2009 | ± SE | Prob | | 1991 | ± SE | 2009 | ± SE | Prob |
|------------------------|----------------|------|------|------|------|--|----------------|------|------|------|------|
| | ------(%)----- | | | | | | ------(%)----- | | | | |
| | Grazed Area | | | | | | Exclosure | | | | |
| Grasses | | | | | | | | | | | |
| Bluebunch wheatgrass | 0.0 | 0.00 | 2.0 | 0.93 | ** | | 0.0 | 0.00 | 0.1 | 0.00 | ** |
| Canada bluegrass | 1.7 | 0.60 | 6.4 | 2.89 | | | 1.3 | 0.51 | 0.0 | 0.00 | ** |
| Cheatgrass | 2.1 | 0.69 | 0.0 | 0.00 | ** | | 1.1 | 0.43 | 0.0 | 0.00 | ** |
| Columbia needlegrass | 4.7 | 1.08 | 0.5 | 0.31 | ** | | 0.0 | 0.00 | 3.8 | 1.06 | ** |
| Idaho fescue | 0.0 | 0.00 | 0.1 | 0.05 | ** | | 0.0 | 0.00 | 0.0 | 0.00 | |
| Kentucky bluegrass | 23.8 | 2.50 | 19.7 | 3.56 | | | 16.0 | 1.94 | 8.4 | 3.03 | ** |
| Prairie Junegrass | 1.9 | 0.70 | 1.3 | 0.80 | | | 0.8 | 0.42 | 0.1 | 0.10 | |
| Rough fescue | 0.0 | 0.00 | 0.0 | 0.00 | | | 0.0 | 0.00 | 2.0 | 1.95 | |
| Western needlegrass | 7.5 | 1.44 | 7.0 | 2.32 | | | 14.9 | 1.91 | 4.9 | 1.92 | ** |
| Forbs | | | | | | | | | | | |
| Chickweed | 3.3 | 1.01 | 0.0 | 0.00 | ** | | 10.2 | 1.36 | 0.1 | 0.10 | ** |
| Cinquefoil species | 1.4 | 0.85 | 6.5 | 1.40 | ** | | 0.6 | 0.42 | 0.1 | 0.10 | |
| Spreading dogbane | 2.2 | 0.49 | 8.3 | 1.45 | ** | | 1.2 | 0.51 | 4.6 | 1.69 | ** |
| Western yarrow | 0.4 | 0.12 | 0.6 | 0.42 | | | 0.5 | 0.14 | 0.2 | 0.10 | |
| Shrubs | | | | | | | | | | | |
| Bitterbrush | 20.9 | 2.51 | 11.6 | 3.26 | ** | | 12.4 | 2.45 | 12.3 | 3.04 | |
| Saskatoon | 7.4 | 2.33 | 4.3 | 1.77 | | | 6.5 | 2.39 | 8.2 | 3.15 | |
| Soil Substrates | | | | | | | | | | | |
| Bryophytes | 21.2 | 1.95 | 5.0 | 1.26 | ** | | 11.7 | 2.22 | 0.6 | 0.42 | ** |
| Litter | 35.9 | 3.42 | 78.6 | 3.34 | ** | | 23.4 | 3.41 | 94.6 | 1.94 | ** |
| Rock | 0.9 | 0.43 | 0.7 | 0.42 | | | 2.4 | 0.68 | 0.4 | 0.30 | ** |
| Soil | 4.0 | 1.02 | 5.6 | 1.80 | | | 11.2 | 2.04 | 0.4 | 0.30 | ** |

Asterisks indicate significance at ** P<0.05.

knapweed were all found in the Grazed Area but none were recorded on transects (Wikeem and Ross, pers. observ. 2009).

Shrub cover increased slightly in the Grazed Area from about 19 to 23% between 1991 and 2009. Bitterbrush was the dominant shrub comprising over 20% cover in 1991, which declined ($P < 0.05$) to less than 12% by 2009 (Table 11). Saskatoon, low Oregongrape, buckbrush, snowberry, and rose were all present on the site but Saskatoon and snowberry were the only species that produced more than 5% cover between 1991 and 2009 (Appendix 10).

Soil substrates varied considerably between 1991 and 2009. Bryophytes declined ($P < 0.05$) from over 20 to 5% cover during the period, whereas Litter cover more than doubled ($P < 0.05$).

Exclosure 1991-2009 - Kentucky bluegrass and western needlegrass were the dominant grasses inside the Exclosure with a combined cover of about 30% in 1991 (Appendix 10). Canada bluegrass, cheatgrass and prairie Junegrass were also present in 1991 as minor species, while bluebunch wheatgrass, Idaho fescue and rough fescue were not present on the site.

By 2009, both Kentucky bluegrass and western needlegrass cover had declined ($P < 0.05$) by more than 50%, whereas bluebunch wheatgrass, rough fescue and Columbia needlegrass were found established on the site as minor species (Table 11).

Overall, forb cover declined from nearly 20% in 1991 to slightly over 10% in 2009, with chickweed itself accounting for most of the change (Table 11). In contrast, spreading dogbane cover nearly doubled ($P < 0.05$) during the period to nearly 5% (Table 11). Other native species, such as balsamroot, field locoweed, Mariposa lily, stoneseed and western yarrow varied annually with minor changes in cover. Cover of none-native species including fairy candelabra, dandelion, bird's foot trefoil, yellow salsify, and black medic also fluctuated in the same manner.

Shrub cover in the Exclosure doubled from about 27 to 54% between 1991 and 2009 (Appendix 10). Bitterbrush was again the dominant shrub but cover remained constant at about 12% between 1991 and 2009 (Table 11). Saskatoon, low Oregon grape, buckbrush, snowberry, and rose were also found inside the Exclosure but only Saskatoon and snowberry yielded substantive cover greater than 10% (Appendix 10).

Cover of Bryophytes, Rock, and Bare Soil all declined significantly ($P < 0.05$) between 1991 and 2009 (Table 11). Bryophyte and Bare Soil cover both declined from just over 11% in 1991 to less than 1% in 2009. In contrast, Litter cover increased ($P < 0.05$) from less than 25 to nearly 95% (Table 11) during the same period.

6.0 Range Condition and Trend

6.1 Skookumchuck Historical Site Old Exclosure

We used the Ponderosa Pine Site as our best approximation to evaluate range condition of the sites at Skookumchuck Prairie. Accordingly, we initially assumed that rough fescue, Idaho fescue, bluebunch wheatgrass, and needle-and-thread were all Decreaser species (McLean and Marchand 1968).

The results of this study, however, indicate that the response of bluebunch wheatgrass and needle-and-thread to grazing protection was not consistent with the definition of a Decreaser species as they proposed. Namely, Decreasers are “species that decrease under prolonged, excessive grazing [and] usually they are perennials that ...dominate the climax community.” Under grazing protection, cover of both species should increase and eventually they will be dominant members of late-seral and climax communities. In the absence of grazing for 60 years, bluebunch wheatgrass and needle-and-thread initially increased in cover and then declined (Table 12).

Conversely, rough fescue and Idaho fescue increased relatively consistently during the same time interval, and after 1970, their cover jointly dominated the plant community inside the Exclosure until 2009 (Table 12). The increasing prominence of Idaho fescue in

Table 12. Range condition and trend at the Skookumchuck Historical Old Exclosure 1960 to 2009.

Grazed

| Species | 1960 | 1970 | 1982 | 1991 | 1994 | 2009 |
|------------------------------|-------------|--------------|-------------|-------------|-------------|-------------|
| | -----%----- | | | | | |
| Increasesers | | | | | | |
| Bluebunch wheatgrass | 6.8 | 13.0 | 14.0 | 7.6 | 6.4 | 0.0 |
| Needle-and-thread | 4.2 | 34.0 | 47.0 | 13.9 | 25.8 | 18.3 |
| Decreasers | | | | | | |
| Idaho fescue | 0.0 | 0.0 | 0.0 | 0.5 | 0.1 | 0.0 |
| Rough fescue | 0.0 | 0.0 | 0.0 | 0.9 | 1.0 | 0.0 |
| Total Decreaser Cover | 0.0 | 0.0 | 0.0 | 1.4 | 1.1 | 0.0 |
| % of Total | 0 | 0 | 0 | 4 | 1 | 0 |
| Range Condition | Poor | Poor | Poor | Poor | Poor | Poor |
| Grass Cover | 53.8 | 77.0 | 66.0 | 24.4 | 48.3 | 20.8 |
| Forb Cover | 34.7 | 27.0 | 16.0 | 12.4 | 30.3 | 22.2 |
| Total Cover | 88.5 | 104.0 | 82.0 | 36.8 | 78.6 | 43.0 |

Old Exclosure

| Species | 1960 | 1970 | 1982 | 1991 | 1994 | 2009 |
|------------------------------|--------------|--------------|--------------|-------------|--------------|-------------|
| | -----%----- | | | | | |
| Increasesers | | | | | | |
| Bluebunch wheatgrass | 24.7 | 55.0 | 12.7 | 5.4 | 8.1 | 2.2 |
| Needle-and-thread | 16.7 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Decreasers | | | | | | |
| Idaho fescue | 0.0 | 0.0 | 1.0 | 7.9 | 25.0 | 18.5 |
| Rough fescue | 6.0 | 20.0 | 58.8 | 23.8 | 32.3 | 23.5 |
| Total Decreaser Cover | 6.0 | 20.0 | 59.8 | 31.7 | 57.3 | 42.0 |
| % of Total | 6 | 19 | 58 | 65 | 56 | 75 |
| Range Condition | Poor | Poor | Good | Good | Good | Good |
| Grass Cover | 88.3 | 90.0 | 76.8 | 38.4 | 70.2 | 44.2 |
| Forb Cover | 13.3 | 18.0 | 27.2 | 10.4 | 31.9 | 11.8 |
| Total Cover | 101.6 | 108.0 | 104.0 | 48.8 | 102.1 | 56.0 |

the community until 1994 led us to previously speculate that this species could ultimately replace rough fescue as the dominant plant (Ross and Wikeem 2002). This did not happen by 2009 but the combined cover of rough fescue and Idaho fescue compared to total grass cover increased from 38 to 42% of canopy cover between 1994 and 2009. The following discussion of range condition for Skookumchuck Prairie, Premier Ridge and Pickering Hills assumes that rough fescue and Idaho fescue are the Decreaser species, and that bluebunch wheatgrass and needle-and-thread are Increasers except on dry sites with coarse textured soils.

Old Exclosure - The original range condition at the Skookumchuck Old Exclosure site only can be inferred from the plant list that was compiled when the Exclosure was constructed. In 1951, Sandberg's bluegrass and low pussytoes were the dominant species on the site in association with prairie Junegrass and needle-and-thread. Bluebunch wheatgrass, Idaho fescue and rough fescue were not listed. Dominance by these plants would place the site in Poor range condition.

Between 1960 and 1970 range condition was assessed as Poor inside the Exclosure. Idaho fescue was not present on the site. Although rough fescue cover nearly tripled inside the Exclosure during this period, total Decreaser cover only equaled 20% (Table 12).

Idaho fescue emerged on the site in 1982 but produced only 1% canopy cover, whereas rough fescue cover had advanced to nearly 59%. Total Decreaser cover was sufficient in 1982 to upgrade the range condition classification to Good and the site was progressing on an upward trend (Table 12).

Between 1991 and 2009 rough fescue cover declined from its peak in 1982 and then fluctuated between 20 and 35% cover. Idaho fescue, however, continued to increase in cover until 1994 and then declined slightly in 2009. Despite these fluctuations, rough fescue and Idaho fescue provided approximately equal contributions to total Decreaser

cover in 1994 and 2009 and range condition status remained Good. This community appears to have reached a steady state (Table 12).

Grazed Area - Although bluebunch wheatgrass and needle-and-thread have had a persistent presence and cover on the Grazed area, both species are regarded as Increasers on the site. The combined cover of these species peaked in 1982 (61%) but has decreased with some fluctuations since. In 2009, their collective cover equaled only slightly more than 18% compared to 11% in 1960 (Table 12). All of this cover was provided by needle-and-thread as bluebunch wheatgrass was absent on the site in 2009.

The Decreasers rough fescue and Idaho fescue had only a brief presence on the site in 1991 and 1994, when their combined cover was about 1%. In 2009, neither species was found on the site. Overall, range condition has remained Poor on the site for nearly 60 years with no sign of improvement (Table 12).

6.2 Skookumchuck Historical Site New Exclosure

The New Exclosure was constructed in 1991. At that time the site was dominated by bluebunch wheatgrass and needle-and-thread with a combined cover exceeding 35% (Appendix 5). Rough fescue and Idaho fescue also occurred on the site as subordinates, collectively accounting for less than 3% cover.

After 18 years of protection, total grass cover had changed only marginally but bluebunch wheatgrass and needle-and-thread both declined significantly with their combined cover totaling 19.3% (Table 5). Although rough fescue cover increased to more than 8% between 1991 and 2009, Idaho fescue cover did not change significantly (Table 13). The New Exclosure appears to be following the same trend as in the Old Exclosure where bluebunch wheatgrass and needle-and-thread are being replaced by Idaho fescue and rough fescue. However, Decreaser cover has not increased sufficiently between 1991 and 2009 to reclassify the site from the Poor range condition class.

Table 13. Range condition and trend at the Skookumchuck Historical New Exclosure 1991 to 2009.

| Species | 1991 | 1994 | 2009 |
|------------------------------|-------------|-------------|-------------|
| Idaho fescue | 1.6 | 0.3 | 0.6 |
| Rough fescue | 1.0 | 3.8 | 8.3 |
| Total Decreaser Cover | 2.6 | 4.1 | 8.9 |
| % of Total | 5 | 4 | 16 |
| Range Condition | Poor | Poor | Poor |
| Grass Cover | 43.0 | 70.0 | 37.5 |
| Forb Cover | 6.3 | 27.2 | 16.6 |
| Total Cover | 49.3 | 97.2 | 54.1 |

6.3 Skookumchuck Prairie Three-way Exclosure

Cover of numerous individual species has changed considerably on all four sites at Skookumchuck Prairie between 1991 and 2009 (Table 5; Table 6; Table 7; Table 8), which has subsequently altered range condition and trend on some sites.

The most noteworthy change has occurred in the Ungulate Exclosure, where range condition has advanced from Poor in 1991 to Fair by 2003, and the site has remained in Fair condition since (Table 14). Decreaser species made up only 3% of the total grass and forb cover in 1991, whereas they increased to 50% in both 2003 and 2009.

Most of the improvement in range condition resulted from an increase in rough fescue cover from less than 1% in 1991 to more than 22% in 2009 (Table 14). Similar, but less dramatic, increases in Idaho fescue cover also contributed to the improved range condition rating on the site (Table 14). Although it only comprised about 6% in 2009, it had increased from less than 1% in 1991. In general, the trend in range condition appears to be improving on this site.

Table 14. Range condition and trend at Skookumchuck Prairie Three-way Exclosure 1991 to 2009.

| Species | Combined Use | Cattle Only | Wildlife Only | Exclosure |
|------------------------------|--------------|-------------|---------------|-------------|
| 1991 | -----%----- | | | |
| Idaho fescue | 3.8 | 4.1 | 7.2 | 0.8 |
| Rough fescue | 2.7 | 1.8 | 1.1 | 0.6 |
| Total Decreaser Cover | 6.5 | 5.9 | 8.3 | 1.4 |
| % of Total | 14 | 15 | 20 | 3 |
| Range Condition | Poor | Poor | Poor | Poor |
| Grass Cover | 30.7 | 29.3 | 28.3 | 26.2 |
| Forb Cover | 14.7 | 9.1 | 12.3 | 16.8 |
| Total Cover | 45.4 | 38.4 | 40.6 | 43.0 |

1994

| | | | | |
|------------------------------|-------------|-------------|-------------|-------------|
| Idaho fescue | 5.9 | 8.1 | 18.8 | 3.3 |
| Rough fescue | 5.3 | 7.2 | 1.5 | 4.8 |
| Total Decreaser Cover | 11.2 | 15.3 | 20.3 | 8.1 |
| % of Total | 15 | 21 | 29 | 10 |
| Range Condition | Poor | Poor | Fair | Poor |
| Grass Cover | 51.9 | 51.9 | 49.0 | 59.2 |
| Forb Cover | 20.4 | 22.0 | 21.0 | 19.5 |
| Total Cover | 72.3 | 73.9 | 70.0 | 78.7 |

2003

| | | | | |
|------------------------------|-------------|-------------|-------------|-------------|
| Idaho fescue | 1.7 | 11.4 | 12.8 | 5.5 |
| Rough fescue | 2.3 | 11.8 | 1.3 | 17.6 |
| Total Decreaser Cover | 4.0 | 23.2 | 14.1 | 23.1 |
| % of Total | 11 | 47 | 31 | 50 |
| Range Condition | Poor | Fair | Fair | Fair |
| Grass Cover | 21.8 | 37.2 | 31.5 | 37.5 |
| Forb Cover | 14.6 | 12.1 | 14.3 | 8.3 |
| Total Cover | 36.4 | 49.3 | 45.8 | 45.8 |

2009

| | | | | |
|------------------------------|-------------|-------------|-------------|-------------|
| Idaho fescue | 2.6 | 5.5 | 7.2 | 5.6 |
| Rough fescue | 1.6 | 13.8 | 1.6 | 22.7 |
| Total Decreaser Cover | 4.2 | 19.3 | 8.8 | 28.3 |
| % of Total | 10 | 42 | 25 | 50 |
| Range Condition | Poor | Fair | Poor | Fair |
| Grass Cover | 27.7 | 32.3 | 23.0 | 50.7 |
| Forb Cover | 15.5 | 14.2 | 12.1 | 6.0 |
| Total Cover | 43.2 | 46.5 | 35.1 | 56.7 |

Range condition on the Cattle Only Area improved from Poor to Fair between 1991 and 2009 mostly because of the increase in rough fescue (Table 14). Rough fescue cover has steadily increased on this site throughout the study period, in contrast to Idaho fescue, whose cover has been variable over time. Decreasers contributed only 15% to cover in 1991, whereas in 2003 and 2009 cover had increased to 47 and 42%, respectively (Table 14). Overall, range trend appears to be improving on this site.

Range condition in the Wildlife Only Area was Poor in 1991 and remained so in 2009. In 1991 and 2009 Decreasers comprised 20 and 25%, respectively, of total cover (Table 14). Range condition had improved to Fair during 1994 and remained so until 2003. Idaho fescue cover fluctuated among years, which has accounted for variations in range condition, but it was consistent between 1991 and 2009 and rough fescue cover was unchanged during that time period. Range trend at the Wildlife Only Area appears to be static.

Range condition in the Combined Use in 1991 was rated as Poor, and after 18 years of grazing, it continues to be. Although Decreasers have consistently comprised between 10 and 15% of the total cover between 1991 and 2009, the site has remained in Poor range condition over the past 18 years with no apparent upward trend.

6.4 Premier Ridge

Range condition at Premier Ridge was assessed as Poor in 1991. Over 18 years, only slight increases in total grass cover have occurred on both the Grazed Area and the Exclosure (Table 15). No Decreasers were recorded on either the Grazed Area or in the Exclosure in 1991.

Despite grass cover and total cover more than doubling between 1991 and 1994, range condition remained Poor in 1994. In 2009, neither rough fescue nor Idaho fescue had re-established on the site, which makes the prospects for recovery on the site unlikely in the short-term.

Table 15. Range condition and trend at Premier Ridge 1991 to 2009.

| Species | 1991 | | 1994 | | 2009 | |
|------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | Grazed | Exclosure | Grazed | Exclosure | Grazed | Exclosure |
| | -----%----- | | -----%----- | | -----%----- | |
| Idaho fescue | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rough fescue | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Decreaser Cover | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| % of Total | 0 | 0 | 0 | 0 | 0 | 0 |
| Range Condition | Poor | Poor | Poor | Poor | Poor | Poor |
| Grass Cover | 29.2 | 33.3 | 63.3 | 70.5 | 45.8 | 39.4 |
| Forb Cover | 7.8 | 11.8 | 15.3 | 11.8 | 12.5 | 12.6 |
| Total Cover | 37.0 | 45.1 | 78.6 | 82.3 | 58.3 | 52.0 |

Range condition inside the Exclosure also remained Poor after 18 years of protection from grazing (Table 15). Although no rough fescue or Idaho fescue were encountered on the transects, several vigorous rough fescue plants were found inside the Exclosure suggesting that ecological potential for recovery exists on the site (Wikeem and Ross, pers. observ. 2009). Stagnation inside the Exclosure may have resulted partly from prescribed fires that were conducted at Sheep Pasture in 2001 and 2008, which spread through the Exclosure as well. Litter accumulation on the site could have produced a hot fire that negatively affected plant community recovery inside the Exclosure.

6.5 Pickering Hills

Range condition on both the Grazed Area and the Exclosure at Pickering Hills was ranked as Poor in 1991 and remained Poor on both sites in 2009 (Table 16). Similar to Premier Ridge, this site appears to have some ecological capacity for improvement. Idaho fescue was encountered on transects in the Grazed Area in both 1994 and 2009, although cover in each year was less than 1% (Table 16). Other scattered plants were also found in the space between transects across the site (Wikeem and Ross, pers. observ. 2009).

Although no Idaho fescue was found inside the Exclosure between 1991 and 2009, rough fescue cover totaled 2% on transects inside the Exclosure in 2009 (Table 16). A few scattered plants, which were not recorded in plots, were also found adjacent to transects. The presence of both fescues on the site (Grazed and Exclosure) provides a nucleus for recovery that was not apparent in 1991 but an upward trend in range condition does not appear likely in the short-term.

7.0 Management Implications

7.1 Range Condition Assessment

Based on the results from this study, we believe that Idaho fescue and rough fescue are Decreaser species at Skookumchuck Prairie, Pickering Hills and Premier Ridge, and likely at similar sites in the Ponderosa Pine and Douglas-fir zones in the region.

Saskatoon should also be regarded as a Decreaser, especially in mixed ungulate systems

Table 16. Range condition and trend at Pickering Hills 1991 to 2009.

| Species | 1991 | | 1994 | | 2009 | |
|------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | Grazed | Exclosure | Grazed | Exclosure | Grazed | Exclosure |
| | -----%----- | | -----%----- | | -----%----- | |
| Idaho fescue | 0.0 | 0.0 | 0.3 | 0.0 | 0.1 | 0.0 |
| Rough fescue | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 |
| Total Decreaser Cover | 0.0 | 0.0 | 0.3 | 0.0 | 0.1 | 2.0 |
| % of Total | 0 | 0 | 0 | 0 | 0 | 5 |
| Range Condition | Poor | Poor | Poor | Poor | Poor | Poor |
| Grass Cover | 42.7 | 35.4 | 72.1 | 73.0 | 38.0 | 32.4 |
| Forb Cover | 18.6 | 19.3 | 16.1 | 12.9 | 22.9 | 10.1 |
| Total Cover | 61.3 | 54.7 | 88.2 | 85.9 | 60.9 | 42.5 |

where browse comprises a significant part of the forage. For most sites in the dry Douglas-fir and Ponderosa Pine zones, bluebunch wheatgrass, needle-and-thread and Richardson's needlegrass act as *Increasers*. Bitterbrush also appears to increase under mixed ungulate grazing in the East Kootenay, and should be considered an *Increaser* on these sites.

Common *Invaders* on these sites include cheatgrass, dandelion, mustard species, yellow salsify, and noxious weeds such as spotted knapweed, diffuse knapweed, hound's-tongue, sulphur cinquefoil, and Dalmatian toadflax. Black medic, chickweed, compound fleabane, field filago, and prickly lettuce are other non-native species that appear naturalized at Skookumchuck Prairie, Premier Ridge and Pickering Hills, and should also be considered *Invaders* on these sites.

The role of individual plant species as *Decreasers*, *Increasers* or *Invaders* becomes obscured as the demand for forage outweighs supply, especially in mixed ungulate systems. Individual animal species can no longer express preference for one plant species over another, and eventually all plant species are eaten. At some point along a physiological continuum, plants are defoliated beyond their capacity to recover and each species becomes a *Decreaser* (Pitt and Bawtree 1998).

Demand for forage appears to exceed supply in most of the grazed areas sampled in this investigation. Range condition at Pickering Hills, Premier Ridge, the Grazed Area at Skookumchuck Historical Site, and the Combined Use and Wildlife Only Areas at the Skookumchuck Three-way Exclosure all began in Poor range condition and have not advanced in range trend from 20 to 60 years later.

The Skookumchuck Historical Site (Old and New), and the Ungulate Exclosure and Cattle Only Area at the Three-way Exclosure site, are exceptions to this observation. In all these cases, where ungulate grazing pressure has been eliminated or modified, range condition has trended upward. The greatest advancements have been made inside

exclosures but the Cattle Only Area has followed a similar pattern of recovery as the Ungulate Exclosure at the Three-way Exclosure Site although at a slower rate. These examples demonstrate that the rangelands are much more resilient than perhaps previously thought and they have a capacity to recover given proper management and sufficient time. The outcome of recovery, however, will not be the historical “climax” plant community. Rather, it will likely be an assemblage of plants approximating historical climax but containing a mix of native dominant species and naturalized alien plants that have reached a “steady state” (potential natural community). These communities will reflect current ecological conditions and the long-term effects of past disturbance. Some of these past effects may not be reversible, which makes historic climax communities an unrealistic benchmark for current management.

Range condition assessments conducted in this study also revealed that range condition on some sites has not improved for up to 60 years. Continued heavy and/or sequential forage use have placed these sites in a steady state that is not readily reversible (Laycock 1991) and unlikely with grazing management alone.

7.2 Implications of Mixed Grazing Systems

Several factors, such as past and present cattle grazing, wild ungulate grazing, season of use, and precipitation, have interacted to affect plant community composition at Skookumchuck Prairie, Premier Ridge and Pickering Hills.

At Premier Ridge and Pickering Hills, cattle grazing prescriptions between 1991 and 1994 generally incorporated a spring/fall rotation. These rotations were structured so that pastures would be grazed in spring and fall in alternate years. This pattern has not been maintained at either site since that period. Recommendations from the original study called for avoiding cattle turn-out on ungulate winter ranges in early May in order to avoid sequential use by wild ungulates and cattle (Ross 1997). The recommendation to avoid turn-out in early May has been adopted but usually the grazing season has not altered between spring and fall at these sites. Pickering Hills and Premier Ridge have generally been grazed between July and September.

Rotations have not been implemented at the Skookumchuck Prairie Three-way Exclosure. Since about 1997, the Cattle Only Area has mostly been grazed in May, while the Combined Use Area is regularly used in May and June (Table 2). Similarly, the Skookumchuck Historical Exclosure Site has regularly grazed by cattle between May 6 and June 24 except in 2007 when there was no use, and 2009 when it was grazed in July (Table 2). This grazing prescription, combined with increased elk numbers (Table 3), has likely been responsible for elimination of all Decreaser species in the Grazed Area, and for maintaining the site in Poor range condition between 1991 and 2009 (Table 11).

Range condition was rated as Poor at Premier Ridge in 1991 and 2009. Although some favorable changes have occurred, such as increases in Kentucky bluegrass and Columbia needlegrass cover and higher litter cover, no improvements in range condition are likely at this site in the short-term.

Between 2000 and 2009 cattle were grazed in early summer to early fall at Premier Ridge (Table 2). Elk typically winter in the area for about six months, with half the herd migrating from the site in early May and the remaining animals by early June (Jamieson and Hebert 1993). The discontinuation of the spring/fall cattle rotation may have had some positive effects by giving the plant community a rest in late spring and early summer. Increases in the elk population (Table 3), however, could offset benefits from altering the grazing rotation.

Similar to Premier Ridge, range condition at Pickering Hills is unlikely to improve in the short-term under the current management program. Cattle have grazed the site in late summer in 11 of the last 14 years while the elk population in the area has increased by 67% between 1992 and 2008 (Table 3). Some encouraging changes have occurred at Pickering Hills, such as bluebunch wheatgrass cover increasing marginally, and Idaho fescue appearing in the Grazed Area. Although litter cover has improved in both the Grazed Area and the Exclosure, it is unlikely that the summer/fall cattle rotation is responsible for this improved accumulation of litter.

8.0 Recommendations

8.1 Overview

In summarizing the findings of the Grassroots Report, Brink (cited in Agriculture Canada 1972) stated, "Man, his logging, and his fires, have produced vegetation which made more forage available to native and domestic ungulates and their numbers have increased. A further point must be quickly added viz. forest fires set by man are now few and although it is a slow process, in most areas of the East Kootenay regeneration of the forest is occurring. As the forest regenerates, the range forage is declining, at probably logarithmic rates." He also noted that "the rangelands of the East Kootenay are a product of human activity and human activity will be needed to maintain them. Livestock and wildlife may be in conflict but the conflict is surely secondary."

The most important objective for the sustainability of integrated resources is land management, and in particular, management of soils, herbaceous forage species, and browse. Instead of independently managing each ungulate, landscape units should be managed holistically with livestock and wildlife considered as components of the system. Range condition is influenced by stocking levels, and the season and intensity of defoliation on key species. Continued high levels of forage use on sites, such as the Combined Use Area at Skookumchuck Prairie, and the grazed areas at the Skookumchuck Historical Enclosure, Premier Ridge and Pickering Hills, will maintain these sites in lower seral stages, and may result in further declines in range condition. Without management inputs, altering the grazing management will likely have little effect in changing the composition of plant communities on these sites.

Both grazing management and external management inputs may be required to achieve desired plant communities on some sites. Fire, chemical or mechanical treatments may be required to shift bitterbrush-dominated communities across the threshold from their current lower-seral steady state to a higher seral stage that has less bitterbrush and more desirable shrubs such as Saskatoon, low Oregongrape and buckbrush.

Different approaches for cattle management may be required on shared winter/spring ranges with deer or elk. Mule deer mostly use bitterbrush sites, while white-tailed deer and elk use only small amounts of bitterbrush in winter. On mule deer winter/spring ranges, management should focus on key shrubs such as Saskatoon and buckbrush; whereas it should aim for increased amounts of rough fescue, Idaho fescue, and bluebunch wheatgrass to improve capability of for elk.

8.2 Specific Recommendations

Objectives and Planning

- Site-specific plant community objectives should be established based on obtainable ecological, production and social goals. Desired plant communities should represent realistic targets, which reflect these goals but may not always aim to achieve the climax ecological potential.
- Elk and deer population objectives should consider the seasonal availability of preferred forages and be linked to reliable estimates of carrying capacity.
- Forage utilization objectives for key forage species should be developed and incorporated into range use plans, and utilization targets should contain provisions for seasonal use of sites and forage species.
- Wildlife management planning must balance wildlife numbers and distribution with livestock numbers and distribution to ensure that any benefits gained from livestock management are not negated with conflicting wildlife management activities.
- Incorporate information collected from previous studies to provide a scientific foundation for management planning and delivery.

Range and Wildlife Management

- Range management practices, such as modified herd sizes, shorter grazing periods, improved distribution of water, range riders, and salt should be used to obtain even livestock distribution.
- Cattle stocking rates should be set relative to the seasonal availability of preferred forages and known distribution patterns of cattle.
- Turn-out dates should be based on plant development stages and forage abundance rather than height measurements or calendar dates.
- Livestock turn-out dates on key wildlife winter ranges should be adjusted to provide a rest period for forage plants between winter/spring wildlife use and cattle grazing.

- Forage management should aim to provide a carry-over of residual vegetation on key winter ranges to promote litter accumulation and reduce bare soil.
- Site-specific cattle rest-rotations should be introduced where they are not currently used to improve range condition on key winter/spring ranges.
- Cattle grazing rotations should be altered to vary the season of use annually.
- Develop turn-out pastures for livestock on traditional turn-out areas, which contain domestic forages that are ready to graze before the native species.
- Continue ecosystem restoration activities, with an emphasis on reducing forest cover on traditional grassland and maintaining open forest sites.
- Conduct range enhancements, such as lure crops, water development, and ecosystem restoration to improve wildlife distribution and enhance forage quantity and quality for wildlife and cattle.
- Use other management strategies, such as burning and fertilizing, alone or in combination to improve wildlife habitat where these techniques can achieve obtainable objectives.

Monitoring and Research

- Obtain reliable forage production estimates on all range types.
- Monitor the results of ecosystem restoration, and range and wildlife habitat management activities.
- Develop a model to estimate carrying capacity for cattle, deer and elk using range condition and trend, diet preferences, and forage production data.

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Appendix 1. Common and Scientific Names of Plant Species.

| Common Name¹ | Scientific Name |
|--------------------------------|--------------------------------|
| Grass/Grasslike | |
| Bluebunch wheatgrass | <i>Agropyron spicatum</i> |
| Canada bluegrass | <i>Poa compressa</i> |
| Cheatgrass | <i>Bromus tectorum</i> |
| Columbia needlegrass | <i>Stipa columbiana</i> |
| Idaho fescue | <i>Festuca idahoensis</i> |
| Kentucky bluegrass | <i>Poa pratensis</i> |
| Needle-and-thread | <i>Stipa comata</i> |
| Northwest sedge | <i>Carex concinnoides</i> |
| Pinegrass | <i>Calamagrostis rubescens</i> |
| Prairie Junegrass | <i>Koeleria cristata</i> |
| Richardson's needlegrass | <i>Stipa richardsonii</i> |
| Rough fescue | <i>Festuca scabrella</i> |
| Sandberg's bluegrass | <i>Poa sandbergii</i> |
| Sedge species | <i>Carex sp.</i> |
| Slender wheatgrass | <i>Agropyron trachycaulum</i> |
| Smooth brome | <i>Bromus inermis</i> |
| Thickspike wheatgrass | <i>Agropyron dasytachyum</i> |
| Timothy | <i>Phleum pratense</i> |
| Western needlegrass | <i>Stipa occidentalis</i> |
| Western wheatgrass | <i>Agropyron smithii</i> |
| Forbs | |
| Alfalfa | <i>Medicago sativa</i> |
| American vetch | <i>Vicia americana</i> |
| Baker's mariposa lily | <i>Calochortus apiculatus</i> |
| Balsamroot | <i>Balsamorhiza sagittata</i> |
| Bird's-foot trefoil | <i>Lotus corniculatus</i> |
| Bitterroot | <i>Lewisii rediviva</i> |
| Black medic | <i>Medicago lupulina</i> |
| Brown-eyed Susan | <i>Gaillardia aristata</i> |
| Canada goldenrod | <i>Solidago canadensis</i> |
| Chickweed | <i>Cerastium arvense</i> |
| Cinquefoil species | <i>Potentilla sp.</i> |
| Common harebell | <i>Campanula rotundifolia</i> |
| Common mullein | <i>Verbascum thapsis</i> |
| Compound fleabane | <i>Erigeron compositus</i> |
| Dandelion | <i>Taraxacum officinale</i> |
| Death camas | <i>Zigadenus venenosus</i> |
| Desert parsley | <i>Lomatium macrocarpum</i> |
| Douglas' silene | <i>Silene douglasii</i> |

East Kootenay Wildlife-Cattle Vegetation Monitoring

| Common Name ¹ | Scientific Name |
|------------------------------|-----------------------------------|
| Dune goldenrod | <i>Solidago spathulata</i> |
| Early blue violet | <i>Viola adunca</i> |
| Fairy candelabra | <i>Androsace septentrionalis</i> |
| Field filago | <i>Filago arvensis</i> |
| Field locoweed | <i>Oxytropis campestris</i> |
| Hairy golden-aster | <i>Chrysopsis villosa</i> |
| Hawkweed species | <i>Hieracium sp.</i> |
| Hoelboel's rockcress | <i>Arabis holboellii</i> |
| Leafy aster | <i>Aster foliaceus</i> |
| Long-leaved daisy | <i>Erigeron corymbosus</i> |
| Low pussytoes | <i>Antennaria dimorpha</i> |
| Mariposa lily | <i>Calochortus macrocarpus</i> |
| Meadow aster | <i>Aster campestris</i> |
| Narrowleaved blue-eyed grass | <i>Sisyrinchium angustifolium</i> |
| Narrow-leaved goosefoot | <i>Chenopodium leptiphyllum</i> |
| Nine-leaved lomatium | <i>Lomatium triternatum</i> |
| Nodding onion | <i>Allium cernuum</i> |
| Nuttal's pussytoes | <i>Antennaria parviflora</i> |
| Old man's beard | <i>Geum triflorum</i> |
| Pacific anemone | <i>Anemone multifida</i> |
| Prairie crocus | <i>Anemone patens</i> |
| Prairie groundsel | <i>Senecio canus</i> |
| Prairie peppergrass | <i>Lepidium densiflorum</i> |
| Pretty shootingstar | <i>Dodecatheon pauciflorum</i> |
| Prickly lettuce | <i>Lactuca serriola</i> |
| Purple owl-clover | <i>Orthocarpus tenuifolia</i> |
| Rosy pussytoes | <i>Antennaria microphylla</i> |
| Round-leaved alumroot | <i>Heuchera cylindrica</i> |
| Scouler's hawkweed | <i>Hieracium scouleri</i> |
| Shaggy fleabane | <i>Erigeron pumilus</i> |
| Showy aster | <i>Aster conspicuous</i> |
| Showy daisy | <i>Erigeron speciosus</i> |
| Slender hawksbeard | <i>Crepis atrabarba</i> |
| Small-flowered penstemon | <i>Penstemon procerus</i> |
| Smooth agoseris | <i>Agoseris glauca</i> |
| Spiny phlox | <i>Phlox rigida</i> |
| Spotted knapweed | <i>Centaurea maculosa</i> |
| Spreading dogbane | <i>Apocynum androsaemifolium</i> |
| Stickseed | <i>Lappula echinita</i> |
| Stoneseed | <i>Lithospermum ruderales</i> |
| Sulphur buckwheat | <i>Eriogonum umbellatum</i> |
| Sulphur cinquefoil | <i>Potentilla recta</i> |

East Kootenay Wildlife-Cattle Vegetation Monitoring

| Common Name¹ | Scientific Name |
|--------------------------------|--------------------------------|
| Sulphur paintbrush | <i>Castilleja sulphurea</i> |
| Thompson's paintbrush | <i>Castilleja thompsonii</i> |
| Thread-leaved fleabane | <i>Erigeron filifolius</i> |
| Timber milkvetch | <i>Astragalus miser</i> |
| Tiny penstemon | <i>Penstemon confertus</i> |
| Western yarrow | <i>Achillea millefolium</i> |
| White clover | <i>Trifolium repens</i> |
| White sweet-clover | <i>Melilotus alba</i> |
| Wild strawberry | <i>Fragaria virginiana</i> |
| Wyeth's buckwheat | <i>Eriogonum heracleoides</i> |
| Yellow buckwheat | <i>Eriogonum flavum</i> |
| Yellow owl-clover | <i>Orthocarpus luteus</i> |
| Yellow salsify | <i>Tragopogon dubius</i> |
| Trees and Shrubs | |
| Bearberry | <i>Arctostaphylos uva-ursi</i> |
| Birch-leafed spirea | <i>Spirea betulifolia</i> |
| Bitterbrush | <i>Purshia tridentata</i> |
| Buckbrush | <i>Ceanothus velutinus</i> |
| Chokecherry | <i>Prunus virginiana</i> |
| Douglas-fir | <i>Pseudotsuga menziesii</i> |
| Lodgepole pine | <i>Pinus contorta</i> |
| Low Oregongrape | <i>Berberis repens</i> |
| Mock orange | <i>Phileadelphus lewisii</i> |
| Pasture sage | <i>Artemisia frigida</i> |
| Ponderosa pine | <i>Pinus ponderosa</i> |
| Prickly rose | <i>Rosa acicularis</i> |
| Rose species | <i>Rosa sp.</i> |
| Saskatoon | <i>Amelanchier alnifolia</i> |
| Snowberry | <i>Symphoricarpus albus</i> |
| Soopolallie | <i>Shepherdia canadensis</i> |
| Trembling aspen | <i>Populus tremuloides</i> |
| Wood's rose | <i>Rosa woodsii</i> |

¹ Plant species list includes species listed in text and tables.

Appendix 2. Intensive Survey Methodology.

| Intensive Survey Plot | Airphoto | Elevation (m) | Slope (°) | Aspect (°) |
|-----------------------------------|-----------------|----------------------|------------------|-------------------|
| Skookumchuck Prairie | 30BCC865-072 | 825 | 0-5 | 180 |
| Skookumchuck Historical Exclosure | 30BCC865-070 | 805 | 0 | 180 |
| Pickering Hills | 30BCC832-190 | 1025 | 5-25 | 230 |
| Premier Ridge | 30BCC865-067 | 1035 | 5-25 | 240 |

Daubenmire Cover Classes

1 = 0 to 5%; 2 = 6 to 25%; 3 = 26 to 50%; 4 = 51 to 75%; 5 = 76 to 95%; 6 = 96 to 100%

Photopoints

Two photos were taken at each transect at each sampling date;

- 1) oblique at T + 0m
- 2) oblique at T + 50m

Sampling Layout

Transects in grazed areas were 50 m. Transects in exclosures were either 30 or 50 m. At the Skookumchuck Historical Exclosure the Grazed Area and Old Exclosure had one transect from which 50 plots were read. All other sites had either 5 or 10 transects from which ten plots were read as below.

| Transect | Dist from 0 m | | | | | | | | | | |
|-----------------|----------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
| | Plot | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |



UTM Co-ordinates

| Location | Site | Plot | Northing | Easting | Elevation |
|----------------------|-------------|-------------|-----------------|----------------|------------------|
| Historical Exclosure | Grazed | T1 + 0 | 5526581 | 591227 | 805 |
| Historical Exclosure | Ungrazed | T1 + 0 | 5526451 | 591242 | 806 |
| Historical Exclosure | New | T1 + 0 | 5526415 | 591229 | 797 |
| Historical Exclosure | New | T2 + 0 | 5526421 | 591228 | 797 |
| Historical Exclosure | New | T3 + 0 | 5526425 | 591229 | 797 |
| Historical Exclosure | New | T4 + 0 | 5526430 | 591229 | 797 |
| Historical Exclosure | New | T5 + 0 | 5526434 | 591229 | 797 |
| Skookumchuck Prairie | Combined | T1 + 0 | 5526680 | 589055 | 816 |
| Skookumchuck Prairie | Combined | T2 + 0 | 5526333 | 588907 | 812 |
| Skookumchuck Prairie | Combined | T3 + 0 | 5526594 | 588998 | 814 |
| Skookumchuck Prairie | Combined | T4 + 0 | 5526429 | 589033 | 811 |
| Skookumchuck Prairie | Combined | T5 + 0 | 5526432 | 589222 | 812 |
| Skookumchuck Prairie | Combined | T6 + 0 | 5526826 | 589285 | 810 |
| Skookumchuck Prairie | Combined | T7 + 0 | 5526760 | 588936 | 813 |
| Skookumchuck Prairie | Combined | T8 + 0 | 5527066 | 588996 | 824 |
| Skookumchuck Prairie | Combined | T9 + 0 | 5526560 | 589375 | 819 |
| Skookumchuck Prairie | Combined | T10 + 0 | 5526269 | 589283 | 811 |
| Skookumchuck Prairie | Cattle | T1 + 0 | 5526067 | 588612 | 810 |
| Skookumchuck Prairie | Cattle | T2 + 0 | 5526561 | 588287 | 793 |
| Skookumchuck Prairie | Cattle | T3 + 0 | 5526171 | 588508 | 804 |
| Skookumchuck Prairie | Cattle | T4 + 0 | 5526452 | 588199 | 801 |
| Skookumchuck Prairie | Cattle | T5 + 0 | 5526321 | 588411 | 809 |
| Skookumchuck Prairie | Cattle | T6 + 0 | 5526586 | 588538 | 808 |
| Skookumchuck Prairie | Cattle | T7 + 0 | 5526738 | 588682 | 807 |
| Skookumchuck Prairie | Cattle | T8 + 0 | 5527119 | 588484 | 816 |
| Skookumchuck Prairie | Cattle | T9 + 0 | 5527084 | 588596 | 814 |
| Skookumchuck Prairie | Cattle | T10 + 0 | 5527013 | 588603 | 811 |
| Skookumchuck Prairie | Wildlife | T1 + 0 | 5525811 | 588624 | 806 |
| Skookumchuck Prairie | Wildlife | T2 + 0 | 5525604 | 588119 | 803 |
| Skookumchuck Prairie | Wildlife | T3 + 0 | 5525637 | 588580 | 807 |
| Skookumchuck Prairie | Wildlife | T4 + 0 | 5526104 | 588059 | 803 |
| Skookumchuck Prairie | Wildlife | T5 + 0 | 5526280 | 588101 | 804 |
| Skookumchuck Prairie | Wildlife | T6 + 0 | 5525017 | 588271 | 815 |
| Skookumchuck Prairie | Wildlife | T7 + 0 | 5525595 | 588479 | 810 |
| Skookumchuck Prairie | Wildlife | T8 + 0 | 5525704 | 588281 | 806 |
| Skookumchuck Prairie | Wildlife | T9 + 0 | 5525788 | 588141 | 802 |
| Skookumchuck Prairie | Wildlife | T10 + 0 | 5525917 | 588404 | 807 |

UTM Co-ordinates

| Location | Site | Plot | Northing | Easting | Elevation |
|------------------------------|-------------|-------------|-----------------|----------------|------------------|
| Skookumchuck Prairie | Exclosure | T1 + 0 | 5526244 | 588722 | 807 |
| Skookumchuck Prairie | Exclosure | T2 + 0 | 5526243 | 588727 | 811 |
| Skookumchuck Prairie | Exclosure | T3 + 0 | 5526243 | 588733 | 811 |
| Skookumchuck Prairie | Exclosure | T4 + 0 | 5526242 | 588742 | 816 |
| Skookumchuck Prairie | Exclosure | T5 + 0 | 5526242 | 588747 | 817 |
| Skookumchuck Prairie | Exclosure | T6 + 0 | 5526243 | 588751 | 815 |
| Skookumchuck Prairie | Exclosure | T7 + 0 | 5526243 | 588756 | 814 |
| Skookumchuck Prairie | Exclosure | T8 + 0 | 5526244 | 588759 | 813 |
| Skookumchuck Prairie | Exclosure | T9 + 0 | 5526243 | 588764 | 813 |
| Skookumchuck Prairie | Exclosure | T10 + 0 | 5526243 | 588770 | 814 |
| Pickering Hills | Grazed | T1 + 0 | 5478801 | 616126 | 1002 |
| Pickering Hills | Grazed | T2 + 0 | 5478690 | 616188 | 999 |
| Pickering Hills | Grazed | T3 + 0 | 5478653 | 616341 | 1022 |
| Pickering Hills | Grazed | T4 + 0 | 5478533 | 616275 | 988 |
| Pickering Hills | Grazed | T5 + 0 | 5478592 | 616399 | 1010 |
| Pickering Hills ¹ | Exclosure | T1 + 0 | 5478690 | 616437 | 1020 |
| Pickering Hills ¹ | Exclosure | T2 + 0 | 5478685 | 616431 | 1018 |
| Pickering Hills ¹ | Exclosure | T3 + 0 | 5478680 | 616426 | 1016 |
| Pickering Hills ¹ | Exclosure | T4 + 0 | 5478675 | 616420 | 1014 |
| Pickering Hills ¹ | Exclosure | T5 + 0 | 5478670 | 616415 | 1012 |
| Premier Ridge | Grazed | T1 + 0 | 5525483 | 595303 | 927 |
| Premier Ridge | Grazed | T2 + 0 | 5525386 | 595340 | 921 |
| Premier Ridge | Grazed | T3 + 0 | 5525280 | 595511 | 937 |
| Premier Ridge | Grazed | T4 + 0 | 5525148 | 595533 | 926 |
| Premier Ridge | Grazed | T5 + 0 | 5525027 | 595524 | 916 |
| Premier Ridge | Exclosure | T1 + 0 | 5525129 | 595442 | 914 |
| Premier Ridge | Exclosure | T2 + 0 | 5525129 | 595453 | 917 |
| Premier Ridge | Exclosure | T3 + 0 | 5525129 | 595465 | 921 |
| Premier Ridge | Exclosure | T4 + 0 | 5525129 | 595475 | 923 |
| Premier Ridge | Exclosure | T5 + 0 | 5525130 | 595486 | 925 |

¹ Co-ordinates approximate

Appendix 3. Cover and frequency at the Skookumchuck Historical Exclosure 1960-1982.

| Species | Grazed | | | | | | Exclosure | | | | | |
|----------------------|----------------|------|-------------|------|-------------|------|-------------|-------|-------------|------|-------------|------|
| | 1960 | | 1970 | | 1982 | | 1960 | | 1970 | | 1982 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | | | | | |
| Grass | | | | | | | | | | | | |
| Bluebunch wheatgrass | 6.8 | 26.0 | 13.0 | 62.0 | 14.0 | 54.0 | 24.7 | 72.0 | 55.0 | 96.0 | 12.7 | 68.0 |
| Idaho fescue | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 18.0 |
| Needle-and-thread | 4.2 | 68.0 | 34.0 | 98.0 | 47.0 | 0.0 | 16.7 | 74.0 | 1.0 | 4.0 | 0.0 | 0.0 |
| Prairie Junegrass | 16.6 | 90.0 | 20.0 | 94.0 | 5.0 | 66.0 | 23.4 | 94.0 | 9.0 | 72.0 | 4.2 | 58.0 |
| Rough fescue | 0.0 | 0.0 | T | 2.0 | T | 2.0 | 6.0 | 36.0 | 20.0 | 48.0 | 58.8 | 98.0 |
| Sandberg's bluegrass | 26.2 | 98.0 | 10.0 | 94.0 | 0.0 | 0.0 | 17.5 | 100.0 | 5.0 | 50.0 | 0.1 | 4.0 |
| Total Grass | 53.8 | | 77.0 | | 66.0 | | 88.3 | | 90.0 | | 76.8 | |
| | | | | | | | | | | | | |
| Forbs | | | | | | | | | | | | |
| Canada goldenrod | 1.2 | 20.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Compound fleabane | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 |
| Dandelion | 0.0 | 0.0 | 1.0 | 20.0 | T | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Death camas | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Desert parsley | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 4.0 | T | 2.0 | 0.4 | 4.0 |
| Fairy candelabra | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hairy golden-aster | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Holboell's rockcress | 1.3 | 14.0 | T | 14.0 | T | 18.0 | 0.3 | 14.0 | 0.0 | 0.0 | 0.2 | 8.0 |
| Low pussytoes | 26.4 | 98.0 | 8.0 | 58.0 | T | 2.0 | 10.5 | 94.0 | T | 2.0 | T | 2.0 |
| Mariposa lily | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 |
| Nodding onion | 0.1 | 2.0 | 0.0 | 0.0 | T | 2.0 | 0.6 | 4.0 | 0.0 | 0.0 | T | 2.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|-------------------------------|-------------|------|-------------|------|-------------|------|-------------|------|-------------|------|-------------|------|
| | 1960 | | 1970 | | 1982 | | 1960 | | 1970 | | 1982 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| Nuttall's pussytoes | 1.3 | 6.0 | 9.0 | 34.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.0 | 30.0 | 7.6 | 54.0 |
| Old man's beard | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 |
| Pacific anemone | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie groundsel | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 34.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 | 40.0 |
| Rosy pussytoes | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 | 58.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| Shaggy fleabane | 1.2 | 30.0 | 4.0 | 54.0 | 4.0 | 90.0 | 0.7 | 8.0 | 0.0 | 0.0 | 0.2 | 6.0 |
| Slender hawkbeard | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | T | 8.0 |
| Spiny phlox | 1.1 | 14.0 | 3.0 | 22.0 | 2.0 | 40.0 | 0.0 | 0.0 | 11.0 | 60.0 | 10.5 | 62.0 |
| Stoneseed | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 16.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sulphur buckwheat | 1.4 | 38.0 | 2.0 | 22.0 | T | 2.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Timber milkvetch | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 18.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 26.0 |
| Western yarrow | 0.4 | 6.0 | 0.0 | 0.0 | 2.0 | 14.0 | 0.1 | 2.0 | 0.0 | 0.0 | 2.9 | 46.0 |
| Wyeth's buckwheat | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 |
| Yellow buckwheat | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 12.0 | 1.0 | 6.0 | 0.0 | 0.0 |
| Yellow owl-clover | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 4.0 |
| Yellow salsify | 0.0 | 0.0 | T | 2.0 | T | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Forbs | 34.7 | | 27.0 | | 16.0 | | 13.3 | | 18.0 | | 27.2 | |
| | | | | | | | | | | | | |
| Trees and Shrubs | | | | | | | | | | | | |
| Bearberry | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 | 0.0 | 0.0 |
| Ponderosa pine | 0.0 | 0.0 | 0.0 | 0.0 | T | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Trees and Shrubs | 0.0 | | 0.0 | | 0.0 | | 0.0 | | T | | 0.0 | |

Appendix 4. Cover and frequency at the Skookumchuck Historical Old Exclosure in 1991-2009.

| Species | Grazed | | | | | | Exclosure | | | | | |
|----------------------|----------------|-------|-------------|------|-------------|-------|-------------|------|-------------|------|-------------|------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | | | | | |
| Grass | | | | | | | | | | | | |
| Bluebunch wheatgrass | 7.6 | 44.0 | 6.4 | 36.0 | 0.0 | 0.0 | 5.4 | 52.0 | 8.1 | 42.0 | 2.2 | 10.0 |
| Canada bluegrass | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 16.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Idaho fescue | 0.5 | 20.0 | 0.1 | 2.0 | 0.0 | 0.0 | 7.9 | 80.0 | 25.0 | 84.0 | 18.5 | 94.0 |
| Kentucky bluegrass | 0.2 | 0.6 | 0.9 | 6.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Needle-and-thread | 13.9 | 100.0 | 25.8 | 96.0 | 18.3 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie Junegrass | 0.9 | 24.0 | 14.0 | 92.0 | 1.0 | 28.0 | 1.0 | 20.0 | 4.7 | 32.0 | 0.0 | 0.0 |
| Rough fescue | 0.9 | 8.0 | 1.0 | 4.0 | 0.0 | 0.0 | 23.8 | 94.0 | 32.3 | 80.0 | 23.5 | 86.0 |
| Sandberg's bluegrass | 0.4 | 0.6 | 0.1 | 2.0 | 0.1 | 2.0 | 0.3 | 12.0 | 0.1 | 4.0 | 0.0 | 0.0 |
| Total Grass | 24.4 | | 48.3 | | 20.8 | | 38.4 | | 70.2 | | 44.2 | |
| | | | | | | | | | | | | |
| Forbs | | | | | | | | | | | | |
| Bitterroot | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Black medic | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Brown-eyed Susan | 0.0 | 0.0 | 1.4 | 16.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 4.0 | 0.0 | 0.0 |
| Cinquefoil species | 1.3 | 22.0 | 0.0 | 0.0 | 9.3 | 90.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Dandelion | 0.0 | 0.0 | 0.3 | 12.0 | 0.3 | 12.0 | 0.0 | 0.0 | 0.7 | 28.0 | 0.2 | 6.0 |
| Death camas | 0.2 | 8.0 | 0.2 | 8.0 | 0.0 | 0.0 | 0.1 | 4.0 | 2.0 | 38.0 | 0.0 | 0.0 |
| Desert parsley | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Dune goldenrod | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 | 66.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 4.0 |
| Early blue violet | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|----------------------|--------|------|-------|------|-------|------|-----------|------|-------|------|-------|------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| Fairy candelabra | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hairy golden-aster | 0.0 | 0.0 | 0.1 | 2.0 | 0.8 | 12.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hawkweed species | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Holboell's rockcress | 0.0 | 0.0 | 0.3 | 12.0 | 0.4 | 14.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 |
| Low pussytoes | 0.6 | 16.0 | 0.8 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 6.0 | 0.0 | 0.0 |
| Mariposa lily | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.6 | 22.0 | 0.0 | 0.0 |
| Nine-leafed lomatium | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.1 | 4.0 | 0.0 | 0.0 |
| Nodding onion | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 12.0 | 0.0 | 0.0 |
| Nuttall's pussytoes | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 34.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Old man's beard | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 |
| Prairie crocus | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.6 | 6.0 | 0.4 | 4.0 |
| Prairie groundsel | 1.9 | 44.0 | 6.9 | 60.0 | 0.0 | 0.0 | 1.1 | 34.0 | 2.5 | 40.0 | 0.0 | 0.0 |
| Pretty shootingstar | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Purple owl-clover | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rosy pussytoes | 3.0 | 50.0 | 4.6 | 54.0 | 6.0 | 60.0 | 0.0 | 0.0 | 8.3 | 48.0 | 4.3 | 52.0 |
| Shaggy fleabane | 0.2 | 8.0 | 1.9 | 24.0 | 0.6 | 22.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 6.0 |
| Slender hawksbeard | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 8.0 | 0.1 | 4.0 |
| Spiny phlox | 3.1 | 46.0 | 6.7 | 50.0 | 0.7 | 18.0 | 4.8 | 54.0 | 7.6 | 48.0 | 2.9 | 44.0 |
| Stickseed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sulphur buckwheat | 0.1 | 2.0 | 0.3 | 2.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.3 | 2.0 | 0.3 | 2.0 |
| Sulphur cinquefoil | 0.0 | 0.0 | 2.0 | 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Timber milkvetch | 0.6 | 4.0 | 1.6 | 16.0 | 0.4 | 4.0 | 0.2 | 8.0 | 2.2 | 18.0 | 1.7 | 26.0 |
| Western yarrow | 0.1 | 2.0 | 2.2 | 18.0 | 0.1 | 4.0 | 0.6 | 22.0 | 4.3 | 34.0 | 1.9 | 44.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|--------------------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| Wyeth's buckwheat | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yellow owl-clover | 1.2 | 48.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.5 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yellow salsify | 0.0 | 0.0 | 0.6 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 4.0 | 0.0 | 0.0 |
| Total Forbs | 12.4 | | 30.3 | | 22.2 | | 10.4 | | 31.9 | | 11.8 | |
| Trees | | | | | | | | | | | | |
| Ponderosa pine | 0.1 | 2.0 | 0.9 | 6.0 | 0.0 | 0.0 | 2.5 | 14.0 | 12.9 | 32.0 | 11.2 | 34.0 |
| Total Trees | 0.1 | | 0.9 | | 0.0 | | 2.5 | | 12.9 | | 11.2 | |
| Substrates | | | | | | | | | | | | |
| Bryophytes | 18.9 | 100.0 | 26.2 | 100.0 | 37.9 | 98.0 | 37.7 | 100.0 | 30.4 | 98.0 | 31.5 | 88.0 |
| Litter | 24.3 | 100.0 | 22.0 | 100.0 | 11.7 | 100.0 | 53.5 | 100.0 | 58.3 | 100.0 | 65.8 | 100.0 |
| Rock | 2.3 | 72.0 | 2.5 | 58.0 | 1.8 | 60.0 | 0.5 | 10.0 | 0.9 | 18.0 | 0.2 | 6.0 |
| Soil | 32.9 | 100.0 | 17.8 | 100.0 | 28.9 | 100.0 | 0.8 | 22.0 | 1.9 | 36.0 | 2.1 | 34.0 |
| Feces | 1.6 | | 1.4 | | 0.2 | | 0.0 | | 0.0 | | 0.0 | |
| Deer Feces | nd | nd | nd | nd | 0.2 | 8.0 | nd | nd | nd | nd | 0.0 | 0.0 |
| Elk Feces | nd | nd | nd | nd | 2.0 | 58.0 | nd | nd | nd | nd | 0.0 | 0.0 |
| Litter >2 | nd | nd | nd | nd | 0.3 | 2.0 | nd | nd | nd | nd | 0.3 | 2.0 |

Appendix 5. Cover and frequency at the Skookumchuck Historical New Exclosure in 1991 and 2009.

| Species | 1991 | | 2009 | |
|----------------------|-------------|------|-------------|------|
| | Cover | Freq | Cover | Freq |
| Grass | | | | |
| Bluebunch wheatgrass | 20.3 | 86.0 | 9.9 | 62.0 |
| Canada bluegrass | 0.3 | 2.0 | 2.6 | 8.0 |
| Idaho fescue | 1.6 | 32.0 | 0.6 | 4.0 |
| Kentucky bluegrass | 0.0 | 0.0 | 0.0 | 0.0 |
| Needle-and-thread | 15.5 | 90.0 | 9.4 | 64.0 |
| Prairie Junegrass | 3.8 | 60.0 | 6.8 | 60.0 |
| Rough fescue | 1.0 | 8.0 | 8.3 | 40.0 |
| Sandberg's bluegrass | 0.7 | 18.0 | 0.0 | 0.0 |
| Total Grass | 43.0 | | 37.5 | |
| | | | | |
| Forbs | | | | |
| Bitterroot | 0.2 | 8.0 | 0.0 | 0.0 |
| Cinquefoil species | 0.1 | 2.0 | 4.8 | 50.0 |
| Dandelion | 0.0 | 0.0 | 1.4 | 26.0 |
| Death camas | 0.1 | 4.0 | 0.0 | 0.0 |
| Desert parsley | 0.1 | 2.0 | 0.1 | 2.0 |
| Dune goldenrod | 0.0 | 0.0 | 1.6 | 54.0 |
| Fairy candelabra | 0.1 | 4.0 | 0.0 | 0.0 |
| Hawkweed species | 0.0 | 0.0 | 0.1 | 2.0 |
| Holboell's rockcress | 0.0 | 0.0 | 0.2 | 6.0 |
| Mariposa lily | 0.0 | 0.0 | 0.0 | 0.0 |
| Nine-leafed lomatium | 0.1 | 2.0 | 0.0 | 0.0 |
| Prairie crocus | 1.0 | 20.0 | 0.0 | 0.0 |
| Prairie groundsel | 0.7 | 16.0 | 0.0 | 0.0 |
| Purple owl-clover | 0.0 | 0.0 | 0.2 | 6.0 |
| Rosy pussytoes | 0.0 | 0.0 | 4.3 | 42.0 |
| Shaggy fleabane | 0.2 | 6.0 | 0.5 | 8.0 |
| Slender hawksbeard | 0.0 | 0.0 | 0.1 | 2.0 |
| Spiny phlox | 0.7 | 8.0 | 0.5 | 20.0 |
| Stickseed | 0.0 | 0.0 | 0.0 | 0.0 |
| Sulphur buckwheat | 0.0 | 0.0 | 0.6 | 14.0 |
| Timber milkvetch | 0.3 | 2.0 | 0.3 | 2.0 |
| Western yarrow | 0.2 | 6.0 | 1.9 | 24.0 |

East Kootenay Wildlife-Cattle Vegetation Monitoring

| Species | 1991 | | 2009 | |
|--------------------|------------|------|-------------|-------|
| | Cover | Freq | Cover | Freq |
| Wyeth's buckwheat | 1.3 | 42.0 | 0.0 | 0.0 |
| Yellow owl-clover | 1.5 | 38.0 | 0.0 | 0.0 |
| Yellow salsify | 0.1 | 2.0 | 0.4 | 4.0 |
| Total Forbs | 6.3 | | 16.2 | |
| | | | | |
| Trees | | | | |
| Ponderosa pine | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Trees | 0.0 | | 0.0 | |
| | | | | |
| Substrates | | | | |
| Bryophytes | 25.1 | 94.0 | 72.6 | 100.0 |
| Litter | 35.9 | 94.0 | 19.7 | 100.0 |
| Rock | 2.0 | 40.0 | 0.1 | 2.0 |
| Soil | 30.5 | 94.0 | 6.7 | 86.0 |
| Feces | 2.5 | 40.0 | 0.3 | 2.0 |
| Deer Feces | nd | nd | 0.0 | 0.0 |
| Elk Feces | nd | nd | 0.0 | 0.0 |
| Litter >2 | nd | nd | 0.0 | 0.0 |

nd = No data collected.

Appendix 6. Cover and frequency at Skookumchuck Prairie Three-way Exclosure Site in 1991.

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|--------------------------|----------------|------|-------------|------|---------------|------|-------------|------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Grass | | | | | | | | |
| Bluebunch wheatgrass | 9.7 | 61.0 | 11.7 | 72.0 | 12.6 | 78.0 | 4.6 | 43.0 |
| Canada bluegrass | 4.4 | 31.0 | 2.7 | 23.0 | 0.6 | 9.0 | 7.1 | 63.0 |
| Cheatgrass | 0.9 | 11.0 | 0.4 | 2.0 | 0.2 | 4.0 | 2.6 | 13.0 |
| Columbia needlegrass | 0.2 | 2.0 | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 |
| Idaho fescue | 3.8 | 43.0 | 4.1 | 45.0 | 7.2 | 60.0 | 0.8 | 17.0 |
| Kentucky bluegrass | 2.8 | 21.0 | 1.8 | 16.0 | 1.6 | 17.0 | 9.5 | 51.0 |
| Needle-and-thread | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pinegrass | 0.2 | 4.0 | 0.3 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie Junegrass | 1.5 | 24.0 | 2.2 | 34.0 | 2.9 | 37.0 | 0.5 | 10.0 |
| Richardson's needlegrass | 1.9 | 13.0 | 1.4 | 11.0 | 1.1 | 8.0 | 0.0 | 0.0 |
| Rough fescue | 2.7 | 25.0 | 1.8 | 17.0 | 1.1 | 10.0 | 0.6 | 8.0 |
| Sandberg's bluegrass | 0.4 | 14.0 | 0.6 | 15.0 | 0.5 | 20.0 | 0.1 | 3.0 |
| Slender wheatgrass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 1.0 |
| Western needlegrass | 1.7 | 8.0 | 1.9 | 17.0 | 0.3 | 2.0 | 0.4 | 7.0 |
| Total Grass | 30.7 | | 29.3 | | 28.3 | | 26.2 | |
| | | | | | | | | |
| Forbs | | | | | | | | |
| Chickweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 6.0 | 0.0 | 0.0 |
| Cinquefoil species | 0.9 | 10.0 | 0.1 | 5.0 | 0.1 | 2.0 | 4.5 | 40.0 |
| Common harebell | 0.3 | 5.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.2 | 2.0 |
| Dandelion | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Death camas | 0.0 | 1.0 | 0.1 | 2.0 | 0.1 | 2.0 | 0.0 | 0.0 |
| Early blue violet | 0.1 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|--------------------------|----------------|------|-------------|------|---------------|------|-------------|------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Fairy candelabra | 0.0 | 0.0 | 0.1 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Field locoweed | 0.2 | 1.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hairy golden-aster | 1.7 | 10.0 | 1.9 | 22.0 | 0.4 | 5.0 | 2.4 | 31.0 |
| Holboell's rockcress | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Nine-leafed lomatium | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 1.0 | 0.0 | 1.0 |
| Nodding onion | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Nuttal's pussytoes | 0.3 | 8.0 | 0.9 | 9.0 | 0.9 | 13.0 | 0.1 | 2.0 |
| Pacific anemone | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 |
| Prairie crocus | 0.5 | 4.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie groundsel | 0.9 | 14.0 | 0.3 | 6.0 | 0.1 | 5.0 | 0.4 | 11.0 |
| Round-leaved alumroot | 0.6 | 3.0 | 0.7 | 7.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Shaggy fleabane | 0.3 | 11.0 | 0.8 | 20.0 | 0.7 | 18.0 | 0.1 | 3.0 |
| Slender hawksbeard | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Small-flowered penstemon | 1.1 | 10.0 | 0.5 | 9.0 | 0.6 | 7.0 | 0.1 | 2.0 |
| Spiny phlox | 0.1 | 3.0 | 0.4 | 6.0 | 0.8 | 18.0 | 0.1 | 2.0 |
| Spreading dogbane | 0.5 | 10.0 | 0.4 | 16.0 | 0.1 | 3.0 | 0.3 | 11.0 |
| Stoneseed | 0.6 | 1.0 | 0.2 | 3.0 | 0.4 | 1.0 | 0.4 | 1.0 |
| Sulphur buckwheat | 0.0 | 0.0 | 0.2 | 6.0 | 1.2 | 19.0 | 0.0 | 1.0 |
| Sulphur paintbrush | 0.2 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Timber milkvetch | 2.2 | 28.0 | 1.1 | 15.0 | 4.7 | 31.0 | 5.7 | 39.0 |
| Western yarrow | 1.1 | 33.0 | 1.1 | 27.0 | 1.7 | 32.0 | 1.7 | 35.0 |
| Wild strawberry | 0.4 | 6.0 | 0.3 | 8.0 | 0.1 | 4.0 | 0.2 | 3.0 |
| Yellow owl-clover | 0.1 | 2.0 | 0.1 | 2.0 | 0.2 | 8.0 | 0.1 | 4.0 |
| Yellow salsify | 0.1 | 3.0 | 0.1 | 3.0 | 0.0 | 1.0 | 0.4 | 15.0 |
| Total Forbs | 14.7 | | 9.1 | | 12.3 | | 16.8 | |

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|-------------------------------|----------------|-------|-------------|-------|---------------|-------|-------------|-------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Trees and Shrubs | | | | | | | | |
| Bearberry | 2.6 | 14.0 | 4.0 | 28.0 | 0.4 | 7.0 | 1.1 | 4.0 |
| Birch-leaved spirea | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bitterbrush | 9.1 | 58.0 | 4.9 | 42.0 | 8.6 | 60.0 | 11.5 | 67.0 |
| Buckbrush | 0.1 | 2.0 | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Chokecherry | 0.4 | 9.0 | 0.8 | 7.0 | 0.1 | 5.0 | 0.3 | 6.0 |
| Ponderosa pine | 4.0 | 11.0 | 2.4 | 9.0 | 1.6 | 6.0 | 0.0 | 0.0 |
| Rose species | 0.7 | 12.0 | 0.5 | 14.0 | 0.3 | 5.0 | 3.4 | 38.0 |
| Saskatoon | 2.9 | 18.0 | 2.0 | 21.0 | 1.7 | 32.0 | 2.1 | 9.0 |
| Soopolallie | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Trembling Aspen | 0.8 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Trees and Shrubs | 18.2 | | 14.8 | | 12.7 | | 18.4 | |
| | | | | | | | | |
| Substrates | | | | | | | | |
| Bryophytes | 20.3 | 91.0 | 24.6 | 95.0 | 32.3 | 95.0 | 32.0 | 91.0 |
| Feces | 2.5 | 50.0 | 3.5 | 60.0 | 2.6 | 51.0 | 3.0 | 41.0 |
| Litter | 49.3 | 100.0 | 39.5 | 100.0 | 36.0 | 100.0 | 53.9 | 100.0 |
| Rock | 7.1 | 68.0 | 8.2 | 66.0 | 5.6 | 50.0 | 3.6 | 50.0 |
| Soil | 9.4 | 68.0 | 12.9 | 84.0 | 9.9 | 77.0 | 5.8 | 66.0 |

Appendix 7. Cover and frequency at Skookumchuck Prairie Three-way Exclosure Site in 1994.

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|----------------------------------|----------------|------|-------------|------|---------------|------|-------------|------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Grass and Grasslike | | | | | | | | |
| Bluebunch wheatgrass | 8.3 | 44.0 | 8.5 | 47.0 | 7.3 | 43.0 | 5.0 | 27.0 |
| Canada bluegrass | 9.1 | 32.0 | 3.0 | 13.0 | 1.1 | 6.0 | 19.6 | 58.0 |
| Columbia needlegrass | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 1.0 |
| Idaho fescue | 5.9 | 27.0 | 8.1 | 37.0 | 18.8 | 66.0 | 3.3 | 11.0 |
| Kentucky bluegrass | 8.7 | 33.0 | 7.9 | 20.0 | 5.7 | 19.0 | 23.1 | 59.0 |
| Needle-and-thread | 0.0 | 0.0 | 0.4 | 8.0 | 0.6 | 10.0 | 0.0 | 0.0 |
| Pinegrass | 0.8 | 6.0 | 0.7 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie Junegrass | 4.4 | 33.0 | 7.7 | 46.0 | 9.8 | 56.0 | 2.8 | 15.0 |
| Richardson's needlegrass | 7.7 | 24.0 | 8.1 | 23.0 | 3.8 | 13.0 | 0.2 | 1.0 |
| Rough fescue | 5.3 | 27.0 | 7.2 | 28.0 | 1.5 | 10.0 | 4.8 | 15.0 |
| Sandberg's bluegrass | 0.2 | 8.0 | 0.1 | 3.0 | 0.0 | 1.0 | 0.0 | 1.0 |
| Sedge species | 0.3 | 3.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Slender wheatgrass | 0.2 | 1.0 | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 |
| Western needlegrass | 0.8 | 6.0 | 0.2 | 1.0 | 0.2 | 1.0 | 0.0 | 0.0 |
| Total Grass and Grasslike | 51.9 | | 51.9 | | 49.0 | | 59.2 | |
| | | | | | | | | |
| Forbs | | | | | | | | |
| Baker's mariposa lily | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Bitterroot | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Black medic | 0.2 | 1.0 | 0.0 | 0.0 | 0.4 | 3.0 | 0.0 | 0.0 |
| Brown-eyed Susan | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Common harebell | 0.3 | 2.0 | 0.0 | 1.0 | 0.1 | 2.0 | 0.0 | 1.0 |
| Dandelion | 0.4 | 10.0 | 0.5 | 11.0 | 0.1 | 4.0 | 0.1 | 2.0 |

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|--------------------------|----------------|------|-------------|------|---------------|------|-----------|------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Early blue violet | 0.4 | 7.0 | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 |
| Hairy golden-aster | 0.7 | 8.0 | 2.8 | 21.0 | 0.8 | 6.0 | 2.7 | 20.0 |
| Holboell's rockcress | 0.2 | 6.0 | 0.2 | 9.0 | 0.1 | 4.0 | 0.1 | 3.0 |
| Low pussytoes | 0.5 | 6.0 | 1.9 | 7.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mariposa lily | 0.0 | 1.0 | 0.0 | 0.0 | 0.1 | 3.0 | 0.0 | 1.0 |
| Nine-leafed lomatium | 0.0 | 0.0 | 0.4 | 7.0 | 0.2 | 1.0 | 0.3 | 2.0 |
| Nodding onion | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Prairie crocus | 0.3 | 2.0 | 0.3 | 2.0 | 0.2 | 1.0 | 0.2 | 1.0 |
| Prairie groundsel | 1.4 | 15.0 | 0.7 | 8.0 | 0.2 | 4.0 | 0.5 | 4.0 |
| Pretty shooting star | 0.0 | 0.0 | 0.2 | 3.0 | 0.1 | 2.0 | 0.0 | 0.0 |
| Rosy pussytoes | 0.9 | 8.0 | 1.9 | 16.0 | 1.3 | 13.0 | 0.4 | 3.0 |
| Round-leaved alumroot | 1.1 | 5.0 | 0.6 | 6.0 | 0.0 | 1.0 | 0.2 | 1.0 |
| Shaggy fleabane | 0.1 | 2.0 | 0.3 | 7.0 | 0.1 | 3.0 | 0.0 | 0.0 |
| Slender hawksbeard | 0.3 | 4.0 | 0.2 | 3.0 | 0.0 | 1.0 | 0.0 | 1.0 |
| Small-flowered penstemon | 0.6 | 5.0 | 0.4 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Spiny phlox | 0.6 | 5.0 | 1.3 | 8.0 | 2.0 | 17.0 | 0.2 | 2.0 |
| Spreading dogbane | 0.0 | 1.0 | 0.2 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stoneseed | 0.4 | 1.0 | 0.0 | 0.0 | 0.4 | 1.0 | 0.2 | 2.0 |
| Sulphur buckwheat | 0.0 | 0.0 | 0.2 | 3.0 | 1.4 | 11.0 | 0.0 | 0.0 |
| Sulphur cinquefoil | 1.3 | 12.0 | 1.2 | 9.0 | 1.0 | 5.0 | 4.7 | 36.0 |
| Sulphur paintbrush | 0.5 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Timber milkvetch | 2.3 | 19.0 | 2.7 | 22.0 | 4.2 | 25.0 | 2.3 | 16.0 |
| Tiny penstemon | 1.5 | 14.0 | 0.6 | 5.0 | 0.7 | 4.0 | 0.6 | 4.0 |
| Western yarrow | 4.2 | 39.0 | 3.5 | 33.0 | 6.5 | 33.0 | 5.7 | 34.0 |
| Wild strawberry | 1.3 | 9.0 | 0.9 | 9.0 | 0.4 | 3.0 | 0.4 | 1.0 |

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|-------------------------------|----------------|-------|-------------|-------|---------------|------|-------------|-------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Yellow salsify | 0.9 | 9.0 | 0.8 | 10.0 | 0.5 | 4.0 | 0.9 | 11.0 |
| Total Forbs | 20.4 | | 22.0 | | 21.0 | | 19.5 | |
| Trees and Shrubs | | | | | | | | |
| Bearberry | 8.1 | 22.0 | 9.7 | 25.0 | 2.2 | 7.0 | 1.5 | 5.0 |
| Bitterbrush | 15.6 | 60.0 | 11.4 | 45.0 | 18.0 | 61.0 | 17.5 | 65.0 |
| Buckbrush | 0.2 | 2.0 | 0.4 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Chokecherry | 0.1 | 4.0 | 0.5 | 2.0 | 0.3 | 3.0 | 0.0 | 0.0 |
| Mock orange | 0.2 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 7.0 |
| Ponderosa pine | 6.4 | 12.0 | 8.2 | 14.0 | 4.7 | 9.0 | 0.0 | 0.0 |
| Rose species | 1.4 | 9.0 | 0.4 | 5.0 | 0.0 | 0.0 | 3.8 | 33.0 |
| Saskatoon | 5.0 | 20.0 | 1.6 | 18.0 | 1.2 | 10.0 | 1.7 | 7.0 |
| Soopolallie | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Trembling aspen | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Trees and Shrubs | 37.2 | | 32.4 | | 26.4 | | 25.3 | |
| Substrates | | | | | | | | |
| Bryophytes | 18.8 | 86.0 | 21.1 | 82.0 | 23.3 | 86.0 | 21.9 | 84.0 |
| Elk feces | 0.3 | 3.0 | 0.0 | 0.0 | 0.6 | 3.0 | 0.0 | 0.0 |
| Litter | 47.6 | 100.0 | 43.6 | 100.0 | 41.8 | 99.0 | 67.7 | 100.0 |
| Rock | 9.5 | 57.0 | 8.8 | 62.0 | 6.1 | 45.0 | 3.1 | 22.0 |
| Soil | 8.2 | 65.0 | 8.8 | 72.0 | 12.3 | 71.0 | 1.5 | 27.0 |

Appendix 8. Cover and frequency at Skookumchuck Prairie Three-way Exclosure Site in 2009.

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|----------------------------------|----------------|------|-------------|------|---------------|------|-------------|------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Grass and Grasslike | | | | | | | | |
| Bluebunch wheatgrass | 2.4 | 17.0 | 3.8 | 33.0 | 5.1 | 30.0 | 0.9 | 3.0 |
| Canada bluegrass | 7.3 | 44.0 | 0.8 | 4.0 | 1.0 | 5.0 | 11.1 | 21.0 |
| Cheatgrass | 0.2 | 2.0 | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 |
| Columbia needlegrass | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 4.0 |
| Idaho fescue | 2.6 | 30.0 | 5.5 | 39.0 | 7.2 | 59.0 | 5.6 | 26.0 |
| Kentucky bluegrass | 1.6 | 11.0 | 4.7 | 12.0 | 1.5 | 5.0 | 7.8 | 37.0 |
| Needle-and-thread | 0.2 | 1.0 | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 |
| Northwest sedge | 0.2 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Pinegrass | 0.2 | 1.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie Junegrass | 0.8 | 10.0 | 0.8 | 13.0 | 1.9 | 25.0 | 0.3 | 3.0 |
| Richardson's needlegrass | 10.4 | 47.0 | 1.9 | 14.0 | 3.6 | 19.0 | 2.1 | 11.0 |
| Rough fescue | 1.6 | 18.0 | 13.8 | 36.0 | 1.6 | 8.0 | 22.7 | 51.0 |
| Sandberg's bluegrass | 0.0 | 1.0 | 0.8 | 18.0 | 0.9 | 20.0 | 0.0 | 0.0 |
| Western needlegrass | 0.2 | 4.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Western wheatgrass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 1.0 |
| Total Grass and Grasslike | 27.7 | | 32.3 | | 23.0 | | 50.7 | |
| | | | | | | | | |
| Forbs | | | | | | | | |
| Alfalfa | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 |
| Black medic | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Common mullein | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|--------------------------|----------------|------|-------------|------|---------------|------|-----------|------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Dandelion | 1.3 | 12.0 | 1.4 | 13.0 | 0.1 | 5.0 | 0.1 | 2.0 |
| Dune goldenrod | 0.3 | 5.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.2 | 1.0 |
| Early blue violet | 0.3 | 7.0 | 0.2 | 2.0 | 0.2 | 1.0 | 0.0 | 1.0 |
| Field filago | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hairy golden-aster | 5.5 | 42.0 | 0.9 | 9.0 | 2.2 | 15.0 | 0.2 | 2.0 |
| Leafy aster | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mariposa lily | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Nodding onion | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| Old man's beard | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie crocus | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie groundsel | 1.0 | 13.0 | 0.4 | 5.0 | 0.1 | 4.0 | 0.8 | 10.0 |
| Prairie peppergrass | 0.1 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prickly lettuce | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rosy pussytoes | 1.3 | 17.0 | 4.6 | 31.0 | 0.8 | 10.0 | 0.0 | 0.0 |
| Round-leaved alumroot | 0.0 | 1.0 | 0.2 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Scouler's hawkweed | 0.0 | 1.0 | 0.1 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Showy aster | 0.2 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Small-flowered penstemon | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 1.0 | 0.0 | 0.0 |
| Spiny phlox | 0.1 | 2.0 | 1.2 | 12.0 | 1.0 | 11.0 | 0.5 | 6.0 |
| Spreading dogbane | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stickseed | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stoneseed | 0.2 | 2.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.2 | 2.0 |
| Sulphur cinquefoil | 2.2 | 23.0 | 2.1 | 20.0 | 4.6 | 39.0 | 3.3 | 31.0 |

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|------------------------|----------------|------|-------------|------|---------------|------|-------------|------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Sulphur paintbrush | 0.0 | 0.0 | 0.2 | 1.0 | 0.3 | 5.0 | 0.0 | 0.0 |
| Thread-leaved fleabane | 0.3 | 7.0 | 0.0 | 1.0 | 0.1 | 3.0 | 0.0 | 0.0 |
| Timber milkvetch | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 3.0 | 0.0 | 0.0 |
| Tiny penstemon | 0.4 | 6.0 | 0.2 | 2.0 | 0.4 | 4.0 | 0.0 | 0.0 |
| Western yarrow | 0.3 | 10.0 | 2.1 | 30.0 | 1.4 | 30.0 | 0.8 | 17.0 |
| White sweet-clover | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Wild strawberry | 0.8 | 8.0 | 0.4 | 7.0 | 0.1 | 3.0 | 0.0 | 1.0 |
| Yellow salsify | 0.8 | 11.0 | 0.2 | 4.0 | 0.4 | 5.0 | 0.1 | 4.0 |
| Total Forbs | 15.5 | | 14.2 | | 12.1 | | 6.0 | |
| | | | | | | | | |
| Shrubs | | | | | | | | |
| Bearberry | 2.3 | 17.0 | 6.1 | 21.0 | 1.4 | 3.0 | 0.7 | 5.0 |
| Birch-leafed spirea | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Bitterbrush | 8.0 | 43.0 | 4.8 | 17.0 | 15.2 | 44.0 | 10.4 | 30.0 |
| Chokecherry | 0.0 | 1.0 | 0.0 | 0.0 | 4.2 | 9.0 | 0.2 | 1.0 |
| Mock orange | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 1.0 |
| Prickly rose | 0.1 | 4.0 | 0.2 | 3.0 | 0.0 | 0.0 | 1.5 | 12.0 |
| Saskatoon | 0.9 | 11.0 | 0.2 | 1.0 | 0.5 | 3.0 | 2.6 | 7.0 |
| Snowberry | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Soopolallie | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Wood's rose | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Total Shrubs | 11.5 | | 11.3 | | 21.2 | | 15.5 | |
| | | | | | | | | |

| Species | Combined Use | | Cattle Only | | Wildlife Only | | Exclosure | |
|--------------------|----------------|-------|-------------|-------|---------------|------|------------|-------|
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | | |
| Tree | | | | | | | | |
| Ponderosa pine | 5.0 | 11.0 | 4.9 | 12.0 | 2.1 | 8.0 | 0.0 | 0.0 |
| Total Trees | 5.0 | | 4.9 | | 2.1 | | 0.0 | |
| | | | | | | | | |
| Substrates | | | | | | | | |
| Litter | 51.7 | 100.0 | 59.9 | 100.0 | 49.4 | 99.0 | 77.9 | 100.0 |
| Soil | 3.1 | 26.0 | 9.6 | 42.0 | 4.5 | 42.0 | 0.5 | 4.0 |
| Bryophyte | 25.4 | 84.0 | 14.1 | 72.0 | 30.4 | 71.0 | 28.2 | 84.0 |
| Rock | 6.1 | 49.0 | 4.6 | 45.0 | 2.9 | 36.0 | 0.3 | 3.0 |
| Cattle Feces | 1.0 | 7.0 | 1.2 | 10.0 | 0.2 | 2.0 | 0.0 | 0.0 |
| Deer Feces | 0.1 | 4.0 | 0.4 | 1.0 | 0.4 | 10.0 | 0.0 | 0.0 |
| Elk Feces | 2.5 | 35.0 | 0.0 | 0.0 | 2.1 | 38.0 | 0.0 | 0.0 |
| Litter >2 | 1.2 | 13.0 | 1.4 | 10.0 | 0.9 | 10.0 | 1.5 | 5.0 |

Appendix 9. Cover and frequency at Premier Ridge 1991- 2009.

| Species | Grazed | | | | | | Exclosure | | | | | |
|--------------------------|----------------|------|-------------|-------|-------------|------|----------------|------|-------------|------|-------------|------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | ------(%)----- | | | | | |
| Grass | | | | | | | | | | | | |
| Bluebunch wheatgrass | 0.9 | 14.0 | 0.9 | 8.0 | 3.6 | 16.0 | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 |
| Canada bluegrass | 2.0 | 18.0 | 2.0 | 14.0 | 1.9 | 8.0 | 3.1 | 42.0 | 0.8 | 2.0 | 0.0 | 0.0 |
| Cheatgrass | 0.9 | 8.0 | 1.5 | 20.0 | 0.3 | 10.0 | 0.0 | 0.0 | 1.5 | 20.0 | 0.0 | 0.0 |
| Columbia needlegrass | 0.0 | 0.0 | 35.7 | 100.0 | 1.5 | 18.0 | 0.1 | 4.0 | 39.4 | 96.0 | 5.2 | 32.0 |
| Kentucky bluegrass | 15.9 | 86.0 | 0.0 | 0.0 | 32.3 | 88.0 | 17.2 | 98.0 | 0.3 | 2.0 | 15.1 | 74.0 |
| Needle-and-thread | 0.2 | 6.0 | 2.8 | 22.0 | 0.0 | 0.0 | 0.7 | 6.0 | 3.7 | 14.0 | 0.0 | 0.0 |
| Prairie Junegrass | 1.6 | 22.0 | 0.0 | 0.0 | 3.4 | 24.0 | 2.1 | 22.0 | 0.6 | 4.0 | 2.1 | 22.0 |
| Richardson's needlegrass | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sandberg's bluegrass | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.9 | 6.0 | 0.0 | 0.0 |
| Slender wheatgrass | 0.0 | 0.0 | 20.3 | 84.0 | 0.0 | 0.0 | 0.3 | 2.0 | 23.0 | 78.0 | 1.7 | 10.0 |
| Smooth brome | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 |
| Western needlegrass | 7.7 | 72.0 | 0.0 | 0.0 | 3.0 | 30.0 | 9.8 | 80.0 | 0.0 | 0.0 | 15.1 | 70.0 |
| Total Grass | 29.2 | | 63.3 | | 45.8 | | 33.3 | | 70.5 | | 39.4 | |
| | | | | | | | | | | | | |
| Forbs | | | | | | | | | | | | |
| Bird's-foot trefoil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Black medic | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 | 0.4 | 6.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|----------------------|----------------|------|-------|------|-------|------|----------------|------|-------|------|-------|------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | ------(%)----- | | | | | |
| Brown-eyed Susan | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Chickweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 14.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Common mullein | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 1.2 | 8.0 |
| Compound fleabane | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Dandelion | 0.0 | 0.0 | 0.3 | 10.0 | 0.4 | 4.0 | 0.1 | 2.0 | 0.2 | 8.0 | 0.1 | 4.0 |
| Dune goldenrod | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 |
| Early blue violet | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 |
| Fairy candelabra | 0.1 | 4.0 | 0.0 | 0.0 | 0.4 | 4.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Field locoweed | 0.1 | 4.0 | 0.3 | 4.0 | 0.1 | 2.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.3 | 2.0 |
| Hairy golden-aster | 0.4 | 6.0 | 1.5 | 10.0 | 1.5 | 10.0 | 0.8 | 10.0 | 1.5 | 12.0 | 0.0 | 0.0 |
| Holboell's rockcress | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Leafy aster | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 4.0 |
| Low pussytoes | 0.6 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mariposa lily | 0.0 | 0.0 | 0.2 | 8.0 | 0.0 | 0.0 | 0.1 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Meadow aster | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Nine-leafed lomatium | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Nodding onion | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 4.0 | 0.1 | 2.0 | 0.0 | 0.0 |
| Nuttal's pussytoes | 0.7 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 18.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pacific anemone | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 4.0 | 0.0 | 0.0 |
| Prairie crocus | 0.1 | 4.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie peppergrass | 0.8 | 22.0 | 0.0 | 0.0 | 0.1 | 4.0 | 0.5 | 20.0 | 0.0 | 0.0 | 0.1 | 4.0 |
| Rosy pussytoes | 0.0 | 0.0 | 1.5 | 10.0 | 0.9 | 6.0 | 0.0 | 0.0 | 0.4 | 8.0 | 0.0 | 0.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|--------------------------|----------------|------|-------------|------|-------------|------|----------------|------|-------------|------|-------------|------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | ------(%)----- | | | | | |
| Shaggy fleabane | 0.7 | 26.0 | 3.0 | 42.0 | 0.1 | 4.0 | 0.8 | 20.0 | 1.5 | 14.0 | 0.0 | 0.0 |
| Showy aster | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 10.0 |
| Slender hawksbeard | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 | 0.8 | 2.0 |
| Small-flowered penstemon | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Smooth agoseris | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 |
| Spreading dogbane | 2.0 | 38.0 | 0.3 | 4.0 | 3.5 | 20.0 | 1.6 | 44.0 | 0.3 | 2.0 | 1.9 | 10.0 |
| Stoneseed | 0.8 | 2.0 | 1.5 | 4.0 | 1.7 | 10.0 | 0.4 | 6.0 | 1.6 | 6.0 | 2.0 | 10.0 |
| Timber milkvetch | 0.3 | 10.0 | 1.8 | 20.0 | 1.0 | 8.0 | 0.2 | 6.0 | 0.8 | 10.0 | 0.7 | 6.0 |
| Tiny penstemon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 10.0 | 0.0 | 0.0 |
| Western yarrow | 0.5 | 10.0 | 2.0 | 20.0 | 1.3 | 12.0 | 0.4 | 6.0 | 0.8 | 10.0 | 1.6 | 14.0 |
| White clover | 0.0 | 0.0 | 0.1 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Wild strawberry | 0.1 | 2.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Wyeth's buckwheat | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yellow salsify | 0.4 | 14.0 | 1.3 | 12.0 | 1.7 | 18.0 | 0.2 | 6.0 | 0.9 | 8.0 | 0.4 | 6.0 |
| Total Forbs | 7.8 | | 15.3 | | 12.5 | | 11.8 | | 11.8 | | 12.6 | |
| | | | | | | | | | | | | |
| Trees and Shrubs | | | | | | | | | | | | |
| Birch-leafed spirea | 0.8 | 22.0 | 0.6 | 6.0 | 0.0 | 0.0 | 0.1 | 4.0 | 0.6 | 6.0 | 0.0 | 0.0 |
| Bitterbrush | 22.2 | 96.0 | 32.8 | 96.0 | 19.0 | 52.0 | 22.1 | 94.0 | 19.8 | 70.0 | 3.9 | 28.0 |
| Pasture sage | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prickly rose | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 30.0 |
| Rose species | 0.3 | 12.0 | 0.9 | 16.0 | 0.0 | 0.0 | 1.2 | 28.0 | 2.5 | 28.0 | 0.0 | 0.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|-------------------------------|----------------|-------|-------------|-------|-------------|-------|----------------|-------|-------------|------|-------------|-------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | ------(%)----- | | | | | |
| Saskatoon | 4.9 | 74.0 | 7.4 | 78.0 | 0.9 | 6.0 | 4.0 | 60.0 | 8.3 | 54.0 | 5.6 | 48.0 |
| Snowberry | 2.3 | 30.0 | 2.1 | 14.0 | 7.1 | 38.0 | 5.2 | 34.0 | 5.9 | 24.0 | 9.6 | 38.0 |
| Soopolallie | 1.1 | 6.0 | 0.8 | 4.0 | 0.0 | 0.0 | 0.7 | 8.0 | 1.9 | 6.0 | 0.3 | 2.0 |
| Trembling aspen | 0.3 | 12.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 8.0 | 0.0 | 0.0 | 1.1 | 4.0 |
| Total Trees and Shrubs | 31.9 | | 44.6 | | 28.4 | | 34.0 | | 39.0 | | 22.6 | |
| Substrates | | | | | | | | | | | | |
| Bryophytes | 20.4 | 94.0 | 19.0 | 96.0 | 5.0 | 52.0 | 14.2 | 96.0 | 12.6 | 86.0 | 15.1 | 70.0 |
| Litter | 42.0 | 100.0 | 44.5 | 100.0 | 56.7 | 100.0 | 37.8 | 100.0 | 71.1 | 98.0 | 46.9 | 100.0 |
| Rock | 2.5 | 40.0 | 2.8 | 24.0 | 3.5 | 40.0 | 2.0 | 28.0 | 1.5 | 10.0 | 1.7 | 26.0 |
| Soil | 12.6 | 82.0 | 8.3 | 66.0 | 9.7 | 50.0 | 23.0 | 94.0 | 3.3 | 44.0 | 25.4 | 80.0 |
| Feces | 3.9 | 56.0 | 0.1 | 4.0 | nd | nd | 5.7 | 46.0 | 0.0 | 0.0 | nd | nd |
| Cattle Feces | nd | nd | nd | nd | 0.0 | 0.0 | nd | nd | nd | nd | 0.0 | 0.0 |
| Deer Feces | nd | nd | nd | nd | 0.1 | 4.0 | nd | nd | nd | nd | 0.0 | 0.0 |
| Elk Feces | nd | nd | nd | nd | 2.2 | 28.0 | nd | nd | nd | nd | 0.0 | 0.0 |
| Litter >2 | nd | nd | nd | nd | 4.2 | 28.0 | nd | nd | nd | nd | 1.7 | 18.0 |

Appendix 10. Cover and frequency at Pickering Hills 1991 - 2009.

| Species | Grazed | | | | | | Exclosure | | | | | |
|----------------------------------|----------------|------|-------------|------|-------------|------|----------------|-------|-------------|------|-------------|------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | ------(%)----- | | | | | |
| Grass and Grasslike | | | | | | | | | | | | |
| Bluebunch wheatgrass | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 12.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 |
| Canada bluegrass | 1.7 | 28.0 | 1.3 | 12.0 | 6.4 | 16.0 | 1.3 | 20.0 | 1.0 | 4.0 | 0.0 | 0.0 |
| Cheatgrass | 2.1 | 24.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 22.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Columbia needlegrass | 4.7 | 48.0 | 0.0 | 0.0 | 0.5 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.8 | 32.0 |
| Idaho fescue | 0.0 | 0.0 | 0.3 | 2.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Kentucky bluegrass | 23.8 | 98.0 | 34.3 | 94.0 | 19.7 | 78.0 | 16.0 | 100.0 | 29.1 | 86.0 | 8.4 | 38.0 |
| Needle-and-thread | 0.0 | 0.0 | 2.3 | 16.0 | 0.0 | 0.0 | 0.6 | 4.0 | 0.7 | 8.0 | 0.0 | 0.0 |
| Pinegrass | 1.0 | 10.0 | 0.0 | 0.0 | 1.2 | 8.0 | 0.5 | 10.0 | 1.5 | 10.0 | 1.9 | 8.0 |
| Prairie Junegrass | 1.9 | 14.0 | 3.5 | 24.0 | 1.3 | 12.0 | 0.8 | 10.0 | 5.3 | 14.0 | 0.1 | 2.0 |
| Richardson's needlegrass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rough fescue | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 |
| Slender wheatgrass | 0.1 | 4.0 | 0.6 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Thickspike wheatgrass | 0.0 | 0.0 | 1.0 | 4.0 | 0.0 | 0.0 | 0.3 | 10.0 | 1.5 | 12.0 | 11.5 | 24.0 |
| Timothy | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 2.0 | 0.0 | 0.0 |
| Western needlegrass | 7.4 | 54.0 | 28.8 | 88.0 | 7.0 | 38.0 | 14.9 | 88.0 | 33.1 | 82.0 | 4.9 | 30.0 |
| Total Grass and Grasslike | 42.7 | | 72.1 | | 38.0 | | 35.4 | | 73.0 | | 32.4 | |
| | | | | | | | | | | | | |
| Forbs | | | | | | | | | | | | |
| American vetch | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Baker's mariposa lily | 0.0 | 0.0 | 0.5 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 6.0 | 0.1 | 2.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|----------------------|----------------|------|-------|------|-------|------|----------------|------|-------|------|-------|------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | ------(%)----- | | | | | |
| Balsamroot | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 4.0 | 0.8 | 2.0 | 0.0 | 0.0 |
| Bird's-foot trefoil | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Black medic | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 4.0 | 0.0 | 0.0 |
| Chickweed | 3.3 | 32.0 | 0.2 | 6.0 | 0.0 | 0.0 | 10.1 | 82.0 | 0.0 | 0.0 | 0.1 | 2.0 |
| Cinquefoil species | 1.4 | 6.0 | 0.0 | 0.0 | 6.5 | 50.0 | 0.6 | 4.0 | 0.0 | 0.0 | 0.1 | 2.0 |
| Common harebell | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Common mullein | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.3 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Dandelion | 1.5 | 22.0 | 2.5 | 42.0 | 0.1 | 4.0 | 1.8 | 40.0 | 0.3 | 4.0 | 0.0 | 0.0 |
| Death camas | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 6.0 | 0.0 | 0.0 |
| Diffuse knapweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 14.0 | 1.7 | 8.0 |
| Douglas' silene | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 |
| Dune goldenrod | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Field filago | 0.0 | 0.0 | 0.1 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Early blue violet | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fairy candelabra | 7.3 | 72.0 | 0.0 | 0.0 | 0.2 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 6.0 |
| Field locoweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hairy golden-aster | 0.2 | 6.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.3 | 2.0 | 0.0 | 0.0 |
| Hawkweed species | 0.0 | 0.0 | 0.0 | 0.0 | 5.7 | 18.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Holboell's rockcress | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Leafy aster | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 12.0 |
| Mariposa lily | 0.2 | 8.0 | 0.0 | 0.0 | 0.1 | 2.0 | 1.4 | 14.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Blue-eyed grass | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|--------------------------|----------------|------|-------------|------|-------------|------|----------------|------|-------------|------|-------------|------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | ------(%)----- | | | | | |
| Narrow-leaved goosefoot | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Nodding onion | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Nuttal's pussytoes | 1.0 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Prairie peppergrass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rosy pussytoes | 0.0 | 0.0 | 1.6 | 14.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Showy Aster | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 2.0 | 0.0 | 0.0 |
| Small-flowered penstemon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Spotted knapweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 |
| Spreading dogbane | 2.2 | 56.0 | 2.5 | 22.0 | 8.3 | 56.0 | 1.1 | 16.0 | 0.0 | 0.0 | 4.6 | 18.0 |
| Stoneseed | 0.3 | 4.0 | 0.3 | 4.0 | 0.6 | 4.0 | 0.1 | 2.0 | 0.3 | 2.0 | 1.2 | 8.0 |
| Sulphur cinquefoil | 0.0 | 0.0 | 1.6 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 8.0 | 0.0 | 0.0 |
| Thistle species | 0.0 | 0.0 | 0.1 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Timber milkvetch | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 4.0 | 0.6 | 4.0 | 0.0 | 0.0 |
| Tiny penstemon | 0.0 | 0.0 | 0.3 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Western yarrow | 0.3 | 14.0 | 3.2 | 28.0 | 0.6 | 4.0 | 0.5 | 20.0 | 2.8 | 20.0 | 0.2 | 8.0 |
| Wild strawberry | 0.4 | 8.0 | 2.0 | 12.0 | 1.0 | 8.0 | 0.1 | 2.0 | 0.6 | 4.0 | 0.6 | 4.0 |
| Yellow owl-clover | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yellow salsify | 0.2 | 6.0 | 0.1 | 2.0 | 0.1 | 2.0 | 0.3 | 12.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Forbs | 18.6 | | 16.1 | | 22.9 | | 19.3 | | 12.9 | | 10.1 | |
| | | | | | | | | | | | | |
| Trees and Shrubs | | | | | | | | | | | | |
| Bearberry | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.0 | 2.5 | 14.0 |

| Species | Grazed | | | | | | Exclosure | | | | | |
|-------------------------------|----------------|-------|-------------|------|-------------|-------|----------------|-------|-------------|-------|-------------|-------|
| | 1991 | | 1994 | | 2009 | | 1991 | | 1994 | | 2009 | |
| | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq | Cover | Freq |
| | ------(%)----- | | | | | | ------(%)----- | | | | | |
| Birch-leafed spirea | 0.8 | 32.0 | 2.5 | 32.0 | 0.1 | 2.0 | 1.6 | 36.0 | 3.5 | 26.0 | 0.5 | 10.0 |
| Bitterbrush | 20.9 | 80.0 | 29.6 | 76.0 | 11.6 | 36.0 | 12.4 | 68.0 | 23.0 | 74.0 | 12.3 | 52.0 |
| Buckbrush | 2.0 | 22.0 | 0.6 | 6.0 | 0.1 | 2.0 | 2.3 | 30.0 | 9.1 | 38.0 | 11.8 | 44.0 |
| Chokecherry | 0.8 | 12.0 | 0.4 | 6.0 | 0.4 | 4.0 | 0.0 | 0.0 | 0.8 | 2.0 | 0.0 | 0.0 |
| Low Oregongrape | 1.6 | 24.0 | 2.3 | 20.0 | 1.7 | 18.0 | 1.3 | 12.0 | 2.2 | 8.0 | 0.0 | 0.0 |
| Rose species | 3.4 | 28.0 | 4.1 | 28.0 | 0.0 | 0.0 | 1.4 | 24.0 | 2.2 | 16.0 | 0.0 | 0.0 |
| Prickly rose | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 14.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 14.0 |
| Saskatoon | 7.4 | 36.0 | 5.3 | 26.0 | 4.3 | 18.0 | 6.4 | 30.0 | 7.3 | 20.0 | 8.2 | 22.0 |
| Snowberry | 0.0 | 0.0 | 1.8 | 12.0 | 5.9 | 22.0 | 1.4 | 24.0 | 7.2 | 28.0 | 16.0 | 38.0 |
| Soopolallie | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 6.0 | 0.9 | 6.0 | 0.0 | 0.0 |
| Wood's rose | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 4.0 |
| Total Trees and Shrubs | 36.9 | | 46.6 | | 27.3 | | 27.0 | | 56.5 | | 53.9 | |
| Substrates | | | | | | | | | | | | |
| Bryophytes | 21.1 | 94.0 | 8.9 | 86.0 | 5.0 | 44.0 | 11.6 | 84.0 | 6.2 | 66.0 | 0.6 | 4.0 |
| Litter | 35.8 | 100.0 | 43.5 | 98.0 | 78.6 | 100.0 | 23.4 | 100.0 | 81.1 | 100.0 | 94.6 | 100.0 |
| Rock | 0.9 | 16.0 | 0.9 | 16.0 | 0.7 | 8.0 | 2.3 | 34.0 | 0.9 | 8.0 | 0.4 | 4.0 |
| Soil | 4.0 | 50.0 | 9.0 | 76.0 | 5.6 | 32.0 | 11.1 | 92.0 | 2.2 | 30.0 | 0.4 | 4.0 |
| Cattle Feces | 5.2 | 60.0 | nd | nd | 0.8 | 2.0 | 2.2 | 48.0 | nd | nd | 0.0 | 0.0 |
| Deer feces | nd | nd | 0.3 | 2.0 | 0.7 | 8.0 | nd | nd | 0.0 | 0.0 | 0.0 | 0.0 |
| Elk feces | nd | nd | 0.4 | 8.0 | 0.8 | 20.0 | nd | nd | 0.0 | 0.0 | 0.0 | 0.0 |