TOBY - HORSETHIEF RANGE UNIT
FORAGE ASSESSMENT RESEARCH PROJECT

Prepared for

B.C. Ministry of Forests
Invermere Forest District
Invermere, B.C.

by

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EXECUTIVE SUMMARY

This study was the first assessment of rangeland for resource management within the Toby - Horsethief Range Unit. Within selected areas. permanent transects were established and data were acquired. TWINSPAN, a FORTRAN clustering program was used to assist in determining the plant community types. With the aid of clip plots and data from other pertinent research, forage production was calculated. These data were used to determine carrying capacity for the usable range and the allowable stocking rate for each community type. During the study, other relevant management issues were evaluated. These included seasons of use, recreational use, industrial use, wildlife use, and the occurrence of non-native, weedy and poisonous plants.

The Toby-Horsethief Range Unit lies within the Interior Douglas-fir Zone of the B.C. Biogeoclimatic Ecosystem Classification. Recreational use is not restricted. Non-native plants and weeds were abundant. These included Canada thistle, white clover, red clover, sweet-clover, alfalfa, black medic, ox-eye daisy, dandelion and tall buttercup. Weeds of concern to rangeland management included diffuse knapweed and downy brome. Low larkspur, a poisonous plant, was found growing in abundance in the open grassland adjacent to Enid Lake and could pose a problem to domestic livestock in early summer. Timber milk-vetch, another poisonous plant, was common throughout the range unit. Elk and deer use during the winter months is apparently extensive.

Within the range unit, the study concentrated only on the areas under crown ownership. This covered approximately 3,293 ha. Of this, 262 ha (8%) was considered to be primary range, 1,332 ha (40%) was secondary range and the remaining 1,699 ha (52%) was tertiary range. There were numerous private land holdings within the overall study area. Many were unfenced, and were used by livestock. These were excluded in the calculations of carrying capacity and stocking rates.

The total carrying capacity of the area was approximately 998 animal unit months (AUMs). Of this, 37 AUMs were allocated for fall grazing in Peter's Pasture and 961 AUMs were allocated for the main herd. This herd utilised Barbour's Rock, Enid, Fifth, Poplar and Young pastures in a alternating rotational grazing system.

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1.0 INTRODUCTION

The Toby-Horsethief Range Unit, located near Invermere, British Columbia, was established in 1938 when Harry Barber began the permit system. Prior to this, the area had been grazed by feral horses and domestic cattle, who were allowed to roam the open range, unrestricted by fences. The feral horses subsequently were removed and the permit system resulted in the regulation of cattle use (Kirsh, pers. comm.).

The permit system allowed approximately 78 head of cattle on the range between April 1 and October 31. The range was not fenced until 1966-67. At this time, the range unit was divided into six pastures: Peter's, Barbour's Rock, Enid, Fifth, Poplar and Young. Between 1969 and 1974, breeding herds of between 120 and 225 animals were on the range each year between May 1 and October 31 (Kirsh, pers. comm.). The stocking rate was estimated at approximately 900 animal unit months (AUMs).

In order to determine the proper stocking rate for the pastures, Biota Consultants was contracted to identify and describe rangeland community types and to assess the forage resource within the range unit. The study took place during the grazing period of 1994 and also addressed other land use practices in relation to livestock grazing.

2.0 DESCRIPTION OF THE STUDY AREA

2.1 Physical Characteristics

The designated rangeland under crown ownership within the Toby-Horsethief Range Unit covers approximately 3,293 ha and ranges in elevation from 850 to 1,200 m above sea level along the Toby Benches. It is located on the west side of the Columbia River Valley in the Rocky Mountain Trench of south-eastern British Columbia (Figure 1).

The terrain consists mainly of gently undulating drumlinized and morainal till benches varying in texture with frayed scarps forming rough breaks where erosion has occurred. Drumlinized areas vary from rounded, narrow hills with steep north slopes and long south slopes, to rounded hills with moderate slopes in all directions. Morainal features have moderate to strongly rolling relief. Glacio-fluvial sand, silt and till deposits in addition to post-glacial lacustrine dunes occur in some areas, as well as small alluvial fans where drainage water has deposited the readily erodable sand and silt deposits. These deposits are transversed on the south and north by deeply incised meltwater channels which are now named Toby Creek and Horsethief Creek, respectively (Ryder 1981).

Figure 1. General location of the Toby-Horsethief Range Unit.

The majority of the range unit is comprised of a limy till parent material laid down by the Spillimacheen Glacier. This material is named the Wycliffe till (Schofield 1915) and ranges in thickness from less than a metre to 15 metres or more. It is a greyish white, loamy, calcareous mixture of silt, grit, gravels, stones and boulders in varying amounts, with little clay. When dry, it is compressed and cemented, but when wet, it tends to soften.

The drainage for the range unit is comprised of small intermittent tributaries which supply Wilmer and Neave Creeks. The peak water flow occurs in the spring during snow melt, and in June, which is normally the greatest rainfall month. In some depression areas where hard packed till occurs near the surface, ponding of water occurs. However, for most of the study area, the nature of the soils is such that they are well to rapidly drained, causing them to dry quickly and reducing water availablity to plants and animals.

The soil which has developed over the till is referred to as the Wycliffe silt loam, and generally supports forests (Kelly and Holland 1961). In areas where alluvial fans have developed, the soil is referred to as the Nokie silt loam and also generally supports forests. On relatively flat-bottom channels formed by glacial rivers, and on terraces, the Elko-Saha soils have developed. These are generally Dark Brown Soils and are associated with grasslands (Kelly and Holland 1961).

The typical Wycliffe soil profile for the Douglas-fir forested areas has been described by Kelly and Holland (1961) and is presented below:

Horizon	*Depth (cm.)*	*Description*
A_0	3 - 0	Forest litter, fluffy, well decomposed in the lower part. pH 5.7.
A	0 - 4	Light brownish grey (dry), dark greyish-brown (moist) silt loam. Thin platy structure; loose, porous, scattered gravel, stones and boulders. Many fine roots. pH 6.7.
AB	4 - 25	Light yellowish-brown (dry), dark yellowish-brown (moist) silt loam. Weak subangular blocky structure; slightly compact, scattered gravels, stones and boulders. Many fine roots. pH 6.6.
Cca	25 - 35	Pale yellow (dry), light olive (moist) silt loam. Weak medium subangular blocky structure; scattered lime coated gravels, stones and boulders. pH 8.0.
C_1	35 - 55	Light grey (dry), pale brown (moist) gritty silt loam. Massive, breaking to subangular clods, compact, stony, calcareous. pH 8.5.
C_2	55 +	Light grey (dry), pale brown (moist), gritty silt loam, calcareous glacial till. Stony, hard, cemented, impervious. pH 8.9.

A similar soil profile has been described by Spilsbury and Tisdale (1944) for the Douglas-fir zone in the Tranquille area and has been classified as a Brown Podzolic soil (Beaton 1953, McLean and Holland 1958).

The typical Elko-Saha soil profile for the grassland areas has been described by Kelly and Holland (1961) and is presented below. This soil type has been classified as a chernozemic Dark Brown soil and is representative of mid-elevation grasslands within the Douglas-fir zone (Tisdale 1947, McLean and Holland 1958, van Ryswyk *et al.* 1966)

Horizon	*Depth (cm.)*	*Description*
A_1	0 - 12	Dark greyish brown (dry), or very dark brown (moist) loam. Coarse, breaking to medium granular structure; soft, friable, scattered gravel. Many fine roots. pH 7.7.
B_1	12 - 20	Brown (dry), dark greyish-brown (moist) loam. Fine to medium subangular blocky structure; soft slightly compact, scattered gravel, calcareous. Root mats in the lower part. pH 7.9.
B-Dca	20 - 28	Light grey (dry) to yellowish-brown (moist) gritty loam mixed with lime-coated stones and gravel. Fine subangular blocky structure between stones, lime cemented. Scattered roots. pH 8.2.
D	28 +	Roughly stratified mixture of sand, gravel and stones to considerable depth. Porous, lime-coated stones in upper part. pH 8.5.

This soil originally developed in association with native bunch grasses, which generally have been eliminated by overgrazing and have been replaced subsequently by spear grass and less desirable forb species.

2.2 Climate

The area is influenced by a continental climate characterised by warm, dry summers and cool winters. Easterly movements of damp air from the Pacific Ocean dominate the climate. The general distribution of precipitation is affected by the north-south orientation of the mountain ranges, which act as barriers. The heaviest precipitation falls on the western windward slopes of the Purcell Mountains. A dry climate results in the Columbia River Valley. As a result, moisture deficiencies occur periodically throughout the year (Kelly and Holland 1961).

The mountain ranges shield the Columbia River Valley from the full effects of the mild maritime air and protect it from the cold extremes of cold arctic air. The Rocky Mountains form a barrier against polar air masses moving south in Alberta, although sometimes the cold air spills through the mountain passes into the Rocky Mountain Trench. Yukon air moving southward in the mountain valleys brings the coldest weather. Dry, warm air from the southern plateaux of the United States sometimes penetrates into the upper Columbia River Valley. In the summer these conditions produce hot day-time temperatures with cool nights (Kelly and Holland 1961).

Climatic data for the Columbia River Valley has been collected by different government agencies since the turn of the century. The data for Golden has been collected yearly since 1902, whereas in the Invermere area, the data is not as complete. Data collection began in Invermere with the establishment of an experimental station administered by the Canada Department of Agriculture in 1911. The station moved to the Elkhorn Ranch in 1928 and was used by the federal government until 1939. Climatic data continued to be collected until 1948 (Kelly and Holland 1961). More recently, the Ministry of Forests for the province of British Columbia, collects weather data to determine the forest fire hazard within the valley. There are often gaps in this data, as periods during the winter have low fire hazard ratings and the computerised systems occasionally malfunction.

Depending upon the location within the Columbia River Valley, differences in the climate are evident. Although higher precipitation values occur at Golden compared to stations further south within the valley (Tables 1 and 2), the annual temperature at Golden and in the Invermere area are very similar (Table 3). This results in a drier climate at the southern end of the valley. In addition to macroclimate variation from north to south, microclimatic variations occur due to topographic features. Wilmer, due to its protected location, is generally warmer and drier than Windermere during the growing season, even though it is only a few kilometres away (Tables 2 and 3).

The precipitation pattern within the valley is illustrated in Figure 2, which represents the climatic normals. The precipitation at Golden is highest during the winter compared to the rest of the year due to the amount of snowfall. In contrast, Windermere has the highest precipitation during the summer months and low snowfalls during the winter. At all stations within the valley, March and April are the driest months (McLean and Holland 1958).

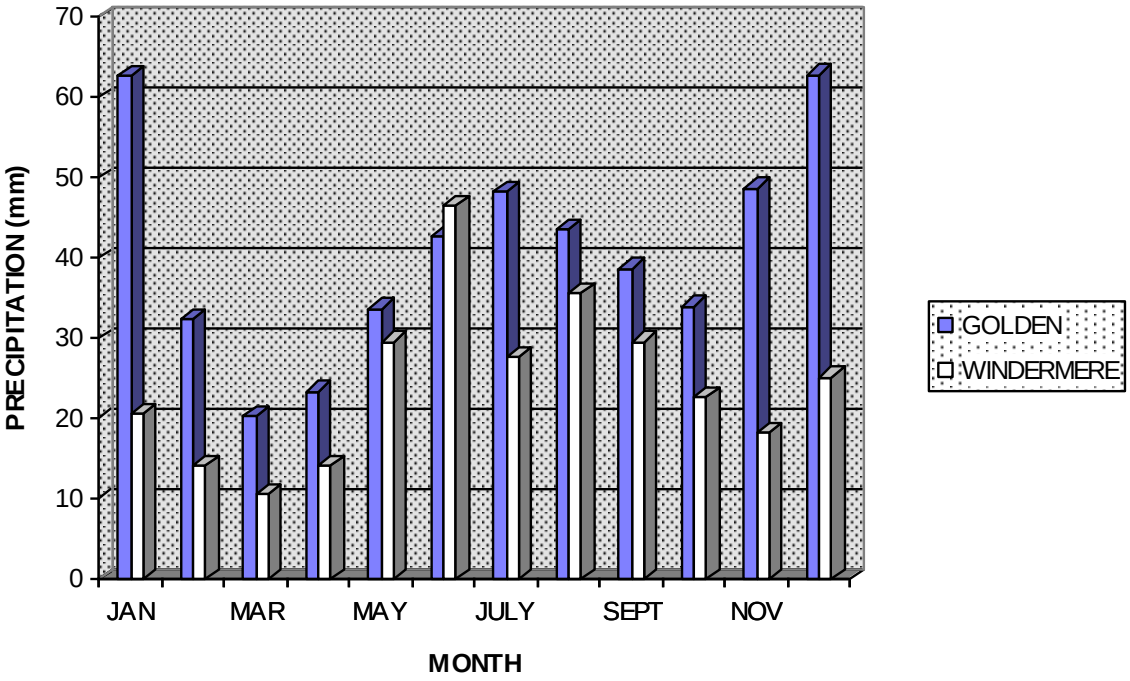

Figure 2. Monthly precipitation patterns from January to December in the upper Columbia River Valley. The climate at Golden represents the north part of the valley and the climate at Windermere represents the south part.

Table 1. Average monthly and annual precipitation (mm) at four meteorological stations in the upper Columbia River Valley for the years when weather records were taken.

Station	Elevation (m)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year	Years of Record
Golden[1]	787	62.6	32.4	20.3	23.4	33.7	42.7	48.2	43.5	38.7	34.0	48.6	62.7	490.7	1902-90
Invermere[2]	851	27.2	20.6	8.4	19.8	30.7	38.9	30.2	38.1	28.9	17.3	14.7	27.4	302.3	1913-48
Windermere[3]	865	20.6	14.2	10.7	14.2	29.5	46.5	27.7	35.6	29.5	22.6	18.3	25.2	294.4	1914-49
Wilmer[4]	945	31.2	15.5	13.2	13.2	30.5	41.7	32.8	38.9	27.9	19.8	22.4	29.2	319.0	1909-25

Table 2. Per cent precipitation as snow, and the high, low, average, annual and growing season precipitation values at meteorological stations in the upper Columbia River Valley.

Station	Percent as Snowfall	Annual Precipitation			May-September Precipitation		
		High	Low	Average	High	Low	Average
Golden[1]	37.5	589.3	249.7	490.7	285.6	83.8	171.1
Windermere[2]	26.6	404.9	164.3	294.4	262.9	77.0	164.1
Wilmer[4]	28.3	364.2	253.0	318.3	224.0	79.2	149.6

Table 3. Average seasonal temperatures (°C) at meteorological stations in the upper Columbia River Valley.

Station	Winter	Spring	Summer	Autum	Yearly Mean
Golden[1]	-8.9	5.0	15.6	4.4	4.0
Windermere[2]	-8.9	5.0	15.6	4.4	4.0
Wilmer[4]	-8.3	5.5	16.1	4.4	4.4

Source: 1 Canadian Climate Normals, Environment Canada, Atmospheric Environment Service,1961-90, Vol. 2 and 3
2 Climate of British Columbia, Department of Agriculture, Victoria, B.C., 1916-59 (Kelly and Holland 1961)
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2.3 Biogeoclimatic Zonation

The Toby-Horsethief Range unit is located in the Interior Douglas-fir dry, mild (IDFdm) Biogeoclimatic Zone (Meidinger and Pojar 1991). This zone occupies the rolling hills and valley terrain of the south-central Interior Plateau and Rocky Mountain Trench within British Columbia. The zone also extends into Idaho, Montana, Washington , Oregon and Alberta. The Douglas-fir zone occurs at elevations below the Montane Spruce zone and above the Ponderosa Pine zone.

Within British Columbia, this zone occurs at elevations between 350 m (in some valleys) and 600 m, with upper elevations ranging from 900 m to 1450 m, and is characterised by warm, dry summers, a fairly long growing season and cool winters. The mean annual temperature ranges from 1.6 to 9.6°C and the mean annual precipitation ranges from 295.1 to 1198.9 mm, of which 20-50% falls as snow (Hope *et al*. 1991). Moisture deficits are common throughout the growing season and frosts are common.

Pure open and closed Douglas-fir (*Psuedotsuga menziesii*) stands are common depending upon the fire history. In areas where ground fires were frequent, large, widely spaced, mature trees with thick bark are prevalent. Where crown fires have occurred, there are mixed stands of lodgepole pine (*Pinus contorta*) amongst the Douglas-fir. Another seral species, trembling aspen (*Populus tremuloides*), is common in clones on mesic sites, especially on alluvial fans. In moist areas (i.e., drainage channels and creek beds), hybrid white spruce (*Picea engelmannii* x *glauc*a) occurs (McLean and Holland 1958).

Depending on the topographic, edaphic and hydrologic conditions, and fire history, grassland communities may have evolved. Although large extensive grasslands do occur in other areas of the Interior Douglas-fir zone, they occur as small isolated areas in the Toby-Horsethief Range Unit. Many of these grasslands have been modified by domestic livestock grazing. A description and condition of specific grasslands within this range unit are presented in the results and discussion section of this document.

2.4 Vegetation of the Range Unit

The Douglas-fir zone for this area of the Columbia River Valley has been sub-divided into two sub-zones and the wetlands (hydroseres). The sub-zones have been designated as Douglas-fir groveland and Douglas-fir forest (McLean and Holland 1958).

The Douglas-fir groveland sub-zone occupies the driest portions of the valley, and generally occurs on dry benches and south-facing lower slopes. It is closely affiliated with the Pinegrass (*Calamagrostis rubescens*) and Ponderosa Pine Biogeoclimatic Zone with respect to plant species composition. With an increase in moisture holding capacity, reduced evaporation or increased precipitation, this sub-zone develops into the Douglas-fir forest subzone (McLean and Holland 1958). Due to the extreme variability of the terrain (i.e., aspect, slope and exposure), the vegetation expression is influenced greatly. This results in a mosaic of vegetation associations within a relatively small geographic area.

2.4.1 Douglas-fir Groveland Sub-zone.

Due to the savannah or park-like nature of this subzone, islands of grassland occur amongst scattered scrubby trees of Douglas-fir and Rocky-Mountain Juniper (*Juniperus scopulorum*). Within this subzone, the fescue/snowberry and Douglas-fir/wheatgrass associations can be found (McLean and Holland 1958). The first association is characterised by an equal occurrence of bluebunch wheatgrass (*Elymus spicatum*) and fescue (both *Festuca idahoensis* and *F. campestris*). Commonly associated shrub and forb species include: snowberry (*Symphoricarpos occidentalis*), Saskatoon-berry (*Amelanchier alnifoilia*), Rose (*Rosa* spp.), soopolallie (*Sheperdia canadensis*), Kinnikinnick (*Arctostaphylos uva-ursi*), pussytoes (*Antennaria parvifolia*), timber milk-vetch (*Astragalus miser),* golden-aster (*Heterotheca villosa*), brown-eyed Susan (Gaillardia aristata), Columbia gromwell (*Lithospermum ruderale*), long-leaved fleabane or daisy (*Erigeron corymbosus*) and thread-leaved fleabane or daisy (*Erigeron filifolius* var. *filifolius*).

The second association (Douglas-fir/wheatgrass) represents the climatic climax for this subzone (McLean and Holland 1958). Although the ground cover is similar to the previous association, there is an increase in snowberry and rose. Sandberg bluegrass (*Poa secunda*) is common and Pinegrass (*Calamagrostis rubescens*) may occur locally in moist sites, especially on east slopes. In sandy areas, rabbit brush (*Chrysothamus nauseosus*), silverberry (*Elaeagnus commutata*) and creeping juniper (*Juniperus horizontalis*) are common. This

association can also be found within the bluebunch wheatgrass/fescue association, where it is restricted to the driest sites and shallow soils.

2.4.2 Douglas-fir Forest Sub-zone.

This sub-zone is the most extensive plant community in the range unit and consists of a number of different associations depending upon the site factors. Two of the most prominent associations are the Douglas-fir/pinegrass and the Douglas-fir/snowberry . The former represents the climatic climax for this sub-zone (McLean and Holland 1958).

The principal shrubs include soopolallie, rose, kinnikinnick and twinflower (*Linnaea borealis*). After fire , willows (*Salix* spp.) and dwarf bilberry (*Vaccinium caesiptosum*) are common during the early seral stages. Associated forb species include: showy aster (*Aster conspicuus*), timber milk-vetch, yellow peavine (*Lathyrus ochroleucus*), wild strawberry (*Fragaria virginiana*) and heart-leaved arnica (*Arnica cordifolia*). American vetch (*Vicia americana*) and peavine are common on the moister sites especially within aspen clones on the deeper soils. Pinegrass and kinnicknick constitute the dominant species depending upon the fire history. The latter is very susceptible to fire damage.

In moist depression areas and on deep soils, snowberry (*Symphoricarpos albus*) increases in abundance, resulting in the Douglas-fir/snowberry association. Associated species include rose, birch-leaved spiraea (*Spiraea lucida*), Oregon grape (*Berberis repens*), silverberry, soopolallie and Saskatoon-berry.

Throughout this subzone within the range unit, both commercial logging and Christmas tree cutting has been carried out extensively. In areas of landings, sawmills , skid trails and logging roads, tame forage mixes have been seeded in an attempt to increase the forage production for cattle grazing. This has introduced species such as Kentucky bluegrass (*Poa pratensis*), Canada bluegrass (*Poa compressa*), white clover (*Trifolium repens*), alfalfa (*Medicago sativa*), black medic (*Medicago lupulina*) and sweet clover (*Melilotus alba* and *M. officinale*). These species have spread throughout the area and threaten many native rangeland species.

2.4.3 Hydroseres.

In catchment basins or areas of poor drainage, wetlands occur. These include sedge fens dominated by such species as water sedge (*Carex aquatilis*), beaked sedge (*C. rostrata*) and slender sedge (*C. lasiocarpa*). In shallow depressions and around open lakes, cattail (*Typha latifolia*) and great bulrush (*Scirpus lacustris*) are common. In some areas, sodium salts (alkali) are abundant in the soil and have caused saline meadows. These areas are dominated by halophytic plants such as alkali grass (*Distichlis stricta*), Nuttall's alkaligrass (*Puccinellia nuttalliana*) and foxtail barley (*Hordeum jubatum*). Along stream channels and moist drainages, low and tall shrub species are prevalent. These include scrub birch (*Betula glandulosa*), swamp birch (*B. pumila*) and willows (*Salix* spp.).

3.0 LAND USE

3.1 Historic Land Use

The first Caucasian to enter the Columbia River Valley was David Thompson in 1807. He established the "Kootenae House" near Athalmer as a trading post to acquire firs from the local indigenous peoples. Thereafter, the population within the valley expanded.

In 1884 the Elkhorn Ranch was established near Windermere. Agricultural production was an integral part of the ranch. Within the area, wheat, oats, barley, clover, alfalfa, other hay, hardy vegetables, small fruits, hardy fruit trees and a variety of livestock were produced (Kelly and Holland 1961). In the belief that the upper Columbia River Valley was a potential tree-fruit growing district, an experimental station was established at Invermere by the Canada Department of Agriculture in 1911. By 1922, it was realised that commercial apple and pear production was futile. In 1923 the experimental station was moved to the Elkhorn Ranch and continued to operate until 1939 (Kelly and Holland 1961). Under the pioneer conditions which prevailed, it was determined that livestock production, especially cattle ranching, was the most profitable agricultural activity.

The area of the Toby-Horsethief Range Unit was originally incorporated as the Columbia Valley Irrigated Fruitlands Limited in 1911. Although the land holdings extended as far south as Canal Flats, the development area concentrated on the north side of Toby Creek. Boulder and Goldie creeks fed the system of wooden and steel flumes supported by lumber

trestles, open ditches and wooden stave pipes. The system was abandoned after World War II (Kelly and Holland 1961).

The Toby-Horsethief Range Unit was established in 1938 when Harry Barber began the permit system. Prior to this, the area had been grazed by feral horses and domestic cattle which roamed the free range. The population of the horse herd reached approximately 2,000 head by 1948, when they were shot and sent to the packing plant (Kirsh, pers. comm.). Although the cattle were allowed to freely roam the area between Toby and Horsethief creeks, the season of use was restricted to between April 1 and October 31, and the number was restricted to approximately 78 head (Kirsh, pers. comm.). The number of livestock utilising the range each year between 1938 and 1969 is uncertain, however, government documents for the period from 1969 to 1974 indicate that breeding herds of between 120 and 225 animals had been on the range between May 1 and October 31. In 1966-67, the range unit was fenced and divided into the six pastures (Kirsh, pers. comm.).

3.2 Present Land use

The land within the Toby-Horsethief Range Unit is owned by both the British Crown (in trust to the Province of British Columbia) and private holdings. On the crown land, annual permits are issued for cattle grazing, Christmas tree cutting and logging.

There are four range tenure holders in the area. The Statham family run 174 cow/calf pairs and 7 bulls from approximately May 10 to October 31 in a five pasture rotation. The Kirsh family generally run 52 cow/calf pairs and 2 bulls in the same pastures as the Stathams. Mr. Albert Cooper runs 16 horses from May 10 to September 5 in the same rotation. Mr. Kaspar Heiz runs 30 cattle on Peter's Pasture for the month of September. Throughout the central area of the range unit, there are numerous small private property holdings, many of which are unfenced. This poses some unique problems with respect to livestock distribution and trespass.

Two areas have been designated for recreational use. At Lake Enid there is a primitive campground, boat launch and docking facility. At Lillian Lake, a day use facility includes picnic tables. Both lakes have been stocked with fish and are used by anglers on a regular basis. Random camping is prevalent in the areas surrounding Lake Enid, and in the open grasslands of Poplar Pasture. This activity takes place mainly during the summer weekends and is tolerated, although not encouraged.

4.0 METHODS

4.1 Preliminary Work

Preliminary work involved meeting with the Resource Officer, Range, Invermere Forest District. An initial assessment of the study area involved reviewing the available aerial photography, maps and background information on the range unit. The methodology, schedule of events and mode of transport within the study area were discussed. A meeting with the permittees was held in conjunction with a tour of the range unit. This allowed an opportunity to become acquainted with the area and management practices.

4.2 Field Survey

Access to the study area was by road and on motorcycle. Initial field sampling to determine plant community types was conducted between June 15 and July 11, 1994, in accordance with standards specified by the Resource Officer, Range, and the range survey manual. Forage production assessment using standard clipping techniques was performed between July 24 and 30. A final assessment of the range unit to evaluate forage utilisation and grazing patterns was conducted on October 18, 19 and 20, 1994.

Areas to be sampled were delineated on aerial photography and then were traversed in the field to assess the homogeneity of the vegetation community. Transects adjacent to previously established forage production cages (range exclosures) were named using the same number as the cages. Some community types were deemed important to survey using a transect but were not represented by a production cage. All of the transects were given alpha-numeric labels that represented the area in which they were located.

Metal spikes were inserted at either end of the transect and detailed notes were made on the transect's exact position with respect to other features, to aid in future relocation. In addition, a hand held G.P.S. Unit (Global Positioning System) was used to determine the latitude and longitude of each transect. This information was recorded on the data sheet and is presented in Appendix A. In addition, the location of each transect is also illustrated on aerial photography.

Each transect was placed to best represent the community to be sampled. On slopes, the transect was placed parallel to slope contours. Each transect was 30 m in length with

microplots placed at 2 m intervals for a total of 15 microplots per site. At each interval, the per cent canopy cover of each plant species and site factor (bare ground, rock, litter and wood debris) in a 20 X 50 cm plot was estimated. A 1 m² plot was used for shrubs. Plant species were denoted by a seven letter code consisting of the first four letters of the genus and the first three letters of the species. Appendix B lists the full scientific names and acronyms of all of the plant species encountered along the transects. For each transect, 35 mm colour photographs were taken for documentation and future comparisons.

Although the minimum site size was originally set at 2 ha (5 acres), field inspections revealed that some areas of smaller size had to be surveyed as they were important foraging areas. During the course of field inspections, notes were taken to describe plant communities on sites for which quantitative data were not acquired. Important plant species observed in the surveyed areas but not recorded on transects also were noted.

A ½ m² area was clipped inside each forage production cage. A ½ m² area was clipped in a representative area if no cage was present. Each area was clipped to the standard 2 cm stubble height and separated into grass, forbs and shrubs. Each cage was moved from its original position and relocated in the same location after the area inside had been clipped.

Selected floral specimens from the areas sampled were collected, pressed, identified or verified, and labelled. In rare cases, the specimens obtained were not adequate to allow conclusive identification. These plant species are followed by a "?" when referenced in this document. Scientific nomenclature follows the B.C. Ministry of Forests "The Vascular Plants of British Columbia" (Douglas *et al*. 1989, 1990, 1991, 1993). To aid in identification, the "Flora of the Pacific Northwest" (Hitchcock and Cronquist 1978) and "Flora of Alberta" (Moss 1983) were consulted.

4.3 Data Analysis

The clipped samples were weighed to the nearest tenth of a gram to determine wet (or fresh) weight and then placed in a drying oven. Each sample was re-weighed to determine oven dry weight.

Calculations were performed on the transect data using Lotus 1-2-3 spreadsheet software to determine the average cover, species composition and prominence value of each plant

species. The species composition data were sorted in descending order to determine the species with the highest values in each stratum.

The data were subjected to TWINSPAN, a FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. The analysis sorted the data into similar groups or clusters. Each cluster was then evaluated and the sites were assigned a preliminary habitat (range) type[1] classification.

The assigned range types are preliminary, since they were designated using a classification adopted from the Alberta Forest Service. The range types may change when a standard classification is implemented by the B.C. Ministry of Forests.

The range type classification used for this study is based on the vegetation type, landscape position, moisture regime and plant community complexes. The designations for each category are defined in Table 4.

Table 4. Range type classification.

VEGETATION TYPE	LANDSCAPE POSITION	MOISTURE REGIME	PLANT COMMUNITY COMPLEXES
1 - Grassland 2 - Wetland meadow 3 - Cutblock 4 - Prostrate shrubland 5 - Brushland 6 - Coniferous forest 7 - Forb meadow 8 - Rock 9 - Mixedwood forest 10 - Deciduous forest 11 - Alpine meadow	B - Bottomland L - Lower slope T - Terrace F - Plain U - Upper slope P - Upland H - Hilltop	Hd - Hydric Hg - Hygric M - Mesic Sm - Submesic X - Xeric	A|B - B is 80-100% of A C/D - D is 51-80% of C E//F - F is 26-50% of E G///H - H is 5-25% of G

The plant species composition used for the plant community complexes is based upon the transect data and other sites where detailed notes were taken. This was based primarily on predetermined, selected sites within the primary and secondary rangeland. The forested

[1] A habitat (range) type is a collective term for all areas in which the integrated sum of all environmental conditions allows succession to proceed toward the same climax association (Daubenmire 1976). A climax association is self-perpetuating in the absence of disturbance and is not susceptible to natural replacement by another community under the existing conditions of climate, soil and flora.

region throughout this range unit has not been adequately surveyed to produce a definitive vegetation classification of all possible habitat types. This was outside the scope of the terms of reference for this study.

4.3.1 Carrying Capacity

The data obtained from the clippings were used to determine the carrying capacity[2]. To determine the carrying capacity, the following guidelines were applied to the type of animal utilising the forage (Table 5).

Table 5. Animal equivalent and forage consumption by different animals.

TYPE OF ANIMAL	WEIGHT lbs (kgs)	ANIMAL UNIT EQUIVALENT	FORAGE CONSUMED PER MONTH lbs (kgs)
Horse	1100 (495)	1.25	1000 (450)
Range cow (w/calf)	1200 (650)	1.2	960 (430)
Animal Unit (AU)	1000 (455)	1.0	800 (360)
Cow Elk	500 (225)	0.38	035 (135)
Domestic Sheep	200 (90)	0.25	200 (90)
Whitetail Deer	130 (60)	0.125	100 (45)

The forage assessment carrying capacity was based on cattle (range cow (with calf)), as they constitute the primary domestic grazing animals in the study area. To determine the carrying capacity (in AUMs[2]) for each range type, the following formula was applied:

$$\text{AUM} = \frac{\text{AREA (ha) X PRODUCTION (kg/ha) - SAFE USE FACTOR (50\%)}}{\text{ANIMAL UNIT FORAGE CONSUMPTION PER MONTH}}$$

where: AREA (ha): usable area is the total area minus the unusable area due to tree, shrub or water cover;

[2] Animal unit month (AUM) is defined as the forage removed by one 1000 lb (454 kg) beef animal grazing for one month. The animal is referred to as an "animal unit" (AU). A horse is considered to weigh an average of 1100 lbs (495 kg) resulting in a value of 1.25 AU, and consumes 1000 lbs (450 kg) of dried forage per month.

PRODUCTION (kg/ha): forage production for grass and forbs based on the clip data;

SAFE USE FACTOR (50%): At least half of the annual forage should be left for carry over (a requirement for plant regrowth, seed production, winter insulation and erosion control. Half of this 50% should be dedicated for wildlife forage);

ANIMAL UNIT CONSUMPTION: Horses consume approximately 450 kg of dried forage per month (or 15 kg per day).

4.4 Mapping

The mapping was done initially on acetate overlays covering the 1:20,000 colour imagery. Stereo paired photos were used to delineate the boundaries of the range type polygons. The information was subsequently transferred to a 1:20,000 digital base map using a zoom-transfer scope. Vegetation communities of isolated polygons were inferred from similar sampled community types based on air photo interpretation . Forest cover maps were used to determine per cent crown closure and type of overstorey on a macro scale.

The transect and plot locations were placed onto mylars overlays. The range type polygons were placed on a different mylar. Each range type polygon was assigned a number. A description of the range type of each polygon was placed in the legend. A three character range type classification code was used which includes associated vegetation type, landscape position and moisture regime. The community type was placed below the range type classification. This follows the procedure outlined in the "Canadian Vegetation Classification System" (Strong *et al*. 1990). Dashes (-) separated species of the same growth form and slashes (/) separated species of different growth forms.

Each polygon was given a sequential number (1-180) to aid in digitising the maps so that they can be used in a Geographical Information System (G.I.S.) by the Ministry of Forests.

5.0 RESULTS and DISCUSSION

Both the qualitative and quantitative results of the forage inventory are presented in this section. Qualitative information is discussed along with accompanying photography to exemplify the issue. Quantitative data from the vegetation survey and forage production assessments are summarised. The original forms, photography and maps are kept on file with the Ministry of Forests, Invermere Forest District, Invermere.

5.1 Vegetation Types and Communities

Quantitative data were collected from 54 sites. The level of sampling during this study was adequate for the purposes outlined in the terms of reference. Although field notes were taken describing species composition in the major vegetation communities, not all of the vegetation types within the area were fully assessed to determine forage production (e.g., forest cover types, forest cut-blocks designated for reforestation, wetlands and private land which was not fenced to restrict access by free-roaming cattle).

The TWINSPAN program separated eleven groups or community types. These are illustrated in Figure 3. Within some groups, further divisions can be made based upon specific species composition. For each of the groups, the average per cent cover of the dominant species, the species composition, site characteristics, forage production and stocking rate are presented.

A list of the plant species encountered on the transects are presented in Appendix B. It includes the scientific name, common name and the seven letter code used on the data sheets and in the plant community type (range type) legend for the map.

Based on the plant community classification and the forest cover types, 180 community type polygons were identified. These are presented in Appendix C. Maps accompany the list of polygons for each pasture.

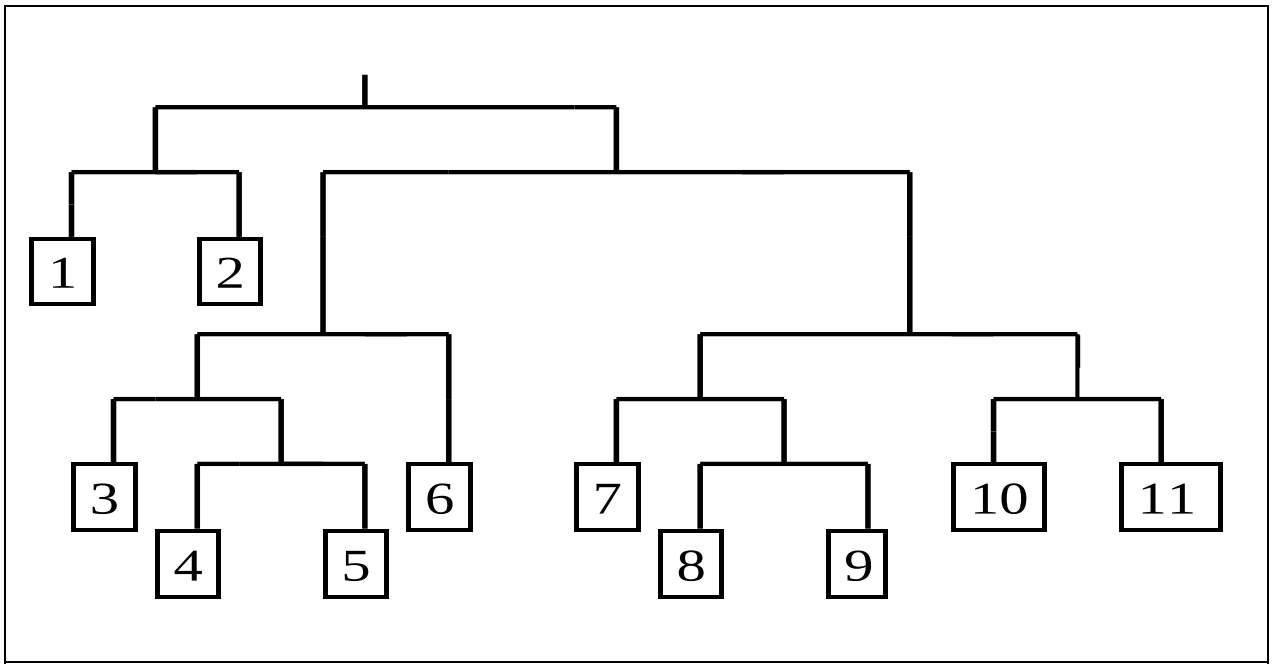

Figure 3. Clustering of plant communities within the Toby-Horsethief Range Unit study area.

Plant Community	Corresponding Polygons
1. Potentilla anserina / Sonchus asper (N=1)	(121)
2. Agrostis stolonifera/ Carex spp. / Potentilla anserina (N=1)	(122)
3. Arctostaphylos uva-ursi / Festuca campestris / Calamagrostis rubescens (N=11)	(11, 74, 84, 148, 178, 179)
4. Stipa nelsonii | Stipa richarsonii // Poa compressa / Antennaria parviflora (N=7)	(32, 38, 47, 62, 85, 89, 177)
5. Stipa comata / Antennaria microphylla | Erigeron pumila (N=3)	(119, 152, 153)
6. Poa pratensis // Medicago sativa //Elymus hispidus (N=4)	(31, 151, 155, 156)
7. Poa compressa // Trifolium repens / Stipa richardsonii | Oxytropis sericea (N=4)	(81, 82, 123, 132)
8. Poa compressa // Trifolium repens | Medicago lupulina // Taraxacum officinale (N=12)	(12, 20, 22, 40, 41, 50, 52, 53, 65, 66, 72, 76)
9. Poa compressa // Trifolium repens | Taraxacum officinale / Medicago lupulina (N=4)	(33, 61, 92, 144)
10. Poa compressa // Antennaria microphylla / Medicago lupulina (N=6)	(116, 148, 153, 174, 176, 177)
11. Poa compressa | Taraxacum officinale // Agrostis gigantea (N=1)	(86)

A|B - B is 80-100% of A

C/D - D is 51-80% of C

E//F - F is 26-50% of E

G///H - H is 5-25% of G

5.1.1. ***Potentilla anseina - Sonchus asper* Community Type (N=1).**

The silverweed (*Potentilla anserina*) [57.4%] - prickly sowthistle (*Sonchus asper*) [33.1%] community type was found in only one location within the range unit. This area was situated in a moist alkali drainage basin above Enid Lake (Plate 1). It is considered to be of minor value as a foraging area due to the species composition.

Representative sites: EN-03

Ecosystem: Interior Douglas-fir (forest sub-zone)

Landscape position: Upland (P)

Elevation: 963 m

Slope: None

Aspect: None

Moisture regime: Hygric

Productivity (kg/ha): graminoids - 31.0
forbs - 1527 (unpalatable)

Stocking rate:
31 kg/ha÷450 kg/ha X 50% safe use =
0.03 AUMs per hectare
(5.4 hectares per AUM)

Vegetation: (most abundant species)

Agrostis stolonifera (creeping bentgrass)
Carex praticola (meadow sedge)
Elymus trachycaulus (slender wheatgrass)
Juncus balticus (Baltic rush)
Poa glauca (glaucous bluegrass or muttongrass)

Potentilla anserina (silverweed)
S*onchus asper* (prickly sowthistle)

5.1.2. ***Agrostis stolonifera - Carex spp. / Potentilla anserina*** **Community Type(N=1)**

The creeping bentgrass (*Agrostis stolonifera*) [39.5%] - sedge (*Carex* spp.) [10.7%] / silverweed (*Potentilla anserina*) [4.8%] community type was located in the drainage channel between the previous community type and Enid Lake (Plate 2). It was likely a glacio-fluvial meltwater channel and continues to receive subterranean moisture from the surrounding landforms.

Representative sites: EN-03

Ecosystem: Interior Douglas-fir (forest sub-zone)

Landscape position: Upland (P)

Elevation: 963 m

Slope: None

Aspect: None

Moisture regime: Hygric

Productivity (kg/ha): graminoids - 1181
forbs - 160

Stocking rate:
1341 kg/ha÷450 kg/ha X 50% safe use =
1.49 AUMs per hectare
(0.1 hectares per AUM)

Vegetation: (most abundant species)

Agrostis stolonifera (creeping bentgrass)
Carex praticola (meadow sedge)
Poa pratensis (Kentucky bluegrass)

Antennaria sp. (everlasting)
Crepis runcinata (dandelion hawksbeard)
Melilotus alba (white sweet-clover)
Potentilla anserina (silverweed)
Sonchus asper (prickly sowthistle)
Trifolium repens (white clover)
Viola adunca (early blue violet)

Plate 1. Site EN-02 representing the *Potentilla anserina* - *Sonchus asper* community type.

Plate 2. Site EN-03 representing the *Agrostis stolonifera* - *Carex* spp. */ Potentilla anserina* community type.

5.1.3. *Arctostaphylos uva-ursi / Festuca campestris - Calamagrostis rubescens* Community Type (N=13).

The bearberry (*Arctostaphylos uva-ursi*) [19.1%] / rough fescue (*Festuca campestris*) [14.8%] - pinegrass (*Calamagrostis rubescens*) [10.3%] community type represents the climatic climax community (Plate 3). However, in some areas, due to long term grazing and seeding practices, the natural character of this community has been altered by the introduction of tame forage species.

Representative sites: PE-01-06, BA-04, PO-05, YO-03, YO-08, YO-13

Ecosystem: Interior Douglas-fir Groveland sub-zone (fescue/snowberry association)

Landscape position: Upland (P)

Elevation: 841 - 983 m

Slope: 0 - 28%

Aspect: 0 - 198º

Moisture regime: Mesic

Productivity (kg/ha): graminoids - 63.4 to 921.4 (mean = 611.8)
forbs - 2.6 to 338.0 (mean = 123.6)
shrubs - 0 to 1176.4 (mean = 259.2)

Stocking rate:
462.6 - 1673.6 kg/ha÷450 kg/ha X 50% safe use = 0.51 - 1.86 AUMs per hectare (mean 1.1)
0.32 - 0.09 hectares per AUM (mean 0.15)

Vegetation: (most abundant species)

Calamagrostis rubescens (pinegrass)
Danthonia californica (California oatgrass)
Elymus spicata (bluebunch wheatgrass)
Festuca campestris (rough fescue)
Koelaria macrantha (June grass)
Poa compressa (Canada bluegrass)
Poa pratensis (Kentucky bluegrass)
Stipa nelsonii (Columbian needlegrass)
Stipa richardsonii (spreading needlegrass)

Anemone multifida (cut-leaved anemone)
Antennaria parviflora (everlasting)
Astragalus miser (timber milk-vetch)
Balsamorhiza sagittata (arrow-leaved balsamroot)
Erigeron pumilus (shaggy fleabane)
Heterotheca villosa (golden aster)
Lithospermun ruderale (Columbia gromwell)
Medicago lupulina (black medic)
Medicago sativa (alfalfa)
Oxytropis sericea (silky locoweed)
Penstemon confertus (yellow penstemon)
Solidago missouriensis ((Missouri goldenrod)
Tragopogon dubius (yellow slasify)
Trifolium repens (white clover)

Amelanchier alnifolia (Saskatoon-berry)
Arctostaphylos uva-ursi (bearberry)
Chysothamnus nauseosus (common rabbit-brush)
Rosa spp. (rose)
Symphoricarpos albus (common snowberry)

5.1.4. *Stipa nelsonii - Stipa richardsonii - Poa compressa / Antennaria parviflora* Community Type (N=7).

The Columbian needlegrass (*Stipa nelsonii*) [20.7%]- spreading needlegrass (*Stipa richardsonii*) [17.4%]- Canada bluegrass (*Poa compressa*) [8.1%] / Nuttall's pussytoes (*Antennaria parviflora*) [5.2%] community type represents a regressive community which has characteristics similar to the community previously described in section 5.1.3 (Plate 4). This is a result of long term grazing practices.

Representative sites: BA-09, BA-10, EN-05, FI-03 FI-04, YO-05, YO-15

Ecosystem: Interior Douglas-fir Groveland sub-zone (fescue/snowberry association)

Landscape position: Upland (P)

Elevation: 957 - 1050 m

Slope: 0 - 18%

Aspect: 90 - 220º

Moisture regime: Mesic

Productivity (kg/ha): graminoids - 183.0 to 744.4 (mean = 507.3)
forbs - 27.2 to 251.2 (mean = 102.4)

Stocking rate:
210.2 - 858.2 kg/ha÷450 kg/ha X 50% safe use = 0.23 - 0.95 AUMs per hectare (mean 0.68)
0.7 - 0.17 hectares per AUM (mean 0.24)

Vegetation: (most abundant species)

Calamagrostis rubescens (pinegrass)
Danthonia californica (California oatgrass)
Elymus trachycaulus (slender wheatgrass)
Festuca campestris (rough fescue)
Koelaria macrantha (June grass)
Poa compressa (Canada bluegrass)
Poa pratensis (Kentucky bluegrass)
Stipa nelsonii (Columbian needlegrass)
Stipa richardsonii (spreading needlegrass)

Anemone multifida (cut-leaved anemone)
Antennaria parviflora (Nuttall's pussytoes)
Astragalus miser (timber milk-vetch)
Balsamorhiza sagittata (arrow-leaved balsamroot)
Erigeron pumilus (shaggy fleabane)
Erigeron caesiptosus (tufted fleabane)
Lithospermun ruderale (Columbia gromwell)
Medicago lupulina (black medic)
Oxytropis sericea (silky locoweed)
Penstemon confertus (yellow penstemon)
Tragopogon dubius (yellow slasify)
Trifolium repens (white clover)
Vicia americana (American vetch)

Amelanchier alnifolia (Saskatoon-berry)
Arctostaphylos uva-ursi (bearberry)

Plate 3. Site PE-06 represents the *Arctostaphylos uva-ursi / Festuca campestris - Calamagrostis rubescens* community type.

Plate 4. Site YO-05 represents the *Stipa nelsonii - Stipa richardsonii - Poa compressa / Antennaria parviflora* community type.

5.1.5. ***Stipa comata / Antennaria microphylla - Erigeron pumilus* Community Type (N=3).**

The needle and thread grass (*Stipa commata*) [26.4%] / rosy pussytoes (*Antennaria microphylla*) [20.8%]- shaggy fleabane (*Erigeron pumilus*) [17.1%] community type occurs on sandy soils and represents a more xeric phase of the community previously described (Plate 5). The main difference is the dominance of needle and thread grass. Its abundance can partially be attributed to long term grazing practices.

Representative sites: EN-01, PO-02, PO-07

Ecosystem: Interior Douglas-fir Groveland sub-zone
(fescue/snowberry association)

Landscape position: Upland (P)

Elevation: 925 - 1000 m

Slope: 0 - 18%

Aspect: 90 - 220º

Moisture regime: xeric

Productivity (kg/ha): graminoids - 228.6 to 881.6 (mean = 524.8)
forbs - 11.6 to 50.6 (mean = 26.9)
shrubs - 0 to 20.2 (mean = 6.7)

Stocking rate:
279.2 - 900.6kg/ha÷450 kg/ha X 50% safe use =
0.3 - 1.0 AUMs per hectare (mean 0.46)
0.53 - 0.16 hectares per AUM (mean 0.35)

Vegetation: (most abundant species)

Elymus hispidus (intermediate wheatgrass)
Elymus spicata (bluebunch wheatgrass)
Koelaria macrantha (June grass)
Poa compressa (Canada bluegrass)
Poa pratensis (Kentucky bluegrass)
Stipa nelsonii (Columbian needlegrass)

Antennaria micophylla (rosy pussytoes)
Astragalus miser (timber milk-vetch)
Erigeron pumilus(shaggy fleabane)
Erigeron caesiptosus (tufted fleabane)
Heterotheca villosa (golden aster)
Medicago lupulina (black medic)
Oxytropis sericea (silky locoweed)
Tragopogon dubius (yellow salasify)

Artemesia frigida (pasture sage)
Chysothamnus nauseosus (common rabbit-brush)

5.1.6. *Poa pratensis / Medicago sativa / Elymis hispidus* Community Type (N=4).

The Kentucky bluegrass (*Poa pratensis*) 47.7%] / alfalfa (*Medicago sativa*) [20.6%] / intermediate wheatgrass (*Elymis hispidus*) [9.2%] community type occurs primarily in forest clearings which have been reclaimed with tame forages (Plate 6). Occasionally, this community type occurs in natural grassland areas which have been subjected to heavy grazing. The native species have been displaced by non-natives.

Representative sites: BA-05, PO-01, PO-03, PO-04

Ecosystem: Interior Douglas-fir forest sub-zone

Landscape position: Upland (P)

Elevation: 923 - 1032 m

Slope: 0 - 7%

Aspect: 0 - 90º

Moisture regime: xeric to mesic

Productivity (kg/ha): graminoids - 657.2 to 1159.4
(mean = 1024.3)
forbs - 41.0 to 375.4
(mean = 158.5)
shrubs - 0 to 21.2
(mean = 5.3)

Stocking rate:
698.2 - 1504.8 kg/ha÷450 kg/ha X 50% safe use =
0.78 - 1.67 AUMs per hectare (mean 0.21)
0.21 - 0.10 hectares per AUM (mean 0.12)

Vegetation: (most abundant species)

Carex spp. (upland sedges)
Elymus hispidus (intermediate wheatgrass)
Elymus spicata (bluebunch wheatgrass)
Koelaria macrantha (June grass)
Poa compressa (Canada bluegrass)
Poa pratensis (Kentucky bluegrass)
Stipa nelsonii (Columbian needlegrass)

Antennaria parviflora (Nuttall's pussytoes)
Heterotheca villosa (golden aster)
Medicago lupulina (black medic)
Medicago sativa (alfalfa)
Oxytropis sericea (silky locoweed)
Tragopogon dubius (yellow slasify)

Artemesia frigida (pasture sage)
Elaeagnus commutata (silverberry)
Rosa spp. (rose)
Symphoricarpos albus (common snowberry)

Plate 5. Site PO-07 represents the *Stipa comata / Antennaria microphylla - Erigeron pumilus* community type.

Plate 6. Site PO-04 represents the *Poa pratensis / Medicago sativa / Elymis hispidus* community type.

5.1.7. ***Poa compressa / Trifolium repens / Stipa richardsonii / Oxytropis sericea*** **Community Type (N=4).**

The Canada bluegrass (*Poa compressa*) [35.0%] / white clover (*Trifolium repens*) [13.1%] / spreading needlegrass (*Stipa richardsonii*) [7.9%] | silky locoweed (*Oxytropis sericea*) [6.5%] community type represents a native grassland (see 5.1.4) which has undergone change as a result of heavy grazing pressure, logging and past seeding practices (Plate 7). Many of the desirable native species have low cover values, and have been displaced by two dominant non-native species, Canada bluegrass and white clover.

Representative sites: EN-07, EN-08, YO-02, YO-12

Ecosystem: Interior Douglas-fir forest sub-zone

Landscape position: Upland (P)

Elevation: 936 - 1040 m

Slope: 0 - 5%

Aspect: variable

Moisture regime: Mesic

Productivity (kg/ha): graminoids - 603.8 to 1849.0
(mean = 1166.6)
forbs - 27.4 to 220.4
(mean = 90.2)

Stocking rate:
640.8 - 1851.7 kg/ha÷450 kg/ha X 50% safe use = 0.71 - 2.06 AUMs per hectare (mean 1.40)
0.23 - 0.08 hectares per AUM (mean 0.12)

Vegetation: (most abundant species)

Calamagrostis rubescens (pinegrass)
Danthonia californica (California oatgrass)
Elymus trachycaulus (slender wheatgrass)
Festuca campestris (rough fescue)
Koelaria macrantha (June grass)
Poa compressa (Canada bluegrass)
Poa pratensis (Kentucky bluegrass)
Stipa nelsonii (Columbian needlegrass)
Stipa richardsonii (spreading needlegrass)

Anemone multifida (cut-leaved anemone)
Aster ericoides (tufted white prairie aster)
Astragalus miser (timber milk-vetch)
Medicago lupulina (black medic)
Penstemon confertus (yellow penstemon)
Oxytropis sericea (silky locoweed)
Solidago missouriensis (Missouri goldenrod)
Trifolium repens (white clover)
Vicia americana (American vetch)

Arctostaphylos uva-ursi (bearberry)

5.1.8. *Poa compressa / Trifolium repens - Medicago lupulina - Taraxacum officinale* Community Type (N=12).

The Canada bluegrass (*Poa compressa*) [41.3%] / white clover (*Trifolium repens*) [17.2%] - alfalfa (*Medicago luplina*) [15.1%] - dandelion (*Taraxacum officinale*) [7.2%] community type represents a further regressive community, yet has characteristics similar to the community previously described (Plate 8). This is a result of past seeding and long term grazing practices. Some of the sites represented in this community type are located in reclamation areas, such as utility zones (linear hydro line clearings) and clearings (log landing areas).

Representative sites: BA-01, BA-02, BA-03, BA-06, BA-07, YO-04, YO-06, YO-09, YO-10, YO-11, YO-14, YO-16

Ecosystem: Interior Douglas-fir forest sub-zone

Landscape position: Upland (P)

Elevation: 891 - 1042 m

Slope: 0 - 14%

Aspect: variable

Moisture regime: Xeric to Mesic

Productivity (kg/ha): graminoids - 190.6 to 2,428.8 (mean = 785.0)
forbs - 9.9 to 585.4 (mean = 198.4)

Stocking rate:
195.7 - 2,737.0 kg/ha÷450 kg/ha X 50% safe use = 0.22 - 3.04 AUMs per hectare (mean 1.1)
0.73 - 0.5 hectares per AUM (mean 0.15)

Vegetation: (most abundant species)

Bromus inermis (smooth brome)
Dactylis glomerata (orchard grass)
Elymus trachycaulus (slender wheatgrass)
Festuca campestris (rough fescue)
Festuca rubra (creeping red fescue)
Juncus balticus (Baltic rush)
Koelaria macrantha (June grass)
Poa compressa (Canada bluegrass)
Poa pratensis (Kentucky bluegrass)
Stipa nelsonii (Columbian needlegrass)
Stipa richardsonii (spreading needlegrass)

Anemone multifida (cut-leaved anemone)
Antennaria microphylla (rosy pussytoes)
Antennaria parviflora (Nuttall's pussytoes)
Cirsium arvense (Canada thistle)
Erigeron pumilus (shaggy fleabane)
Medicago lupulina (black medic)
Medicago sativa (alfalfa)
Oxytropis sericea (silky locoweed)
Penstemon confertus (yellow penstemon)
Taraxacum officinale (dandelion)
Tragopogon dubius (yellow slasify)
Trifolium repens (white clover)
Vicia americana (American vetch)

Rosa spp. (rose)
Symphoricarpos albus (common snowberry)

Plate 7. Site EN -08 represents the *Poa compressa / Trifolium repens / Stipa richardsonii / Oxytropis sericea* community type.

Plate 8. Site BA-01 represents the *Poa compressa / Trifolium repens - Medicago lupulina - Taraxacum officinale* community type.

5.1.9. ***Poa compressa / Trifolium repens - Taraxacum officinale - Medicago lupulina*** **Community Type (N=4).**

The Canada bluegrass (*Poa compressa*) [32.8%] / white clover (*Trifolium repens*) [14.1%] - dandelion (T*araxacum officinale*) [11.7%] - alfalfa (*Medicago luplina*) [8.3%] community type is similar to the community previously described (5.1.8). However, there are fewer desirable native species, and more non-natives, some of which are classified as weeds* (Plate 9). All of the sites represented in this community type are located in areas which have been disturbed by logging and have possibly been seeded. These include utility zones (linear hydro line clearings), clearings (log landing areas), and an old homestead site. A unique species occupying each site is ox-eye daisy (*Chrysanthemum leucanthemum*), which has an average cover of 6.1%.

Representative sites: BA-08, EN-06, FI-01, YO-07

Ecosystem: Interior Douglas-fir forest sub-zone

Landscape position: Upland (P)

Elevation: 936 - 1058 m

Slope: 0 - 10%

Aspect: variable

Moisture regime: Mesic

Productivity (kg/ha): graminoids - 491.6 to 2,169.0
(mean = 1,267.5
forbs - 24.0 to 276.8
(mean = 144.2)

Stocking rate:
515.6 - 2,304.0 kg/ha÷450 kg/ha X 50% safe use = 0.57 - 2.56 AUMs per hectare (mean 1.57)
0.28 - 0.6 hectares per AUM (mean 0.10)

Vegetation: (most abundant species)

Dactylis glomerata (orchard grass)
Phleum pratense (Timothy)
Poa compressa (Canada bluegrass)
Stipa nelsonii (Columbian needlegrass)

Chrysanthemum leucanthemum (ox-eye daisy)*
Cirsium arvense (Canada thistle)*
Medicago lupulina (black medic)
Penstemon confertus (yellow penstemon)
Taraxacum officinale (dandelion)*
Trifolium repens (white clover)
Vicia americana (American vetch)

Amelanchier alnifolia (Saskatoon-berry)

5.1.10. *Poa compressa / Antennaria microphylla - Medicago lupulina* Community Type (N=6).

The Canada bluegrass (*Poa compressa*) [43.4%] / rosy pussytoes (*Antennaria microphylla*) [15.3%] - black medic (Medicago lupulina) [8.6%] community type represents the disclimax plant community as described in 5.1.5. This a result of heavy grazing pressure. It has also been influenced by the introduction of non-native species, specifically, tame forage species (Plate 10).

Representative sites: EN-04, EN-09, PO-06, PO-8 PO-09, PO-10

Ecosystem: Interior Douglas-fir forest sub-zone

Landscape position: Upland (P)

Elevation: 940 - 976 m

Slope: 0 - 7%

Aspect: 90 - 270º

Moisture regime: Sub-Mesic

Productivity (kg/ha): graminoids - 377.3 to 437.8 (mean = 407.6)
forbs - 10.0 to 30.0 (mean = 20.0)

Stocking rate:
378.3 - 467.8 kg/ha÷450 kg/ha X 50% safe use =
0.42 - 0.52 AUMs per hectare (mean 4.7)
0.38 - 0.31 hectares per AUM (mean 0.34)

Vegetation: (most abundant species)

Elymus smithii (western wheatgrass)
Elymus spicata (bluebunch wheatgrass)
Koeleria macrantha (June grass)
Poa compressa (Canada bluegrass)
Stipa nelsonii (Columbian needlegrass)
Stipa richardsonii (spreading needlegrass)

Anemone multifida (cut-leaved anemone)
Antennaria microphylla (rosy pussytoes)
Aster ericoides (tufted white prairie aster)
Astragalus miser (timber milk-vetch)
Erigeron pumilus (shaggy fleabane)
Medicago lupulina (black medic)
Medicago sativa (alfalfa)
Oxytropis sericea (silky locoweed)
Solidago missouriensis ((Missouri goldenrod)
Tragopogon dubius (yellow salasify)
Trifolium repens (white clover)

Arctostaphylos uva-ursi (bearberry)
Rosa spp. (rose)
Symphoricarpos albus (common snowberry)

Plate 9. Site FI-01 represents the *Poa compressa / Trifolium repens - Taraxacum officinale Medicago lupulina* community type.

Plate 10. Site PO-08 represents the *Poa compressa / Antennaria microphylla - Medicago lupulina* community type.

5.1.11. *Poa compressa / Taraxacum officinale / Agrostis gigantea* Community Type (N=1).

The Canada bluegrass (*Poa compressa*) [32.0%] / dandelion (*Taraxacum officinale*) [34.4%] / redtop (*Agrostis gigantea*) [13.2%] community type represents a plant community which has some of the same species described in 5.1.8, but contains a high cover of dandelion (Plate 11). In addition, this site has species which are normally associated with wetter soil conditions. It has also been influenced by the introduction of non-native species, specifically, tame forage species.

Representative sites: FI-02

Ecosystem: Interior Douglas-fir forest sub-zone

Landscape position: Upland (P)

Elevation: 1015 m

Slope: 0 - 2%

Aspect: variable

Moisture regime: Sub-Mesic

Productivity (kg/ha): graminoids - 1,170.8
forbs - 78.8

Stocking rate:
1558.2 kg/ha÷450 kg/ha X 50% safe use =
1.38 AUMs per hectare
0.12 hectares per AUM

Vegetation: (most abundant species)

Agrostis gigantea (redtop)
Carex praegracilis (field sedge)
Juncus balticus (Baltic rush)
Phleum pratense (Timothy)
Poa compressa (Canada bluegrass)
Poa fendleriana (muttongrass)?

Cerastium fischerianum (Fisher's chickweed) ?
Cirsium arvense (Canada thistle)
Galeopsis tetrahit (hemp nettle)
Medicago lupulina (black medic)
Potentilla anserina (silverweed)
Ranunculus acris (tall buttercup)
Sisyrinchium idahoense (Idaho blue-eyed-grass)
Taraxacum officinale (dandelion)
Trifolium repens (white clover)
Vicia americana (American vetch)

Plate 11. Site FI-02 represents the *Poa compressa / Taraxacum officinale / Agrostis gigantea* community type.

5.2 Forage Production and Carrying Capacity.

The carrying capacity for domestic livestock within the entire range unit is approximately 998.4 AUMs, of which 181.5 AUMs are on primary range and 816.9 AUMs are on secondary range (Table 6). This value is based on 50% of the total forage production derived from actual clip plots and data extrapolated from other sources, and then applied to each usable polygon on crown land. For the five pasture rotation of the main livestock herd, the carrying capacity is approximately 961 AUMs. For Peter's Pasture, the estimated carrying capacity is 37 AUMs.

The annual forage production data were collected primarily on open rangeland and for only one growing season (1994) (Appendix D). They may not represent the average production over many years. The amount of precipitation during 1993 was above the norm during the growing season but fell below the norm during the fall months (Figure 4). The below average trend continued throughout the winter with low snowfall levels. In 1994, the amount

of rainfall was below the norm and possibly resulted in low production values. These data should be used only as a guide until long term forage production data have been acquired.

Table 6. Total area (ha) and AUMs on primary, secondary, and tertiary range within each pasture.

	PRIMARY		SECONDARY		TERTIARY		TOTAL	
PASTURE	ha	AUMs	ha	AUMs	ha	AUMs	ha	AUMs
BARBOUR'S ROCK	19.7	20.3	472.2	275.2	208.8	0	700.7.	295.5
YOUNG	151.4	123.5	347.7	173.9	77.0	0	576.1	297.4
FIFTH	14.3	14.9	144.2	98.2	275.8	0	434.3	113.1
ENID	57.4	14.2	26.4	62.0	996.3	0	1080.1	76.2
POPLAR	19.2	8.6	289.3	170.2	141.5	0	450.0	178.8
PETER'S	0	0	51.9	37.4	0	0	51.9	37.4
TOTAL	262.0	181.5	1331.7	816.9	1699.4	0	3293.1	998.4

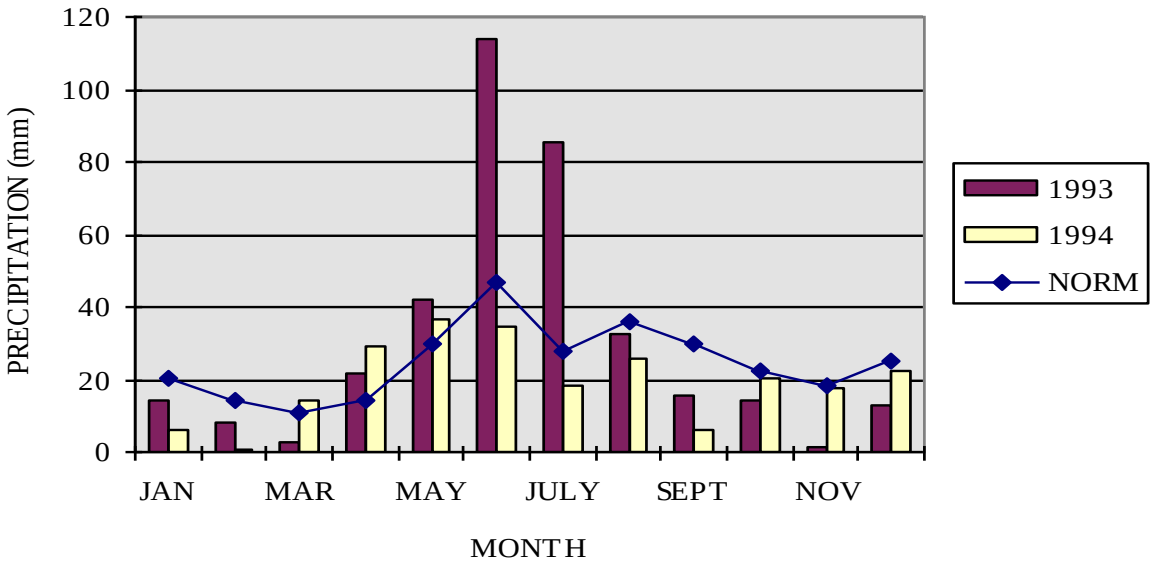

Figure 4. Average monthly precipitation for 1993 and 1994 compared to a 35 year average in the Invermere area.

Another consideration when assessing forage production and correlating it to precipitation is the precipitation/evaporation (P/E) ratio. If the temperatures are high, the evaporation levels are elevated, resulting in less soil moisture. Precipitation during the growing season, (i.e., late July, August and early September) often has little effect on plant growth and therefore forage production, since the vegetation generally matures prior to this time. In 1993, precipitation exceeded evaporation, likely resulting in high forage yields. One wet year will affect production, however, a period of two or more successive wet or dry years are required to alter basal frequency cover (Olson *et al*., 1985). In contrast, 1994 precipitation levels were below the norm and temperatures were high, likely resulting in low forage yields.

A close relationship exists between environmental factors and plant growth and development (Leopold and Kriedemann 1975). With weather fluctuations, yearly forage production and species composition can vary, as indicated in numerous studies (Clarke *et al*. 1947, Coupland 1958, McLean and Smith 1973, Perry 1976, Weaver and Collins 1977, Newbauer *et al*. 1980, Bronson and Miller 1981). Generally, effective soil moisture for plant growth is supplied in the spring by melting snow (van Ryswyk *et al*. 1966).

In addition to natural variability of forage production due to fluctuations in weather and climate, the natural landscape has been altered in many areas of the range unit. Although some of the range unit has naturally occurring Douglas-fir forest, the majority of the forest has been modified by logging and Christmas tree harvesting, Although efforts were made to sample some representative sites, many areas have not been fully sampled. Therefore, to determine forage production and carrying capacity, it was necessary to assess other relevant research pertaining to the Interior Douglas-fir zone and extrapolate forage production data. These data should only be used as a guide until actual data has been acquired for this range unit.

Tisdale (1950) reported that within the Interior Douglas-fir zone, the principal herbaceous species is pinegrass. It commonly composes 40 to 50 per cent of the ground cover and 50 to 70 per cent of the forage yield (Tisdale 1950, Tisdale and McLean 1957). However, the understorey vegetation cover is strongly affected by the tree canopy cover, the age of the stand and the type of tree (Tisdale and McLean 1957). The amount of herbaceous cover is highest in poplar stands, intermediate in lodgepole pine and mixed conifer-poplar stands, and lowest in Douglas-fir stands.

Numerous studies in the Interior Douglas-fir zone have measured the herbaceous growth under different forest canopies by clipping plots and determining the dry weights. The results of such studies are presented in Table 7. Dodd *et al*. (1972), also determined the forage (herbage) production beneath different canopy covers of Douglas-fir.

Table 7. Herbage production (kg/ha) beneath different forest types and per cent canopy cover.

	TYPE OF FOREST CANOPY COVER				
REFERENCE	ASPEN	MIXEDWOOD	LODGEPOLE PINE	MATURE DOUGLAS-FIR	IMMATURE DOUGLAS-FIR
Tisdale (1950)	724	376	465	193	114
Tisdale and McLean (1957)	720	-	465	201	-
McLean, Lord and Green (1971)	-	-	-	672	-
McLean (1979)-	-	-	-	273	-
Stout and Quinton (1986)	-	-	-	292	67
Wilkeen and Stout (1983)	720	-	-	180	-

Dodd, McLean and Brink (1972)	-	-	-	677 (5% tree cover) 660 (10% tree cover) 629 (15% tree cover) 598 (20% tree cover) 555 (25% tree cover) 511 (30% tree cover) 475 (35% tree cover) 440 (40% tree cover) 410 (45% tree cover) 380 (50% tree cover) 344 (55% tree cover) 307 (60% tree cover) 263 (65% tree cover) 219 (70% tree cover) 190 (75% tree cover) 161 (80% tree cover)	

The study by Dodd *et al*. (1972) on the relationship between tree-crown cover and grazing value was conducted in forests with relatively even Douglas-fir crown covers without evident clumpiness, tree regeneration or species other than Douglas-fir. All plots were located on south-facing slopes of 5 to 20%. In the Toby-Horsethief Range Unit, it was observed that south-facing slopes had more forage growth compared to the north- and east-facing slopes. Also, it was evident that the steeper the slope on the north and east aspects, the less understorey herbage production. Many of the morainal and drumlin formations in the study area are oriented in a northwest-southeast direction.

Therefore, caution must be used in extrapolating data from one region to another and even between areas within the same study area. For instance, in Barbour's Rock Pasture, understorey herbage production can vary depending in the overstorey cover. Although both sites in this pasture were on level terrain, Plate 12 illustrates the lack of herbage when the forest canopy cover is approximately 45%. The ground cover is primarily moss, although small patches of pinegrass do occur. In areas of canopy openings, light can penetrate to the ground, resulting in an increase in pinegrass cover (Plate 13).

According to Stout and Quinton (1986), pinegrass range at lower elevations in British Columbia can be grazed for up to 120 days starting in May or June. Stocking rates vary from 0.08 AUMs/ha on dense grass stands to 0.01 AUMs or less depending upon such factors as distance from water, accessibility, topography, fencing, crown closure of trees, soils, site

productivity, etc. On average, Douglas-fir - lodgepole pine forests with interspersed openings can be stocked at about 0.02 AUMs/ha (Stout and Quinton 1986).

Considering that the approximate area within the Toby-Horsethief Range Unit is 3,293 ha, a stocking rate of 0.02 AUMs/ha would allow 263 AUMs. This would be a 73% reduction from the previously calculated rate (960 AUMs) and current stocking rates (936 AUMs). However since the primary rangeland is severely over-utilised and much of the secondary range is under-utilised, a stocking rate at 263 AUMs may be more in line with current management practices.

As displayed in Table 5, calculations indicated that the primary range should support 181.5 AUMs. However, the utilisation ranges from 40% to 94% with an average of 68%. To reduce the overall utilisation to the 50% safe use factor, implementation of better management techniques is essential.

Plate 12. Sparse herbaceous ground cover beneath 45% crown canopy cover of Douglas-fir.

Plate 13. Opening in the forest canopy which results in an increased herbaceous ground cover.

5.3 Management Issues

5.3.1 Water Availability

The availablity of water within the range unit is one of the most crucial elements of a livestock management grazing system. The sources of water for Poplar Pasture include the south side of Wilmer Lake (Plate 14), portions of the Columbia River on its east side and a small area of the Horsethief Creek on the north side. Access to the river and creek involve traversing steeply eroded banks. Water for Enid Pasture is supplied by Lake Enid, Wilmer Creek and some small wetlands in the valley of Wilmer Creek. Wilmer Creek also cuts through Fifth Pasture and is its only water source. Neave Creek, a small drainage tributary to Lillian Lake cuts through Barbour's Rock Pasture (Plate 15). Lillian Lake is fenced off to livestock and used as a recreational facility. Some cottages border its banks. Long Lake, although small, also provides a water supply for this pasture (Plate 16). Young Pasture has the least amount of quality water. Although water from Lake Eileen is available, its alkaline nature reduces the quality and livestock tend to avoid drinking it. The only water sources in this pasture are small depression watering holes (Plates 17, 18, and 19). The source of these watering areas is primarily surface runoff during snowmelt. The quality is reasonable in the spring. However, it degenerates throughout the summer with the growth of algae and duckweed (*Lemna minor*). The edges are muddy, often causing the water to be murky. The grassland range surrounding these areas are considered primary range and are heavily grazed.

5.3.2 Recreational Properties and use of Highway to Panorama

West of Invermere, a considerable number of seasonal and permanent resident land holdings compound problems associated with livestock management. Some of these properties have fences to exclude roaming livestock while others do not. In both cases, special problems arise. Fences can interfere with normal livestock movement (i.e., migrating from water to foraging areas) and the lack of fences allows cattle to wander into unwanted territory, resulting in property damage. Due to complaints from landowners who do not have their properties fenced, cattle have been removed from the pasture ahead of schedule (e.g., in Fifth Pasture). This causes utilisation problems and interferes with proper management of the resource. Another issue of concern to some is the open range policy and vehicle traffic along the highway to Panorama. Although the use of the range by livestock dates back many decades, some people feel that cattle should not be allowed to be on the paved roads.

Plate 14. Poplar Pasture adjacent to Wilmer Lake.

Plate 15. Neave Creek, a well used livestock watering location in Barbour's Rock Pasture.

Plate 16. Long Lake and a heavily utilised range on the south side. The wire cage (exclosure) is used to restrict grazing. Clips from inside this cage assisted in the determination of forage production at this location.

Plate 17. One of five small watering holes in an area commonly referred to as the "potato patch" in Young Pasture.

Plate 18. A heavily used watering hole on the side of the road to Panorama, in Young Pasture. The green plant covering the surface of the water is duckweed.

Plate 19. Another watering hole in Young Pasture, adjacent to the hydro line.

5.3.3 Livestock Distribution

Throughout this study, it became apparent that there was a problem with the distribution of livestock. Some areas of the range unit were under-utilised and other areas were severely over-utilised. As previously mentioned, the range near the waterbodies was utilised at 94% of the production, well beyond the acceptable 50% safe-use factor. This is generally the result of inadequate management techniques, including daily range riding to move livestock to the secondary ranges and location of salting areas.

Recreational activities can cause distribution problems. In areas such as around Lake Enid and in Poplar Pasture, random camping and use of all-terrain vehicles can "spook" cattle, causing them to leave an area, or concentrate in other areas.

5.3.4 Livestock Grazing System

As mentioned in section 3.2 (present land use), the livestock grazing system is primarily concerned with the main cow/calf breeding herd and a small herd of accompanying horses. The grazing system has been consistent since 1977. Generally, in the odd numbered years (i.e., 1977, 1979,...1993) the herd has been released onto Poplar Pasture in May. They are then herded onto Enid Pasture, then Barbour's Rock Pasture, and finally onto Young Pasture, where they are removed in October. In the even years (1978, 1980, ...1994), they are first released onto Young Pasture. They then move to Barbour's Rock, Enid and, finally, Poplar Pasture. A small herd is usually separated from the main herd in mid-season and released onto Fifth Pasture. These animals are slated for sale in the late summer.

The rotation grazing system is summarised in Table 8. This information was extracted from the actual range use forms and includes the AUMs used in each pasture since 1977. Prior to 1977, government records were unavailable.

The use of Young Pasture in late spring (May) one year, and then in late fall (September - October) the next year is to reduce land use conflict with private land owners. Within this pasture, there are many unfenced small recreational properties which are used primarily during the summer months. Therefore, to reduce interaction, the livestock herds are kept in other pastures. This rotational system is dependent upon the availability of water, which is the most critical factor for this rotational system.

Table 8. Animal unit months (AUMs) and rotational sequence (in brackets) between 1977-1994.

Pasture	YEAR																	
	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94
Barbour's Rock	320 (3)	320 (2)	320 (3)	374 (2)	295 (3)	255 (2)	247 (3)	298 (2)	230 (3)	350 (2)	248 (3)	348 (2)	248 (3)	348 (2)	248 (3)	320 (2)	285 (3)	309 (2)
Enid	320 (2)	320 (3)	320 (2)	240 (3)	200 (2)	247 (3)	213 (2)	180 (3)	262 (2)	173 (3)	261 (2)	217 (3)	261 (2)	231 (3)	261 (2)	228 (3)	200 (2)	171 (4)
Fifth	-	-	-	-	65 (3)	75 (3)	90 (3)	120 (3)	100 (3)	110 (3)	62 (3)	25 (3)	75 (3)	33 (3)	75 (3)	38 (3)	72 (3)	80 (3)
Poplar	120 (1)	120 (4)	120 (1)	160 (4)	160 (1)	110 (4)	127 (1)	90 (4)	175 (1)	85 (4)	174 (1)	93 (4)	174 (1)	93 (4)	174 (1)	114 (4)	206 (1)	90 (5)
Young	120 (4)	120 (1)	120 (4)	120 (1)	160 (4)	128 (1)	138 (4)	170 (1)	119 (4)	175 (1)	124 (4)	217 (1)	155 (4)	208 (1)	155 (4)	206 (1)	143 (4)	246 (1)
Cow/Calf	880	880	880	880	880	815	815	858	886	886	869	900	913	913	913	906	906	896
Bulls	18	18	18	18	18	18	18	20	20	20	23	23	23	23	23	25	24	26
Total	898	898	898	898	898	833	833	878	906	906	892	923	936	936	936	931	930	922

5.3.5 Non-native Plants and Weed Infestations

The potential for the establishment and spread of non-native plant species (especially weeds) is a concern to rangeland and resource managers. The aggressive nature of many non-native plants allows them to out-compete the native flora for space. This causes a change in plant species composition and can affect the quality and quantity of the native forage resource.

One problem which many range managers face is the use of non-natives for reclamation after industrial activity. Throughout the Toby-Horsethief Range Unit, past practices of seeding logging roads, skid trails and landings has resulted in the invasion of seeded species into many native range areas. Not only do these aggressive species disperse naturally, but also by cattle when they consume them and disseminate the seeds through their digestive tracts. The non-native species which are prolific throughout the range include white and red clover (*Trifolium repens* and *T. pratense*, respectively) (Plate 20), white and yellow sweet clover (*Melilotus alba* and *M. officinale*, respectively), alfalfa, black medic, Canada bluegrass and Kentucky bluegrass. Other species which have colonised specific sites include Timothy, orchard grass, ox-eye daisy (Plate 22), tall buttercup (*Ranunculus acris*) (Plate 23) and dandelion.

Plate 20. Logging trail which was been seeded with tame forage species and is now dominated by clovers.

Plate 21. A weed infested gravel pit in Barbour's Rock Pasture.

Plate 22. Ox-eye daisy in a linear utility clearing in Enid Pasture.

Plate 23. Tall buttercup growing along a logging road.

Two species of particular concern within the range unit are downy brome (*Bromus tectorum*) and diffuse knapweed (*Centaurea diffusa*). Downy brome grows in abundance along the gravel roadsides in the southern portion of the area. It was also found in a gravel pit in Barbour's Rock Pasture with numerous other weed species (Plate 21). The distribution of this species should be carefully assessed, mapped and then eliminated as it poses a great threat to the adjacent rangelands. Diffuse knapweed was found growing in one location, along a dirt trail at the north end of Poplar Pasture, (50º 34.31' N latitude, 116º 05.44' W longitude, W5M). It appeared to have been introduced with a pile of organic waste, dropped off at the roadside. The plant was hand picked and removed from the site to reduce the spread of seeds. This site should be re-visited next year to determine if seedlings exist.

5.3.6 Poisonous Plants

Two poisonous plants were observed within the range unit, although others may exist. These included low larkspur (*Delphinium bicolor*) and timber milk vetch (*Astragalus miser*).

Low larkspur was found growing in the grassland at the north side of Enid Lake. This plant was relatively abundant in cover in early June during the range tour, but was not evident during the actual inventory in the later part of June and July. The concentration of a neurotoxic alkaloid within this plant varies with its phenological development and topo-edaphic conditions (Majak 1993). It is most toxic during its vegetative stage while growing under moisture stress, especially to cattle, although horses can be affected. It is relatively palatable and if enough plants are consumed, poisoning can occur.

Timber milk-vetch was found growing throughout the entire range unit. Its toxicity levels differ from area to area. In addition, its toxicity levels can increase with an increase in precipitation during its growth (McLean 1979). Its toxicity is greatest just before flowering. If dry conditions prevail, toxic conditions decline soon after flowering, and the plants generally lose their toxicity once the green foliage fades. For more details see McLean (1979:33).

During years of heavy precipitation (i.e., unseasonably heavy rains or a long, cool, summer season), problems can arise from poisoning due to prolonged growth of low larkspur and timber milk-vetch (McLean 1979). This problem is accentuated if there is insufficient other forage available for livestock to graze.

5.3.7 Other Land Uses

5.3.7.1 Wildlife Use

During the forage assessment within the study area, deer grazing was evident and both whitetail and mule deer were observed on numerous occasions. The number of wildlife using the forage resource was not assessed in this study. However, during the winter months, the number of ungulates utilising the forage within the range unit increases (Kirsh, pers. comm.).

5.3.7..2 Recreational Use

Most recreational use in the range unit occurs during the spring, summer and fall. This includes fishing and hunting, random camping, driving all-terrain vehicles and target shooting. Fishing and hunting do not appear to be of concern to livestock management. However, the other activities are problematic.

At Lake Enid, a primitive camping facility is located on the south shore. On weekends during the summer, this area was observed to be overcrowded. No controls are in place to regulate where people camp. Some appeared to prefer camping along the north shore of the lake (Plate 24). This poses special problems with respect to human waste. If this practice continues, toilet facilities should be constructed near the popular campsites to prevent indiscreet use of the forest.

Another problem is random driving across the rangeland. The dry nature of the soil causes dusty conditions. People tend to drive off the dirt tracks in the grass to keep the dust down (Plate 25). This results in denudation of the vegetation, widens the trail and ultimately promotes erosion.

West of Lake Enid, a long narrow valley has been used as a firearm target range (Plate 26). In addition to the placement of targets at various distances, a camp site had been established, including numerous tables and fire pits. Unfortunately garbage littered the ground. Again, the lack of toilet facilities was evident.

In Poplar Pasture, another grassland has been used on a regular basis for camping and parties. Although there is no water at this site, it apparently was a popular location. Numerous camp

fire pits were evident (Plate 27). Broken bottles and burned tin cans littered the ground.

Plate 24. Campers on top of a grassy knoll on the north side of Lake Enid. Numerous fire pits occur in the area from past use.

Plate 25. Degrading rangeland as a consequence of vehicle use.

Plate 26. Camping site and target shooting range in an open grassland valley.

Plate 27. Degrading rangeland in Poplar Pasture where parties and recreational driving are common.

Apart from this, the indiscriminate use of vehicles to "burn donuts" and drive up the slopes has caused degradation of the range. Although the attitude amongst some local people is that this activity is normal and acceptable, from a resource management perspective, the use of valuable rangeland in this manner is unwarranted.

Other areas in Poplar Pasture (e.g., steep slopes) are showing signs of severe erosion due to use of all-terrain vehicles (i.e., dirt bikes, quads and four-wheel drives) for recreational pleasure.

5.3.7.3 Timber Harvesting

The logging of merchantable timber within the Toby-Horsethief Range Unit has taken place since the valley was first colonised. Initially, the Douglas-fir was cut to supply timber for local use. In more recent times, the timber has been cut to supply various regional mills and, generally, the products are widely distributed.

Based on recent forest cover maps, the majority of logging within this range unit has taken place over the past twenty years. Portions of Fifth Pasture were logged between 1973 and 1975, and another portion was logged in 1988. Enid Pasture was also logged between 1973 and 1975, with other areas subjected to logging in 1982, 1988 and 1989. The area most recently logged in this pasture was burned by a wildfire in 1994. In Barbour's Rock Pasture, the area south of Neave Creek was heavily logged between 1976 and 1983 and selected sites were logged in 1988. North of Neave Creek, areas were logged in 1985, 1986 and 1987. Young Pasture was logged in 1982, 1983 and 1988. A linear utility corridor (hydro line) bisects this pasture and was cleared of timber in 1980. Peter's Pasture was heavily logged on 1980. Large blocks in the north-central area of Poplar Pasture were logged in 1984.

5.3.7.4 Industrial Activity

A Christmas tree cutting industry has been part of the local economy for many decades (Kelly and Holland 1961). With the removal of the larger Douglas-fir trees, many areas have regenerated with stands of small trees. Since Douglas-fir has the capability to readily regenerate from stumps, especially if lower branches are left on the trunk, this method of harvesting Christmas trees is renewable. In addition, this practice also keeps the stands open and assists in understorey forage production.

5.3.8 The 1994 Enid Forest Fire

On the evening of July 25, 1994, an electrical storm passed through the range unit. One of numerous lightning strikes ignited a forest fire which began to burn out of control the following day (Plate 28). It started north-west of Lake Enid in Enid Pasture and burned eastward, passing through part of Fifth Pasture and into Poplar Pasture. A portion of the range which burned was under assessment during this study. Approximately two weeks before the burn, some of the range was selected and permanent transects were established. Species composition data was collected. This data will be useful to compare the vegetation before and after a wildfire. Unfortunately, the fire occurred prior to conducting the forage productivity component of the study. Therefore, for some areas of the range unit, accurate forage production and utilisation could not be ascertained.

Fencing the area of the burn has been recommended to control rehabilitation efforts. Salvage logging will remove some of the timber and erosion control has be initiated. A tame forage mix of 60% orchard grass, 20% perennial rye grass and 20% alsike clover was aerial seeded at a rate of 3-4 kg/ha on level terrain and 6 kg/ha on slopes. This should contribute to the forage production of the range. However, the burned area should be monitored to determine if natural regeneration occurs, and the influence of the seeding and reclamation efforts.

Some of the range sites are illustrated with photography prior to the fire and immediately after the fire. These include, paired plots EN-09 and PO-09 (Plates 29 and 30, respectively), site En -04 (Plates 31 and 32), En-05 (Plate 33 and 34) and En 07 (Plates 35 and 36).

Plate 28. Enid forest fire as it burned across the north end of Kirsh's property on July 26th.

Plate 29. Paired plots EN-09 (south side of fence, left) and PO-09 (north side of fence, right) on July 9, 1994, prior to the burn.

Plate 30. Paired plots EN-09 (south side of fence, left) and PO-09 (north side of fence, right) on July 28, 1994, after the burn.

Plate 31. Range site EN-04 on July 9, 1994, prior to the burn.

Plate 32. Site EN-04 on July 28, 1994, after the burn.

Plate 33. Range site EN-05, July 10, 1994, prior to the burn.

Plate 34. Site En-05, July 28, 1994, after the burn.

Plate 35. Range site EN-07, July 9, 1994, prior to the burn.

Plate 36. Site EN-07, July 29, 1994, after the burn

5.3.9 Vegetation Monitoring Programme

The 54 vegetation transects established during this study were set up so that they could be relocated and reread. They constituted a series of permanent monitoring plots to detect changes in the vegetation over time. The general location of the transects is indicated in Plates 37 to 43. More accurate descriptions are presented on the 1994 field data sheets, which are accompanied by oblique photographs.

To monitor the vegetation and possibly recognise shifts in the per cent species composition, it is recommended that these transects be reread every three to five years. The methodology used in this survey should be adopted to ensure compatible results. Only the per cent species composition values should be used for comparative purposes, and not the relative cover values. Cover values can vary with the time of observation, short term weather or long term climatic fluctuations. If the data analysis revealed a change in the species composition, an evaluation of the causes would be warranted. Such changes could result from over-utilisation of the forage resource due to livestock distribution problems. If so, management practices should be reviewed to ensure that the natural resources remain sustainable and the range is not deteriorating due to unpalatable forages or weed infestations.

The monitoring programme should be expanded to include assessment of the vegetation within forested areas. It was noted that the forests are under-utilised due to poor livestock distribution and the species composition (i.e., abundance of pinegrass).

Areas of weed infestations should be determined, mapped and monitored. If eradication treatments are implemented, then a monitoring system should be implemented to determine the effectiveness of the treatments.

In the burned area, monitoring plots should be established to assess plant species composition, and the effect of rehabilitation efforts. The seeded area should be closely evaluated to determine the success of germination, growth and forage production.

In addition, it was noted that random camping and other recreational activities have occurred in the open grasslands, causing damage to ground vegetation and soils. These areas are extremely sensitive and susceptible to environmental degradation due to sparse vegetative cover and poor structure of the soils. Selected sites should be monitored to detect if any damage to this fragile ecosystem occurs in the future. Recreational pressure will undoubtedly increase and have an impact on such areas.

6.0 SUMMARY OF MANAGEMENT ISSUES AND RECOMMENDATIONS

During this study, it became apparent that there are a number of management issues which should be addressed by the Ministry of Forests to ensure that the forage resource can be sustained for perpetuity for both domestic livestock and wildlife.

Therefore, based on the results and observations obtained during this study, we submit the following recommendations:

- The forage production cages should be clipped again at the end of the 1995 growing season. The data should be combined with the 1994 data and averaged over the two years. Then the carrying capacity should be recalculated. Production data should be acquired every five years.

- Forage production within various forested areas should be evaluated to assist in the determination of carrying capacity and the stocking rate.

- A vegetation monitoring programme should be implemented to ensure that the stocking rates on rangelands have not been excessive. Regular reassessment of plant species composition on permanent transects builds a data base for management decisions.

- A monitoring programme should include the burned area, especially where the tame forage mix was aerial seeded. The evaluation should include assessment of germination success, the growth and development of the seeded plants and the forage production potential.

- Vegetation monitoring plots should be reassessed every three to five years to detect potential changes due to grazing practices, logging and Christmas tree harvesting, and in Enid and Poplar Pastures, the effect of recreational activities.

- Toilet facilities should be constructed at the popular campsites in the Enid Lake area to prevent indiscreet use of the forest.

- Weedy plant species are a potential threat to the native flora on rangelands. Infestation areas should be determined, mapped, and treated to reduce the chances of spreading.

- Since there are problems associated with livestock distribution and unfenced private land, consideration should be given to implementing a policy to have private land fenced. However, since it is recognised that grazing of the area with livestock reduces the accumulation of potential fire fuel and may assist in reducing the spread of ground fires, only those individuals with livestock trespass concerns, should be encouraged to fence their property.

- To improve the rotational grazing system and promote better utilisation within the north half of Young Pasture, consideration should be given to constructing a fence along the hydro line located south of Lake Eileen on Houlgrave Road, east of the junction of the hydro line and the cattle guard on the gravel road leading to Wilmer.

- The distribution of livestock is of concern. Some areas are severely over-utilised and others under-utilised. A concerted effort should be made to entice the livestock to the more isolated areas. This could be accomplished by a range rider, herding the livestock to various areas on a daily basis. Better use and placement of salt blocks would assist some distribution problems.

- The availability of water in some pastures is a problem, especially during years of drought. The grazing system must take this into consideration and be flexible enough to allow movement between pastures before the scheduled time.

- The availability of palatable forage is another problem, as the curing of some forages (e.g., pinegrass) can influence foraging behaviour and cause some areas to be over-utilised and others to be under-utilised. This should be a consideration during the planning of a rotational grazing system and be flexible enough to allow movement between pastures before the scheduled time if the forage is unpalatable.

- The importance of developing a working relationship between the permittee or leaseholder and the resource manager representing the governing agency cannot be stressed enough.

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8.0 PERSONAL COMMUNICATIONS

Kirsh, D. and N. Kirsh. Permittees holding grazing rights within the Toby-Horsethief Range Unit.

APPENDIX A
Study Plot and Transect Locations

Site Number	Latitude - Longitude	Site Number	Latitude - Longitude
BA-01	50º 34.36´- 116º 06.43´	PO-01	50º 33.23´- 116º 04.33´
BA-02	50º 30.65´- 116º 06.42´	PO-02	50º 33.66´- 116º 04.46´
BA-03	50º 30.99´- 116º 07.02´	PO-03	50º 34.09´- 116º 05.62´
BA-04	50º 30.36´- 116º 06.63´	PO-04	50º 33.71´- 116º 05.28´
BA-05	50º 31.31´- 116º 06.90´	PO-05	50º 33.46´- 116º 05.46´
BA-06	50º 31.98´- 116º 07.33´	PO-06	50º 33.27´- 116º 05.16´
BA-07	50º 31.82´- 116º 06.38´	PO-07	50º 33.38´- 116º 05.01´
BA-08	50º 31.16´- 116º 07.10´	PO-08	50º 33.34´- 116º 05.01´
BA-09	50º 31.22´- 116º 06.71´	PO-09	50º 33.67´- 116º 06.36´
BA-10	50º 31.48´- 116º 07.02´	PO-10	50º 33.42´- 116º 05.84´
EN-01	50º 33.02´- 116º 07.14´	YO-01	Stolen cage (no location)
EN-02	50º 33.18´- 116º 08.03´	YO-02	50º 32.29´- 116º 05.63´
EN-03	50º 33.04´- 116º 07.76´	YO-03	50º 31.90´- 116º 05.05´
EN-04	50º 33.29´- 116º 06.94´	YO-04	50º 31.70´- 116º 04.92´
EN-05	50º 33.48´- 116º 07.06´	YO-05	50º 31.53´- 116º 04.39´
EN-06	50º 32.98´- 116º 10.37´	YO-06	50º 31.54´- 116º 04.08´
EN-07	50º 33.07´- 116º 08.69´	YO-07	50º 31.40´- 116º 04.13´
EN-08	50º 32.61´- 116º 08.73´	YO-08	50º 31.62´- 116º 03.92´
EN-09	50º 33.67´- 116º 06.36´	YO-09	50º 32.03´- 116º 05.53´
PE-01	50º 30.84´- 116º 03.07´	YO-10	50º 31.18´- 116º 05.34´
PE-02	50º 30.74´- 116º 02.95´	YO-11	50º 30.83´- 116º 04.68´
PE-03	50º 30.43´- 116º 02.98´	YO-12	50º 32.37´- 116º 05.19´
PE-04	50º 30.32´- 116º 03.12´	YO-13	50º 32.57´- 116º 04.98´
PE-05	50º 30.46´- 116º 03.14´	YO-14	50º 30.70´- 116º 05.05´
PE-06	50º 30.59´- 116º 02.86´	YO-15	50º 30.36´- 116º 04.79´
FI-01	50º 32.07´- 116º 06.99´	YO-16	50º 30.33´- 116º 04.37´
FI-02	50º 32.29´- 116º 05.96´		
FI-03	50º 32.43´- 116º 05.70´		
FI-04	50º 32.02´- 116º 06.31´		

APPENDIX B
Scientific Names and Corresponding Acronyms
of Plant Species Encountered along the Transects

Scientific name	common name	code letters
Achillea millefolium	common yarrow	achimil
Agoseris glauca	false dandelion	agosgla
Agropyron pectinata	crested wheatgrass	agropec
Agrostis gigantea	redtop	agrogig
Agrostis stolonifera	creeping bentgrass	agrosto
Allium cernuum	nodding onion	allicer
Amelanchier alnifolia	Saskatoon berry	amelaln
Androsace septentrionalis	northern fairy candelabra	andrsep
Anemone multifida	cut-leaved anemone	anemmul
Antennaria microphylla	rosy pussytoes	antemic
Antennaria parviflora	Nuttall's everlasting	antepar
Arabis holboellii	Holboell's rockcress	arabhol
Arabis sp.	rockcress	arabis
Arctostaphylos uva-ursi	common bearberry, kinnikinnick	arctuva
Arnica fulgens	orange arnica	arniful
Artemesia frigida	pasture sage	artefri
Aster ciliolatus	Lindley's aster	astecil
Aster conspicuus	showy aster	astecon
Aster ericoides	tufted white prairie aster	asteeri
Aster falcatus	little grey aster	astefal
Aster laevis	smooth aster	astelae
Astralaglus miser	timber milk-vetch	astrmis
Balsamorhiza sagittata	arrow-leaved balsamroot	balssag
Bromus inermis	smooth brome	bromine
Calamagrostis rubescens	pinegrass	calarub
Campanula rotundifolia	hairbell	camprot
Carex praegracilis	field sedge	carepra
Carex praticola	meadow sedge	careprt
Carex sp.	sedge	care
Cerastium arvense	field chickweed	ceraarv
Cerastium fischerianum	Fisher's ckickweed	ceravul
Chysanthemum leucanthemum	ox-eye daisy	chysleu
Cirsium arvense	Canada thistle	cirsarv
Cirsium sp.	thistle	cirsi
Comandra umbellata	comandra	comaumb
Crepis atrabarba	slender hawksbeard	crepatr
Crepis runcinata	dandelion hawsbeard	creprun
Crepis sp.	hawksbeard	crepi
Dactylis glomerata	orchard grass	dactglo

Danthonia californica	California oatgrass	dantcal
Elaeagnus commutata	silverberry	elaecom
Elymus hispidus	intermediate wheatgrass	elymhis
Elymus smithii	western wheatgrass	elymsmi
Elymus trachycaulus	slender wheatgrass	elymtra
Elymus X saundersii	Saunder's wildrye	elymsau
Erigeron pumilus	shaggy fleabane	erigpum
Festuca campestris	rough fescue	festcam
Festuca rubra	creeping red fescue	festrub
Fragaria virginiana	wild strawberry	fragvir
Gailardia aristata	brown-eye susan	gailari
Galeopsis tetrahit	hemp nettle	galetet
Galium boreale	northern bedstraw	galibor
Geum triflorum	Old man's whiskers	geumtri
Heterotheca villosa	golden aster	hetevil
Heuchera sp.	alumroot	heuch
Juncus balticus	Baltic rush	juncbal
Koeleria macrantha	June grass	koelmac
Lathyrus ochroleucus	pea-vine	lathoch
Linum lewisii	wild blue flax	linulew
Lithospermun ruderale	Columbia gromwell	lithrud
Lomatium triternatum	nine-leaved desert-parsley	lomatri
Mahonia repens	creeping Oregon-grape	mahorep
Medicago lupulina	black medic	medilup
Medicago sativa	alfalfa	medisat
Melilotus albus	white sweet-clover	melialb
Oxytropis sericea	silky locoweed	Oxytser
Penstemon confertus	yellow penstemon	penscon
Phleum pratense	Timothy	phlepra
Plantago major	common plantain	planmaj
Poa glauca	glaucous bluegrass or muttongrass	poa gla
Poa compressa	Canada bluegrass	poa com
Poa cusickii	Cusick's bluegrass	poa cus
Poa fendleriana	Fendler's bluegrass	poa fen
Poa pratensis	Kentucky bluegrass	poa pra
Poa sp.	bluegrass	poa
Populus tremuloides	trembling aspen	poputre
Potentilla anserina	silverweed	poteans
Potentilla argentea	silvery cinquefoil	potearg
Pseudotsuga menziesii	Douglas-fir	Pseumen
Ranunculus acris	tall buttercup	ranuacr
Rosa sp.	rose	rose
Scientific name	common name	code letters
Silene menziesii	Menzie's campion	silemen

Sisyrhinchium idahoense	Idaho blue-eye-grass	sisyida
Solidago missouriensis	Missouri goldenrod	solimis
Sonchus asper	prickly sowthistle	soncasp
Spiraea betuifolia	birch-leaved spirea	spirbet
Stipa comata	needle-and-thread grass	stipcom
Stipa nelsonii	Columbia needlegrass	stipnel
Stipa richardsonii	spreading needlegrass	stipric
Symphoricarpos albus	common snowberry	sympalb
Taraxacum officinale	dandelion	taraoff
Tragopogon dubius	yellow salasify	tragdub
Trifolium pratense	red clover	trifpra
Trifolium repens	white clover	trifrep
Vicia americana	American vetch	viciame
Viola adunca	early blue violet	violadu
Viola canadensis	Canada violet	violcan
Zygadenus elegans	mountain death camas	zygaele

APPENDIX C
Polygon Number and Representative Community Type

BARBOUR'S ROCK PASTURE

POLYGON NUMBER	RANGE TYPE
1	8HX
2	8HX
3	3PSm Arctuva/Festcam-Calarub // 6PSm Pseumen/Calarub
4	3PSm Arctuva/Festcam-Calarub // 6PSm Pseumen/Calarub
5	3PSm Arctuva/Festcam-Calarub // 6PSm Pseumen/Calarub
6	3PSm Arctuva/Festcam-Calarub // 6PSm Pseumen/Calarub
7	Clearing
8	Gravel Pit
9	1PM Calarub // 6PM Pseumen/Calarub
10	1PM Calarub // 6PM Pseumen/Calarub
11	3PSm Arctuva/Festcam-Calarub // 6PSm Pseumen
12	1PM Poacom/Trifrep-Medilup-Taraoff
13	Gravel Pit
14	1PM Calarub // 6PM Pseumen
15	1PM Calarub // 6PM Pseumen
16	1PM Calarub // 6PM Pseumen
17	1PM Calarub // 6PM Pseumen
18	1PM Calarub // 6PM Pseumen
19	9PM Picegla-Poputre
20	3PM Arctuva/Festcam-Calarub /// 6PM Pseumen/Calarub
21	9PM Picegla-Poputre
22	1PM Poacom/Trifrep-Medilup-Taraoff
23	9PM Poputre-Picegla
24	9PM Poputre-Picegla
25	Clearing
26	9PM Poputre-Picegla-Pseumen
27	9PM Poputre-Picegla
28	9PM Poputre-Picegla
29	9PM Picegla-Poptre
30	9PM Picegla-Poptre-Pseumen
31	1PX Poapra/Medisat/Elymhis
32	1PX Stipnel-Stipric-Poacom/Antepar
33	1PM Poacom/Trifrep-Taraoff-Medilup
34	6PM Pseumen // 1PM Calarub
35	3PM Stipnel-Stipric-Calarub /// 6PM Pseumen/Calarub
36	3PM Stipnel-Stipric-Calarub /// 6PM Pseumen/Calarub
37	3PM Stipnel-Stipric-Calarub /// 6PM Pseumen/Calarub
38	3PM Stipnel-Stipric-Calarub /// 6PM Pseumen/Calarub
39	3PM Poacom/Trifrep-Medilup-Taraoff
40	3PM Poacom/Trifrep-Medilup-Taraoff
41	3PM Poacom/Trifrep-Medilup-Taraoff

YOUNG PASTURE

POLYGON NUMBER	RANGE TYPE
42	1PSm Stipnel-Stpric-Poacom/Antepar /// 6PSm Pseumen/Calarub
43	2Hg Carespp/Salispp
44	1PSm Stipnel-Stpric-Poacom/Antepar /// 6PSm Pseumen/Calarub
45	1PSm Stipnel-Stpric-Poacom/Antepar /// 6PSm Pseumen/Calarub
46	6PM Pseumen/Calarub
47	1PSm Stipnel-Stpric-Poacom/Antepar /// 6PSm Pseumen/Calarub
48	1PSm Stipnel-Stpric-Poacom/Antepar /// 6PSm Pseumen/Calarub
49	1PSm Stipnel-Stpric-Poacom/Antepar /// 6PSm Pseumen/Calarub
50	1PSm Poacom/Trifrep-Medilup-Taraoff
51	1PSm Poacom/Trifrep-Medilup-Taraoff
52	1PSm Stipnel-Stpric-Poacom/Antepar /// 6PSm Pseumen/Calarub
53	1PSm Poacom/Trifrep-Medilup-Taraoff
54	1PSm Stipnel-Stpric-Poacom/Antepar /// 6PSm Pseumen/Calarub
55	1PSm Poacom/Trifrep-Medilup-Taraoff
56	1PSm Poacom/Trifrep-Medilup-Taraoff // 6PSm Pseumen/Calarub
57	1PSm Poacom/Trifrep-Medilup-Taraoff // 6PSm Pseumen/Calarub
58	3PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
59	1PSm Poacom/Trifrep-Medilup-Taraoff
60	3PSm Poacom/Trifrep-Taraoff-Medilup /// 6PSm Pseumen/Calarub
61	3PSm Poacom/Trifrep-Taraoff-Medilup /// 6PSm Pseumen/Calarub
62	3PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
63	3PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
64	3PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
65	1PSm Poacom/Trifrep-Medilup-Taraoff
66	1PSm Poacom/Trifrep-Medilup-Taraoff
67	1PSm Poacom/Trifrep-Medilup-Taraoff
68	1PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
69	1PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
70	1PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
71	1PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
72	1PSm Poacom/Trifrep-Medilup-Taraoff
73	3PSm Arctuva/Festcam-Calarub // 6PSm Pseumen/Calarub
74	3PSm Arctuva/Festcam-Calarub // 6PSm Pseumen/Calarub
75	1PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
76	1PSm Poacom/Trifrep-Medilup-Taraoff
77	1PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
78	1PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
79	1PSm Stipnel-Stipric-Poacom/Antepar /// 6PSm Pseumen/Calarub
80	9PM Pseumen/Calarub
81	3PM Poacom/Trifrep/Stipric/Oxytser /// 6PM Pseumen/Calarub
82	1PSm Poacom/Trifrep-Medilup-Taraoff
83	3PM Arctuva/Festcam-Calarub /// 9PM Pseumen-Poputre/Calarub
84	3PM Arctuva/Festcam-Calarub // 6PM Pseumen/Calarub

FIFTH PASTURE

POLYGON NUMBER	RANGE TYPE
85	3PM Poacom/Trifrep/Stipric/Oxytser /// 6PM Pseumen/Calarub
86	1PM Poacom/Taraoff/Agrogig
87	6PM Pseumen/Calarub
88	6 PM Pseumen/Calarub
89	3PX Stipnel-Stipric-Poacom/Antepar /// 6PX Pseumen/Calarub
90	1PM Stipnel-Stipric-Poacom/Antepar /// 9PM Pseumen-Picegla-Poputre/Calarub
91	3PM Stipnel-Stipric-Poacom/Antepar /// 9PM Pseumen-Picegla-Poputre/Calarub
92	3PM Stipnel-Stipric-Calarub /// 6PM Pseumen/Calarub
93	3PM Stipnel-Stipric-Calarub /// 6PM Pseumen/Calarub
94	2WL Carespp/Salispp
95	2WL Carespp/Salispp
96	2WL Carespp/Salispp
97	3PM Stipnel-Stipric-Poacom/Antepar /// 9PM Pseumen-Picegla-Poputre/Calarub
98	3PX Stipnel-Stipric-Poacom/Antepar /// 6PX Pseumen/Calarub
99	9PM Pseumen-Picegla-Poputre
100	9PM Pseumen-Picegla-Poputre
101	6PM Pseumen-Pinucon/Calarub
102	6PM Pseumen-Pinucon/Calarub
103	6PM Pseumen/Calarub
104	2WL Carespp/Salispp
105	1PM Stipnel-Stipric-Poacom/Antepar
106	6PM Pseumen/Calarub
107	1PM Stipnel-Stipric-Calarub /// 6PM Pseumen/Calarub
108	1PM Stipnel-Stipric-Poacom/Antepar
109	6PM Pseumen-Pinucon/Calarub
110	1PM Stipnel-Stipric-Poacom/Antepar
111	6PM Pseumen-Pinucon/Calarub
112	1PM Stipnel-Stipric-Poacom/Antepar
113	6PM Pseumen-Pinucon/Calarub
114	9PM Pseumen-Popubal-Poputre/Calarub
115	Burn

ENID PASTURE

POLYGON NUMBER	RANGE TYPE
116	1PSm Poacom/Antemic-Medilup
117	1PSm Poacom/Antemic-Medilup
118	1PSm Poacom/Trifrep/Stipric/Oxytser /// 6PM Pseumen/Calarub
119	1PX Stipcom/Antemic-Erigpum
120	6PM Pseumen/Calarub
121	7PHg Poteans-Soncasp
122	1PHg. Agrosto-Carespp/Poteans
123	1PX Poacom/Trifrep/Stipric/Oxytser
124	1PM Poacom/Trifrep/Stipric/Oxytser
125	6PM Pseumen/Calarub
126	6PM Pseumen/Calarub
127	6PM Pseumen/Calarub
128	6PM Pseumen-Pinucon/Calarub
129	6PM Pseumen-Pinucon/Calarub
130	6PM Pseumen/Calarub
131	6PM Pseumen/Calarub
132	1PM Poacom/Trifrep/Stipric/Oxytser
133	6PM Pseumen-Picegla/Calarub
134	3PM Pseumen/Calarub
135	9PM Pinucon-Pseumen-Poputre-Picegla
136	9PM Pinucon-Pseumen-Poputre-Picegla
137	9PM Picegla-Pinucon-Pseumen
138	9PM Picegla-Pseumen/Calarub
139	6PM Pseumen/Calarub
140	2PHd Carespp/Salispp
141	6PM Pseumen/Calarub
142	6PM Pseumen-Pinucon/Calarub
143	6PM Pseumen/Calarub
144	1PM Poacom/Trifrep-Taraoff-Medilup
177	Burn

POPLAR PASTURE

POLYGON NUMBER	RANGE TYPE
145	1PX Poacom/Antemic-Medilup
146	6PSm Pseumen-Pinucon/Calarub
147	6PSm Pseumen-Pinucon/Calarub
148	6PM Pseumen/Calarub
149	6PSm Pseumen-Pinucon/Calarub
150	3PM Poacom/Antemic-Medilup /// 6PM Pseumen/Calarub
151	1PSm Poapra/Medilup/Elymhis
152	1PX Stipcom/Antemic-Erigpum
153	1PX Stipcom-Poacom/Antemic-Erigpum-Medilup
154	1PSm Poapra/Medisat/Elymhis
155	1PSm Poapra/Medisat/Elymhis
156	1PSm Poapra/Medisat/Elymhis
157	1PSm Poapra/Medisat/Elymhis
158	6PSm Pseumen-Pinucon/Calarub
159	6PSm Pseumen/Calarub
160	6PSm Pseumen/Calarub
161	6PSm Pseumen/Calarub
162	6PSm Pseumen/Calarub
163	6PSm Pseumen/Calarub
164	6PSm Pseumen-Pinucon/Calarub
165	Gravel Pit
166	6PSm Pseumen/Calarub
167	6PSm Pseumen-Pinucon/Calarub
168	6PSm Pseumen-Pinucon/Calarub
169	6PSm Pseumen-Pinucon/Calarub
170	6PSm Pseumen/Calarub
171	6PSm Pseumen/Calarub
172	6PSm Pseumen/Calarub
173	10PSm Poputre
174	1PX Stipnel-Stipric-Poacom/Antepar-Medilup
175	1PX Poacom/Antepa-Medilup
176	Burn

PETER'S PASTURE

POLYGON NUMBER	RANGE TYPE
178	3PSm Arctuva/Festcam-Calarub /// 6PSm Pseumen/Calarub
179	3PSm Arctuva/Festcam-Calarub /// 6PSm Pseumen/Calarub
180	3PSm Arctuva/Festcam-Calarub // 6PSm Pseumen/Calarub

APPENDIX D
Herbage Production And Utilization

BARBOUR'S ROCK PASTURE						
Date	Plot No.	Forage Class	Ungrazed (g/m^2)	Grazed (g/m^2)	Utilization	Total Forage (kg/ha)
July 29,1994	Ba-01	grass forbs	121.4 15.4	8.8 0.4	93.3 %	2,737.0
	Ba-02	grass forbs	31.6 9.1	3.5 3.7	90.6 %	814.4
	Ba-03	grass forbs	9.5 2.6	-	est. 80 %	195.7
	Ba-04	grass forbs	35.3 7.2	16.7 7.6	42.9 %	848.8
July 28, 1994	Ba-05	grass forbs	57.6 2.2	3.4 0.2	94.0 %	1195.6
	Ba-06	grass forbs	32.4 13.3	1.9 1.4	92.7 %	913.6
	Ba-07	grass forbs	17.0 19.3	5.0 1.4	82.5 %	726.6
	Ba-08	grass forbs	missing data	missing data	missing data	missing data
	Ba-09	grass forbs	12.5 5.0	no data	est. 55 %	351.0
	Ba-10	grass forbs	9.2 1.4	no data	no utilization	210.2

YOUNG PASTURE						
Date	Plot No.	Forage Class	Ungrazed (g/m^2)	Grazed (g/m^2)	Utilization	Total Forage (kg/ha)
July 27,1994	Yo-01	grass forbs	stolen cage	no data	no data	no data
	Yo-02	grass forbs	92.4 1.4	no utilization	no utilization	1851.7
	Yo-03	grass forbs	23.0 0.1	no utilization	no utilization	462.6
July 29,1994	Yo-04	grass forbs	16.6 29.3	4.1 7.0	75.8 %	918.0
July 27,1994	Yo-05	grass forbs	32.1 1.6	18.5 0.4	44.0 %	673.9
	Yo-06	grass forbs	72.7 4.1	35.4 0.8	52.8 %	1536.6
	Yo-07	grass forbs shrubs	101.86 6.6 0.2	47.4 4.5 0	52.1 %	2169.0
	Yo-08	grass forbs	49.0 3.5	25.8 3.2	41.1 %	987.2
	Yo-09	grass forbs	31.5 14.1	-	est 60 %	901.8
	Yo-10	grass forbs	30.3 4.9	-	est 50 %	625.1
	Yo-11	grass forbs	25.6 2.7	-	est 30 %	566.2
	Yo-12	grass forbs	30.2 1.8	-	est 5 %	640.8
	Yo-13	grass forbs	28.5 2.2	-	est 5%	614.0
	Yo-14	grass forbs	11.8 5.3	-	est 60 %	342.2
July 28,1994	Yo-15	grass forbs	35.4 7.5	no utilization	no utilization	858.2
	Yo-16	grass forbs	70.42 3.5	no utilization	no utilization	1477.6

PETER'S PASTURE						
Date	Plot No.	Forage Class	Ungrazed (g/m^2)	Grazed (g/m^2)	Utilization	Total Forage (kg/ha)
July 28,1994	Pe-01	grass forbs shrubs	22.7 3.7 1.6	no visable utilization	no visable utilization	619.6
	Pe-02	grass forbs shrubs	29.7 11.3 42.7	no visable utilization	no visable utilization	1673.6
	Pe-03	grass forbs shrubs	47.8 8.1 11.4	no visable utilization	no visable utilization	1117.0
	Pe-04	grass forbs shrubs	3.2 9.3 12.7	no visable utilization	no visable utilization	451.4
	Pe-05	grass forbs shrubs	42.9 0.2 2.9	no visable utilization	no visable utilization	863.2
	Pe-06	grass forbs	46.1 12.7	no visable utilization	no visable utilization	1176.4

FIFTH PASTURE						
Date	Plot No.	Forage Class	Ungrazed (g/m^2)	Grazed (g/m^2)	Utilization	Total Forage (kg/ha)
July 27,1994	Fi-01	grass forbs	57.1 3.9	no clip data	est 85 %	1418.8
	Fi-02	grass forbs	58.5 3.9	no clip data	est 85 %	1249.6
	Fi-03	grass forbs	37.2 2.7	no clip data	est 70 %	798.6
	Fi-04	grass forbs	25.7 12.6	no clip data	est 70 %	766.0

BARBOUR'S ROCK PASTURE						
Date	Plot No.	Forage Class	Ungrazed (g/m^2)	Grazed (g/m^2)	Utilization	Total Forage (kg/ha)
July 25,1994	En-01	grass forbs	44.1 0.9	no clip data	est 99%	900.6
	En-02	grass forbs	1.6 76.4	no clip data	est 70 %	1558.2
	En-03	grass forbs	109.0 8.0	no clip data	est 95 %	1340.4
	En-04	grass forbs	Burned			0
	En-05	grass forbs	Burned			0
	En-06	grass forbs	24.6 1.2	no clip data	est 70 %	515.6
	En-07	grass forbs	66.1 3.8	no clip data	est 95 %	1297.4
	En-08	grass forbs	50.9 11.0	no clip data	est 95 %	1237.6

POPLAR PASTURE						
Date	Plot No.	Forage Class	Ungrazed (g/m^2)	Grazed (g/m^2)	Utilization	Total Forage (kg/ha)
July 25,1994	Po-01	grass forbs shrubs	32.9 2.0 1.1	no clip data	est 95 %	698.2
	Po-02	grass forbs shrubs	23.2 0.6 1.0	no clip data	est 5 %	475.6
	Po-03	grass forbs	56.5 18.8	no clip data	est 5 %	1504.8
	Po-04	grass forbs	58.0 8.7	no clip data	est 15 %	1332.4
	Po-05	grass forbs shrubs	8.4 4.2 9.0	no clip data	0 %	443.0
	Po-06	grass forbs	21.9 1.5	no clip data	est 60 %	467.8
	Po-07	grass forbs	11.4 2.5	no clip data	est 70 %	279.2
	Po-08	grass forbs	18.7 0.5	no clip data	est 70%	378.3

Herbage production (kg/ha) beneath different forest types and per cent canopy cover.

	TYPE OF FOREST CANOPY COVER				
REFERENCE	ASPEN	MIXEDWOOD	LODGEPOLE PINE	MATURE DOUGLAS-FIR	IMMATURE DOUGLAS-FIR
Tisdale (1950)	724 (0.8 AUM/ha)	376 (0.42 AUM/ha)	465 (0.52 AUM/ha)	193 (0.21 AUM/ha)	114 (0.13 AUM/ha)
Tisdale and McLean (1957)	720 (0.8 AUM/ha)	-	465 (0.52 AUM/ha)	201 (0.22 AUM/ha)	-
McLean, Lord and Green (1971)	-	-	-	672 (0.75 AUM/ha)	-
McLean (1979)-	-	-	-	273 (0.3 AUM/ha)	-
Stout and Quinton (1986)	-	-	-	292 (0.32 AUM/ha)	67 (0.07 AUM/ha)
Wilkeen and Stout (1983)	720	-	-	180 (0.2 AUM/ha)	-
Dodd, McLean and Brink (1972)	-	-	-	677 (5% tree cover) (0.75 AUM/ha) 660 (10% tree cover) (0.73 AUM/ha) 629 (15% tree cover) (0.69 AUM/ha) 598 (20% tree cover) (0.66 AUM/ha) 555 (25% tree cover) (0.61 AUM/ha) 511 (30% tree cover) (0.57 AUM/ha) 475 (35% tree cover) (0.53 AUM/ha) 440 (40% tree cover) (0.49 AUM/ha) 410 (45% tree cover) (0.46 AUM/ha) 380 (50% tree cover) (0.42 AUM/ha) 344 (55% tree cover) (0.38 AUM/ha) 307 (60% tree cover) (0.34 AUM/ha) 263 (65% tree cover) (0.29 AUM/ha) 219 (70% tree cover) (0.24 AUM/ha) 190 (75% tree cover) (0.21 AUM/ha) 161 (80% tree cover) (0.18 AUM/ha)	

To determine AUM's/ha use the following formula : kg/ha÷450 kg/ha X 50% safe use =

Example: Douglas-fir forest with a canopy closure of 15% could likely produce 629 kg/ha dry herbage in the understorey (see table above) and therefore be stocked at 0.69 AUMs/ha .

629 kg/ha÷450 kg/ha X 50% safe use = 0.69 AUMs/ha.

Therefore in the case of polygons 4, 6, and 11 in Barbour's Rock Pasture, the crown closure of douglas-fir was determined to be approximately 15%, based on the forest cover type map and were assigned a carrying capacity of 0.69 AUMs/ha.

Also in Barbour's Rock Pasture, polygon s 12, 25, 39, 40, and 41 are open rangeland. The carrying capacity was calculated from averaging actual cage production data (see section 5.1.8; page 30 of report). Mean grass (785 kg/ha) + forbs (198 kg/ha) = 983 kg/ha.
983 kg/ha÷450 kg/ha X 50% safe use = 1.1 AUMs/ha.