

AN ASSESSMENT OF CARRYING CAPACITY IN THE DUTCH-FINDLAY RANGE UNIT

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Abstract

A range vegetation survey was conducted in the Dutch-Findlay Range Unit near Canal Flats, British Columbia. Twenty-five transects were established, 12 of which had production cages. Based on field surveys conducted in late June and July, 1995, four broad range types were delineated including native grassland, wetlands, mature forest, and cutblocks. Within these range types, seven vegetation community types were classified and mapped. Productivity estimates indicated that the carrying capacity for livestock was 97 AUMs for Dutch Pasture, 263 AUMs for Spur Pasture, 348 AUMs for Sun Lake Pasture and 251 AUMs for Thunderhill Pasture.

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1.0 INTRODUCTION

Rangelands are an important resource in British Columbia, particularly for the ranching industry. In 1989/1990, almost one million animal unit months (AUMs) or 60% of the total forage requirement for beef production in the province, were produced on Crown lands (Meidinger and Pojar 1991). Aside from providing grazeable forage for domestic livestock, rangelands are also important in providing habitat for fish and wildlife, and various recreational opportunities and aesthetic benefits for residents and visitors. Although rangeland includes natural grasslands, shrublands, alpine communities, and wet meadows, forested lands contribute significantly to the forage base, accounting for almost 80% of the rangelands in British Columbia (Meidinger and Pojar 1991). Logging activities and fire are important factors in the conversion of forest into rangelands.

Management of rangelands, in British Columbia falls under the jurisdiction of the Ministry of Forests. Because of the importance of rangelands to other users, the Ministry of Environment is also involved in rangeland management and planning (MOF 1989). Within the Ministry of Forests, technical expertise in managing Crown rangelands is provided by the Range Section which issues grazing tenures and hay cutting permits for domestic livestock, monitors tenure compliance and conducts forage inventories.

Rangeland management and planning activities of the Range Section are based on the guidelines and policies outlined in the Range Program. The program, which was reviewed in 1989 by the Range Program Review Task Force (MOF 1989), is administered through six regions and 43 districts located throughout British Columbia. One of the recommendations of the program was to implement a range inventory process designed to document the carrying capacities of rangelands in these areas.

As part of its on-going range management program in the Invermere Forest District, the Range Section identified a need to conduct a forage assessment of the Dutch-Findlay Range Unit. The following report, which was prepared by D.A. Westworth & Associates Ltd., presents the results of this forage assessment. The information should assist resource managers in developing and implementing management plans that will ensure sustained forage yields for domestic livestock and wildlife while ensuring compatibility with other land uses in the region.

1.1 Objectives

The overall objective of this study was to determine forage production levels and carrying capacity for the Dutch-Findlay Range Unit. Specific objectives of the range inventory were to:

- Identify and map primary and secondary ranges;
- Identify and sample major vegetation communities within primary and secondary ranges; and
- Collect forage productivity data to determine carrying capacity within each vegetation community.

1.2 Regional and Biophysical Setting

The Dutch-Findlay Range Unit is located in the Rocky Mountain Trench on the west side of Columbia Lake, extending from Dutch Creek in the north to the south end of Columbia Lake (Figure 1). The range unit is comprised of four pastures which include Dutch, Spur, Sun Lake, and Thunderhill pastures. Each pasture contains different proportions of Crown and private lands, and range in size from 943 ha to 3713 ha (Table 1). Access to the range unit is provided from the north into Dutch Pasture by an unimproved road from Highway 93/95 and from the south into Thunderhill Pasture via Findlay Creek Road (Figure 1). Major land uses in the area consist of livestock grazing, timber harvesting, Christmas tree farming, and hunting. The Dutch-Findlay Range Unit is presently being grazed by livestock from the Thunderhill Ranch under a 5-year grazing permit granted in 1993 to Brian and David McKersie. Thunderhill Ranch has had grazing permits on this range unit since the ranch was first established by Walter McKersie in the 1960s.

The Dutch-Findlay Range Unit is both geographically and ecologically diverse. Three biogeoclimatic zones are represented in the range unit including the Englemann Spruce-Subalpine Fir, Montane Spruce and Interior Douglas-fir zones (Meidinger and Pojar 1991). However, Crown grazing lands, the focal point of this study, are primarily located in the Interior Douglas-fir zone although elements of the Montane Spruce zone are also present. Based on discussions with the tenure holder (B. McKersie, pers. com.) and Ministry of Forests personnel, the lower elevations of the Dutch-Findlay Range Unit are used extensively by wintering elk herds. During the summer, elk typically move to higher elevations. Whitetail deer and mule deer are also common at lower elevations while moose prefer riparian and cutblock habitats adjacent to forest cover.

Figure 1. Location of Dutch-Findlay Range Unit.

Table 1. Area (ha) of private and Crown lands in the Dutch-Findlay Range Unit.

Pasture	Total Area (ha)	Private Lands (ha)	Crown Lands	
			Utilized ¹ (ha)	Unutilized ² (ha)
Dutch	2375	513	205	1657
Spur	3713	1089	668	1956
Sun Lake	1999	928	454	617
Thunderhill	943	55	746	142

¹ Livestock use focused primarily on these areas, also used by wildlife.

² Areas largely unused by livestock. Consists primarily of forested lands west of Columbia Wildlife Area.

Crown lands within Dutch-Findlay Range Unit are largely confined to a narrow corridor that parallels the north-south oriented British Columbia (B.C.) Hydro transmission line right-of-way that passes through the range unit. Crown lands are bounded to the east by extensive tracts of private land that border the west side of Columbia Lake, and to the west by the Columbia Lake Wildlife Area. Elevations on tenured land range from 900 to 1100 m. The primary water sources for the range unit include numerous small streams and a half-dozen small lakes of which Spur Lake and Sun Lake are the most prominent.

1.3 Pastures of the Dutch-Findlay Range Unit

Dutch Pasture is predominantly forest covered with the north end characterized by uncut lodgepole pine, western larch, and Douglas-fir. The south end of Dutch Pasture was selectively logged in 1979 and consists of open woodland with numerous landings that have been re-seeded to non-native grasses and forbs. Dutch Pasture is accessed via old logging roads from Highway 93 and along B.C. Hydro's transmission line right-of-way.

Spur Pasture is less heavily forested than Dutch Pasture and as a result, is characterized by a more diverse landscape of open forest, closed forest, shrublands, grasslands, and logged areas that have been partially cut or clearcut. Forest cover is predominantly lodgepole pine although Douglas-fir, western larch or aspen are also present at lower densities. Grasslands are largely confined to the northeast or extreme south of the pasture. Spur Pasture is accessed primarily along old logging roads in the east and B.C. Hydro's transmission line right-of-way in the west.

Vegetatively, Sun Lake Pasture is considerably more open than Spur Pasture and is characterized by extensive areas of grassland. The southern portion of this pasture was extensively burned in 1985 and is now slowly regenerating to open lodgepole pine or Douglas-fir forest. The pasture is accessed primarily from the south, along B.C. Hydro's transmission line right-of-way.

Like Sun Lake Pasture, Thunderhill Pasture was also extensively burned during the 1985 fire and remains thinly forested. Lodgepole pine and Douglas-fir are slowly regenerating while the understory is dominated by grasses, forbs and low growing shrubs. Unburned areas consist primarily of open lodgepole pine or Douglas-fir communities. Grasslands are prominent throughout this pasture, especially in the west. The pasture is accessed from the south along a logging road that passes through the Findlay Basin Range Unit and B.C. Hydro's transmission line right-of-way.

2.0 METHODS

2.1 Preliminary Investigations

Prior to the initiation of the field survey, preliminary range types were mapped using 1:20,000 colour or black-and-white aerial photographs and 1:20,000 forest cover maps. A reconnaissance-level field trip of Dutch Creek, Spur, Sun Lake, and Thunderhill pastures was undertaken with the Resource Officer Range to obtain an overview of community types and grazing practices. Sampling effort for the vegetation and range survey was then stratified on the basis of the preliminary range type map and information obtained during the field trip. This sampling approach resulted in the establishment of 25 transects within the four pastures of the Dutch-Findlay Range Unit. Transect locations were marked on aerial photographs to facilitate classification and delineation of community types. In addition, an overview of current and past management practices and issues or concerns was obtained by undertaking interviews with the rancher who currently holds tenure in the range unit.

2.2 Vegetation Survey

A vegetation survey designed to document species composition and percentage cover was conducted between June 28 - July 19, 1995 using sampling methods described in Alberta Forest Service's Range Survey Manual (Alberta Forest Service 1990). Vegetation was sampled on 15 microplots placed at 2 m intervals along 25- 30 m transects. Cover (%) of grass and forb species was estimated using 20 cm x 50 cm quadrats and, when present, shrub species (stems < 2.5 m) cover was estimated on 1 m x 1 m quadrats. A 20 m x 20 m plot was used to determine cover estimates for trees and tall shrubs (stems > 2.5 m). Cover estimates for all species found within the microplots were recorded to the nearest 5% when cover exceeded 5% cover. Cover estimates for species with cover values between 0 and 5% were estimated to the nearest 1%. Cover estimates for trees and tall shrubs in the macroplot were recorded to the nearest 5%. All information was recorded on specifically-designed grazing inventory forms provided by the B.C. Ministry of Forests. A 35 mm colour photograph was also taken along each transect to document existing vegetation conditions. To assist in future range monitoring programs, coordinates (latitude and longitude) for all transect locations were determined using a hand held Global Positioning System unit.

2.3 Forage Production

A major objective of the study was to collect forage production data for use in calculating carrying capacities for the Dutch-Findlay Range Unit. Herbage production and forage use levels

within a range type are typically determined by harvesting vegetation from protected (e.g. range cages) and unprotected quadrats at each transect. In the present study, exclosure cages were constructed from 2.54 cm² wire mesh and were used to exclude herbivore grazing from an area of approximately 1.25 m².

The assessment of forage production in the Dutch-Findlay Range Unit was undertaken between July 26-31, 1995. Vegetation was hand harvested from 3, 50 cm x 100 cm, quadrats at 12 transects which contained exclosure cages (one from beneath the exclosure cage and two outside). In the case of transects where there were no exclosure cages, only 2 quadrats were harvested. In these cases, vegetation was hand harvested from a 50 cm x 100 cm quadrat randomly placed near the beginning and end of each transect. Harvested material was field sorted into grasses (and grass-like vegetation), forbs, and shrubs and placed into appropriately labelled paper bags for drying.

2.4 Laboratory Methods and Data Analysis

Upon completion of the field work, herbage production clips were submitted to the Ministry of Forests where they were oven-dried and weighed to the nearest 0.1 gm. Production (kg/ha) was calculated from raw data (g/0.5m²) using a conversion factor (x20). Herbage production on each range type was then calculated as the average of all clipped plots within each range type. For domestic livestock, forage was defined as that portion of the herbage that is palatable to the grazing animal in question. Since livestock are primarily grazers, the forb portion of all range types was considered to be mostly unpalatable. However, some forbs such as black medic were considered to be palatable and these would provide additional suitable forage for domestic livestock.

Species composition and foliar cover estimates for each quadrat were input into digital files for analysis. Data entry accuracy was verified using the Data Entry II module of SPSS for Windows statistical software, which involved entering the field data twice. Following data entry, average species cover values were calculated for each transect. Transect data were then classified using TWINSpan (Two-way Indicator Species Analysis), a computer program that produces an ordered two-way table in which similar transects are grouped together. The groups established by TWINSpan were then inspected to determine the appropriate level for division into preliminary community types. Final classification of transects into community types was based on TWINSpan divisions and modifications based on variations in dominant plant species. As a

result some community types may exhibit variants based on dominant species amongst the three range units (Table 2).

Table 2. Vegetation community types found in the Dutch-Findlay, Findlay Basin and Torrent Range Units.

Community Type	Range Unit		
	Dutch-Findlay	Findlay Basin	Torrent
1. Bog birch/needle spike-rush	X		
Bog birch/ Baltic rush		X	
2. Prairie rose-snowberry-saskatoon/Kentucky bluegrass	X		
Saskatoon-soopalie-kinnikinnick/pinegrass		X	
Prairie rose-snowberry-saskatoon/pinegrass			X
3. Douglas-fir/pinegrass	X		X
Trembling aspen-Douglas-fir/pinegrass		X	
4. Kinnikinnick/Richardson's needlegrass	X	X	
5. Black medic/Canada bluegrass		X	X
6. Columbian needlegrass-Canada bluegrass	X	X	
7. Columbian needlegrass/shaggy fleabane-bristly stickseed	X	X	
8. Nuttall's alkaligrass - foxtail barley		X	
9. Shrubby cinquefoil - silverberry		X	
10. Kentucky bluegrass/black medic-common dandelion	X		
11. Antelope brush/bluegrass			X
12. Creeping bentgrass/black medic	X		
13. Orchard grass-pinegrass/dandelion		X	X

Data collected from 93 transects in 3 adjoining range units (Dutch-Findlay, Findlay, and Torrent) were jointly analyzed with TWINSpan. Therefore, some community types derived from the classification process occur in each of the three range units while other community types are restricted to one or two range units. The distribution of community types within each range unit is summarized in Table 2.

2.5 Calculating Carrying Capacity

Stratification of the study area into primary, secondary, and non-use (tertiary) ranges is the first step in calculating carrying capacity. Primary range can be defined as those areas that livestock prefer to use under very little management (Maduram 1979). Secondary range is characterized as having some feature(s) that restricts livestock grazing and may include steep slopes, barriers to grazing such as thick brush, long distances to water, or a plant community that does not contain palatable forage species. Carrying capacity for livestock should not include forage growing on secondary range since this could result in overstocking the primary range,

particularly if there is no range rider. Non-use areas or tertiary range were those areas that contained significant barriers to movement such as excessive amounts of deadfall, steep slopes, and/or the absence of palatable forage.

Primary and secondary ranges were further subdivided into vegetation community types. Vegetation community types were characterized by areas exhibiting uniform species composition and herbage production levels. Productivity was then estimated for each community type, and a weighted mean (weighted by area) of herbage production of primary and secondary range was calculated. Unpalatable herbage was subtracted from total herbage to calculate forage available for domestic livestock. A safe use factor was also applied to available forage and was defined as the level of grazing that vegetation can withstand indefinitely without lasting detrimental effects. A safe use factor typically applied in grazing inventories of native rangelands reflects 50% of use of available forage during the growing season. For example, 50% of herbage is allocated for plant recovery while use of the remaining fifty percent is allocated between wildlife and livestock. Tame grass re-seedings can generally withstand a higher level of use of growing season herbivory (60%) than native grass swards. However, considerably higher utilization levels can be accommodated during the dormant season (Stoddart et. al. 1975).

In the present study, available forage for domestic livestock for each community type in the range unit was estimated using the following relationship:

Herbage Production (Primary Range) - Unpalatable herbage - 50% Safe Use Factor.

Since 1 AUM (cow/calf pair) is equal to 450 kg of forage (Basarab 1987), carrying capacity (in AUMs for livestock) can be calculated. All AUMs in this report refer to cow/calf pairs only. Since calculations of wildlife carrying capacity were beyond the scope of the present study, no adjustments for wildlife species AUM values and primary and secondary range map units were made.

3.0 RESULTS AND DISCUSSION

3.1 Community Type Descriptions

Eight vegetation community types characterized by 109 vascular plant species (Appendix 2) were identified in the Dutch-Findlay Range Unit. To provide summary descriptions of each community type identified in the range unit, a checksheet format was used. Each checksheet contains information on site location, important biophysical features, and plant species cover data. The carrying capacity of each community type along with a representative photograph of each transect also accompanies each checksheet.

Community Type 1 (N = 1). Bog birch/needle spike-rush (Photo 1).

This community type has a limited distribution in the study area and is confined primarily to wetlands with standing water. Seaside arrow-grass may be poisonous to livestock if it has been injured or repeatedly grazed. If it has not been injured, seaside arrow-grass appears to be quite palatable to livestock (B. Irving, pers. comm.). Although this site may be used by wildlife, it is also likely used by livestock because of its close proximity to water.

Representative Site: SL7

Landscape Position: Upland (P)

Elevation: 960 m

Slope: 0%

Aspect: Level

Scientific Name	Common Name	Foliar Cover (%)
Forbs		
<i>Eleocharis acicularis</i>	needle spike-rush	12
<i>Utricularia vulgaris</i>	greater bladderwort	5
<i>Juncus balticus</i>	baltic rush	3
<i>Triglochin maritimum</i>	seaside arrow-grass	2
Shrubs		
<i>Betula glandulosa</i>	bog birch	1
<i>Potentilla fruticosa</i>	shrubby cinquefoil	1
<i>Salix candida</i>	hoary willow	1

Production (kg/ha):	Grasses	19*
	Forbs	1147*
	Shrubs	360*
	Total	1526* Estimate

Stocking Rate: 19 kg/ha / 450 kg/ha x 50% safe use = **0.02 AUMs per hectare.**

* Production cages are not present in this community type. Production values are based on utilization plots only.

Community Type 2 (N = 4). Prairie rose-snowberry-saskatoon/Kentucky bluegrass (Photo 2).

This community type is characteristic of open forest or previously forested areas that have either been partially or entirely clearcut and are now in the early stages of regeneration. Shrub, forb and grass cover is generally higher in cutover areas than surrounding mature forest communities. This community type is found primarily in Spur and Dutch pastures along the B.C. transmission line right-of-way and selectively logged sites. Tree cover is variable and aspen and/or Douglas-fir may be absent from some sites.

Representative Sites: DUT3, SPU3, SPU5, SPU8

Landscape Position: Upland (P)

Elevation: 940-1000 m

Slope: 0-5%

Aspect: 140-360°

Scientific Name	Common Name	Foliar Cover (%)
Grasses		
<i>Poa pratensis</i>	Kentucky bluegrass	7
<i>Elymus trachycaulus</i>	slender wheatgrass	1
<i>Festuca rubra</i>	red fescue	1
<i>Calamagrostis rubescens</i>	pinegrass	t
Forbs		
<i>Taraxacum officinalis</i>	dandelion	4
<i>Aster ciliolatus</i>	fringed aster	2
<i>Fragaria virginiana</i>	wild strawberry	2
<i>Galium boreale</i>	northern bedstraw	1
<i>Medicago lupulina</i>	black medic	1
<i>Achillea millefolium</i>	yarrow	1
Shrubs		
<i>Rosa woodsii</i>	prairie rose	7
<i>Symphoricarpos albus</i>	common snowberry	6
<i>Amelanchier alnifolia</i>	saskatoon	4
<i>Symphoricarpos occidentalis</i>	western snowberry	3
<i>Shepherdia canadensis</i>	soopolallie	2
<i>Arctostaphylos uva-ursi</i>	kinnikinnick	1

<i>Elaeagnus commutata</i>	silverberry	1
<i>Spiraea betulifolia</i>	birch-leaved spirea	t
Trees		
<i>Populus tremuloides</i>	trembling aspen	13
<i>Pseudotsuga menziesii</i>	Douglas-fir	3

Production (kg/ha):	Grasses	361*
	Forbs	19*
	Shrubs	360*
	Total	740* Estimate

Stocking Rate: 361 kg/ha / 450 kg/ha x 50% safe use = **0.4 AUMs per hectare.**

* Production cages are not present in this community type. Production values are based on utilization plots only.

Photo 1. Community Type 1, Bog birch/needle spike rush - baltic rush.

Photo 2. Community Type 2, Prairie rose - snowberry - saskatoon/Kentucky bluegrass.

Community Type 3(N = 4). Douglas-fir/pinegrass (Photo 3)

This community type is widely distributed throughout the four pastures of the Dutch-Findlay Range Unit. It is found on sites that are generally drier than the prairie rose-snowberry-saskatoon/Kentucky bluegrass community type. In Thunderhill Pasture, this community type is found in association with CT6 (Columbian needlegrass-Canada bluegrass) on burned areas. Sites in this community type include undisturbed, open forest on steep slopes or areas that have been disturbed, either by fire or selective cutting. TH2 is located on a north-south ridge top similar to TH1 and TH4 of CT6.

Representative Sites: DUT2, SL6, SPU7, TH2

Landscape Position: Upland (P)

Elevation: 960-1000 m

Slope: 0-20%

Aspect: 90-250°

Scientific Name	Common Name	Foliar Cover (%)
Grasses		
<i>Calamagrostis rubescens</i>	pinegrass	10
<i>Elymus trachycaulus</i>	slender wheatgrass	1
<i>Koeleria macrantha</i>	junegrass	1
Forbs		
<i>Taraxacum officinale</i>	common dandelion	3
<i>Antennaria parviflora</i>	Nuttall's pussytoes	1
<i>Astragalus miser</i>	timber milk-vetch	1
<i>Oxytropis sericea</i>	silky locoweed	1
<i>Penstemon confertus</i>	yellow penstemon	1
Shrubs		
<i>Arctostaphylos uva-ursi</i>	kinnikinnick	3
<i>Amelanchier alnifolia</i>	saskatoon	2
<i>Spiraea betulifolia</i>	birch-leaved spirea	1
Trees		
<i>Pseudotsuga menziesii</i>	Douglas-fir	6

Production (kg/ha):	Grasses	570
	Forbs	37
	Shrubs	363
	Total	970

Stocking Rate: $570 \text{ kg/ha} / 450 \text{ kg/ha} \times 50\% \text{ safe use} = \mathbf{0.6 \text{ AUMs per hectare}}$

Community Type 4 (N = 1). Kinnikinnick/Richardson's needlegrass (Photo 4)

This community type is relatively uncommon and is found at the south end of Spur Pasture. It appears to be associated with slightly drier sites than the Douglas-fir/pinegrass community type. These drier conditions tend to favour development of spreading needlegrass rather than pinegrass. Scattered stems of lodgepole pine are prominent in this community type. Based on present low tree recruitment, it appears that it will be a long time before this site becomes forested.

Representative Site: SPU4

Landscape Position: Upland (P)

Elevation: 1000 m

Slope: 0%

Aspect: Level

Scientific Name	Common Name	Foliar Cover (%)
Grasses		
<i>Stipa richardsonii</i>	spreading needlegrass	8
<i>Poa pratensis</i>	Kentucky bluegrass	1
<i>Festuca campestris</i>	rough fescue	1
Forbs		
<i>Agoseris glauca</i>	short-beaked agoseris	3
<i>Galium boreale</i>	northern bedstraw	1
<i>Astragalus miser</i>	timber milk-vetch	t
<i>Penstemon confertus</i>	yellow penstemon	t
Shrubs		
<i>Arctostaphylos uva-ursi</i>	kinnikinnick	2
<i>Amelanchier alnifolia</i>	saskatoon	1
Trees		
<i>Pinus contorta</i>	lodgepole pine	t

Production (kg/ha):	Grasses	1084
	Forbs	136
	Shrubs	66
	Total	1286

Stocking Rate: 1084 kg/ha / 450 kg/ha x 50% safe use = **1.2 AUMs per hectare**

Photo 3. Community Type 3, Douglas-fir/pinegrass.

Photo 4. Community Type 4, Kinnikinnick/Richardson's needlegrass.

Community Type 6 (N = 8). Columbian needlegrass-Canada bluegrass (Photo 5)

This community type represents typical upland grasslands found in all pastures of the Dutch-Findlay Range Unit. This community type is particularly extensive in Thunderhill and Sun Lake pastures, although it also occurs along rights-of-way's in Spur and Dutch pastures. Fires in 1985 burned extensive areas of Thunderhill and Sun Lake pastures. As a result of these fires, most of the forest cover was removed, leaving only a few scattered veterans. Tree seedlings and saplings are present, but these generally have low cover values. For the most part, burned areas are vegetated predominantly by grasses and forbs and to a lesser extent shrubs (e.g. saskatoon). TH1 and TH4 are found along north-south ridge tops similar to TH2 of CT3.

Representative Sites: SL3, SPU1, SPU6, TH1, TH3, TH4, TH5, TH6

Landscape Position: Upland (P)

Elevation: 940-1000 m

Slope: 0-15%

Aspect: 140-230°

<i>Scientific Name</i>	<i>Common Name</i>	<i>Foliar Cover (%)</i>
Grasses		
<i>Stipa nelsonii</i>	Columbian needlegrass	5
<i>Stipa richardsonii</i>	spreading needlegrass	3
<i>Poa pratensis</i>	Kentucky bluegrass	1
<i>Poa compressa</i>	Canada bluegrass	1
<i>Elymus spicata</i>	bluebunch wheatgrass	1
<i>Koeleria macrantha</i>	junegrass	1
Forbs		
<i>Medicago lupulina</i>	black medic	2
<i>Antennaria parviflora</i>	Nuttall's pussytoes	1
<i>Erigeron pumilus</i>	shaggy fleabane	1
<i>Oxytropis sericea</i>	silky locoweed	t
<i>Filago arvensis</i>	field filago	1
<i>Astragalus miser</i>	timber milk-vetch	1
Shrubs		
<i>Amelanchier alnifolia</i>	saskatoon	2
<i>Spiraea betulifolia</i>	birch-leaved spirea	1

Production (kg/ha):	Grasses	820
	Forbs	66
	Shrubs	127
	Total	1013

Stocking Rate: $820 \text{ kg/ha} / 450 \text{ kg/ha} \times 50\% \text{ safe use} = \mathbf{0.9 \text{ AUMs per hectare}}$

Community Type 7 (N = 3). Columbian needlegrass/shaggy fleabane-bristly stickseed (Photo 6)

This community type has some characteristics of the Columbian needlegrass-Canada bluegrass community type, however, lower grass and higher forb cover values suggests that this community type experiences higher grazing pressure. Increased presence and cover of species such as junegrass, shaggy fleabane, bristly stickseed, and field filago are indicative of higher grazing pressure. As a result, forage productivity is significantly lower than in CT6. Poor soils may also be a contributing factor for reduced forage productivity on these sites. CT7 occurs extensively in the northern section of Sun Lake Pasture.

Representative Sites: SL1, SL2, SL5

Landscape Position: Upland (P)

Elevation: 960 m

Slope: 0-8%

Aspect: 140°

Scientific Name	Common Name	Foliar Cover (%)
Grasses		
<i>Stipa nelsonii</i>	Columbian needlegrass	5
<i>Stipa richardsonii</i>	spreading needlegrass	2
<i>Koeleria macrantha</i>	junegrass	1
Forbs		
<i>Erigeron pumilus</i>	shaggy fleabane	4
<i>Lappula squarrosa</i>	bristly stickseed	6
<i>Medicago lupulina</i>	black medic	6
<i>Filago arvensis</i>	field filago	3
<i>Lepidium densiflorum</i>	prairie pepper-grass	2
<i>Antennaria parviflora</i>	Nuttall's pussytoes	1
Shrubs		
<i>Rosa woodsii</i>	prairie rose	1

Production (kg/ha):	Grasses	641
	Forbs	271
	Shrubs	1
	Total	913

Stocking Rate: 641 kg/ha / 450 kg/ha x 50% safe use = **0.7 AUMs per hectare**

Photo 5. Community Type 6, Columbian needlegrass - Canada bluegrass.

Photo 6. Community Type 7, Columbian needlegrass/shaggy fleabane-bristly stickseed.

Community Type 10 (N = 3). Kentucky bluegrass/black medic-common dandelion (Photo 7)

This community type is associated with disturbed sites such as landings, roadsides, and B.C. Hydro's transmission line right-of-way. Species presence and cover values typically vary significantly from site to site. In general, these sites have been seeded to non-native species that produce abundant, highly palatable forage for domestic and native herbivores.

Representative Sites: DUT1, DUT4, DUT5

Landscape Position: Upland (P)

Elevation: 1000 m

Slope: 0%

Aspect: Level

Scientific Name	Common Name	Foliar Cover (%)
Grasses		
<i>Poa pratensis</i>	Kentucky bluegrass	8
<i>Festuca rubra</i>	red fescue	5
<i>Stipa richardsonii</i>	spreading needlegrass	t
<i>Dactylis glomerata</i>	orchard grass	t
<i>Stipa nelsonii</i>	olumbian needlegrass	t
Forbs		
<i>Medicago lupulina</i>	black medic	5
<i>Taraxacum officinale</i>	dandelion	9
<i>Aster laevis</i>	smooth aster	1
<i>Fragaria virginiana</i>	strawberry	1
<i>Achillea millefolium</i>	common yarrow	1

Production (kg/ha):	Grasses	1565
	Forbs	257
	Total	1822

Stocking Rate: 1565 kg/ha / 450 kg/ha x 50% safe use = **1.7 AUMs per hectare**

Community Type 12 (N = 1).Creeping bentgrass/black medic (Photo 8)

This community type is generally associated with wetland margins. Vegetation is patchy and typically dominated by one or two plant species. The community type is probably uncommon in the Dutch-Findlay Range Unit. Since it was observed only once during the field survey, species composition most likely reflects better soil moisture conditions present at this site. The presence of silverweed and foxtail barley suggests soils are slightly alkaline or have periodically experienced elevated levels of alkalinity.

Representative Site: SL4

Landscape Position: Upland (P)

Elevation: 960 m

Slope: 0%

Aspect: Level

Scientific Name	Common Name	Foliar Cover (%)
Grasses		
<i>Agrostis stolonifera</i>	creeping bentgrass	15
<i>Poa pratensis</i>	Kentucky bluegrass	4
Forbs		
<i>Medicago lupulina</i>	black medic	48
<i>Potentilla anserina</i>	silverweed	8
<i>Taraxacum officinale</i>	dandelion	4
<i>Eleocharis palustris</i>	common spike-rush	2
<i>Juncus balticus</i>	Baltic rush	1
<i>Hordeum jubatum</i>	foxtail barley	t

Production (kg/ha):	Grasses	1346
	Forbs	359
	Total	1705

Stocking Rate: 1346 kg/ha / 450 kg/ha x 50% safe use = **1.5 AUMs per hectare**

Photo 7. Community Type 10, Kentucky bluegrass/black medic-common dandelion.

Photo 8. Community Type 12, Creeping bentgrass/black medic.

3.2 Primary and Secondary Ranges

Four broad range types are present in the Dutch-Findlay Range Unit and include native grasslands, wetlands, cutblocks, and mature forests. The mature forest range type comprised by far, the largest area within the range unit, followed by upland native grassland and cutblocks. However, upland native grasslands are more predominant in Sun Lake and Thunderhill pastures compared to Dutch and Spur pastures. The wetland range type, contained two distinct vegetation communities; a wet needle spike-rush community and a patchy community dominated by black medic found adjacent to some sloughs. The wetland range type is limited in size and distribution and at the time the range inventory was conducted, did not appear to receive significant use by either grazing ungulates or domestic livestock. However, species composition of these communities would suggest that they have been influenced by past grazing activities. The upland native range type contained three distinct communities while the remaining range types were characterized by vegetation associated with cutblocks or mature forests.

Herbage and forage production levels and carrying capacities for vegetation community types and primary and secondary ranges in Dutch, Spur, Sun Lake, and Thunderhill pastures are summarized in Table 3. A list of individual map polygon sizes for the primary and secondary ranges of the range unit are presented in Appendix 3. Primary range for livestock in Dutch and Spur pastures is confined primarily to B.C. Hydro's transmission line right-of-way and adjacent forests. Forested areas that have been clearcut also provide good primary range if water is readily accessible. Selectively cut forest areas may provide good secondary range if landings and roadsides have been reseeded with palatable non-native species. Comments from ranchers and Ministry of Forests personnel along with field observations indicate that livestock tend to congregate on reseeded forest landings and roadside edges. Grassland areas are largely absent from Dutch Pasture and only form a small component of Spur Pasture. In contrast, grassland areas are widespread in Sun Lake and Thunderhill pastures, largely a function of an extensive fire which burned through the area in 1985. Most of Sun Lake Pasture is considered to be primary range with the exception of small, widely scattered, thickly forested areas. Thunderhill Pasture is considered for the most part, to be mostly secondary range. Primary range is located in the southwestern part of the pasture where livestock have good access to water. Because of poor access to water, the eastern portion of the Thunderhill Pasture was considered to be secondary range.

Thunderhill Pasture is comprised of two vegetation community types (CT3 and CT6) that were mapped as a single unit (CT6,3). Fire disturbance in this pasture has created a mosaic of immature vegetation types that are not easily mapped either on the ground or from aerial

photographs. Of the six transects surveyed in Thunderhill Pasture, one (TH2) was classified as CT3 while the remaining five were classified as CT6. TH2 is differentiated from the other transects by its high cover of pinegrass and by the absence of both Columbian and spreading needlegrass.

Table 3. Herbage and forage productivity (kg/ha) and carrying capacities for Dutch, Spur, Sun Lake and Thunderhill pastures.

Pasture	Range	Comm. Type	Area (ha)	Grass (kg/ha)	Forbs (kg/ha)	Palatable Forbs ¹ (kg/ha)	Forage (kg/ha)	Total Forage (kg/ha)	AUMs ²
Dutch	Primary	CT3	32	570	37	0	570	18240	17
		CT10	53	1565	257	64	1629	86337	80
		Total	85					104577	97
	Secondary	CT2	33	361	19	0	361	11394	13
		CT3	100	570	37	0	570	57000	53
		Total	133					68394	86
Spur	Primary	CT2	198	361	19	0	361	71478	79
		CT4	48	1084	136	0	1084	52032	58
		CT6	47	820	66	0	820	38540	43
		CT7	117	641	271	0	641	74997	83
		Total	410					237132	263
	Secondary	CT2	190	361	19	0	361	68500	76
		CT3	90	570	37	0	570	51300	57
		CT6	63	820	66	0	820	51660	57
		Total	343					171460	190
Sun Lake	Primary	CT1	4	19	1147	0	19	76	-
		CT2	60	360	19	0	360	21600	24
		CT3	103	570	37	0	570	58710	65
		CT6	246	820	66	0	820	201720	224
		CT7	32	641	271	0	641	20512	23
		CT12	8	1346	359	0	1346	10768	12
		Total	453					313386	348
Thunderhill	Primary	CT6,3	276	820	66	0	820	226320	251
		Total	276					226320	251
	Secondary	CT6,3	402	820	66	0	820	329640	366
		Total	402					329640	366

¹ Palatable forb is black medic.

² AUM = (Total forage x 0.5) / 450 kg.

3.3 Herbage and Forage Productivity

Forage production (kg/ha) for each community type is summarized in Table 4. Community types that have higher levels of forage production (e.g. > 1000 kg/ha) include CT10 (Kentucky bluegrass/black medic-common dandelion), CT12 (creeping bentgrass/black medic) and CT4 (kinnikinnick/Richardson's needlegrass).

Table 4. Forage production for community types found in the Dutch-Findlay Range Unit.

Community Type	Forage Production (kg/ha)
1. Bog birch/needle spike-rush	19
2. Prairie rose-snowberry-saskatoon/Kentucky bluegrass	361
3. Douglas-fir/pinegrass	570
4. Kinnikinnick/Richardson's needlegrass	1084
6. Columbian needlegrass-Canada bluegrass	820
7. Columbian needlegrass/shaggy fleabane-bristly stickseed	641
10. Kentucky bluegrass/black medic-common dandelion	1565
12. Creeping bentgrass/black medic	1346

Moderate levels of forage production (500 - 1000 kg/ha) were recorded in CT6 (Columbian needlegrass-Canada bluegrass), CT7 (Columbian needlegrass/shaggy fleabane-bristly stickseed), and CT3 (Douglas-fir/pinegrass). In comparison, CT2 (prairie rose-snowberry-saskatoon/Kentucky bluegrass) and CT1 (bog birch/needle spike-rush) have forage production levels less than 500 kg/ha.

An important consideration in any range inventory is the effect of variations in annual precipitation on herbage production, particularly with respect to rainfall. Researchers in Canada and the United States have reported vegetation is sensitive to variations in rainfall during the growing season (Smoliak 1956, Bennett et al. 1987, Rosiere 1987). Graminoids, and to a lesser extent forbs, respond to increased rainfall between May and July by exhibiting higher growth rates. In mountainous areas, however, the effects of variations in annual rainfall is less clear, particularly as it relates to amount of snow melt, landscape position and presence of seepage areas. During the present study, the Dutch-Findlay Range Unit received above-normal amounts of rainfall in 1995. During June and July, 1995, the amount of rainfall was almost 2 - 3 times the 30-year normals recorded at Cranbrook (Figure 2). As a result, herbage production levels were likely higher than normal. This also raises the question about the extent to which herbage production measurements obtained in 1995 reflect the average levels that can be expected in the region over the long-term.

Figure 2. Monthly comparisons of 1995 rainfall with 30 year long-term normals, Cranbrook meteorological station.

Because this range inventory represents an initial assessment of forage and herbage production on the Dutch-Findlay Range Unit, there is a need to continue monitor herbage production in future years to account for the effects of variations in annual precipitation. Establishment of reference areas that are clipped annually will assist in providing more accurate, long-term average production data for the Dutch-Findlay Range Unit. At present Ministry of Forest personnel have been conducting annual clips of production cages for the last three years. Production data from these three years were then averaged to determine a base production level for use in establishing carrying capacities in the Dutch-Findlay Range Unit. The Ministry of Forests plans to reassess herbage production levels within the range unit with follow-up clippings in 3-5 years time.

3.4 Range Management Considerations

3.4.1 Limiting Landscape Features

Domestic livestock use of the Dutch-Findlay Range Unit is strongly influenced by topography, vegetation, and available stock water. Lack of accessible stock water is particularly a problem at the north end of Dutch Pasture, the northeast corner of Spur Pasture, and the east side of Thunderhill Pasture. The remaining areas have generally good access to water for domestic livestock. Thick forests and/or rugged topography are major deterrents to livestock grazing on Crown lands in Dutch, Spur, and Sun Lake pastures and to a lesser extent in Thunderhill Pasture. Livestock grazing is confined primarily to the transmission line right-of-way and clearcut or partially cut areas in Dutch and Spur pastures. Sources of livestock water appear to be adequate

in Sun Lake Pasture. Grasslands are more extensive in Sun Lake and Thunderhill pastures which makes them more amenable to grazing by livestock. However, significant areas of Crown land on the west half of Sun Lake and Thunderhill pastures are too thickly forested and/or the terrain is too rugged for livestock grazing.

3.4.2 Patterns of Grazing Use

With few exceptions, a herd of 250 cows and 10 bulls has been grazing the Dutch-Findlay Range Unit from mid-May until the end of October since 1979. Table 5 shows the total AUMs' allocated to each pasture and the annual sequence of pasture rotation since 1978. Grazing rotation commences in either Sun Lake Pasture on even numbered years or in Spur Pasture, on odd-numbered years. Commencement of grazing and the length of the grazing period for each pasture varies slightly from year to year. Each pasture is grazed for one period annually except Spur Pasture, which is usually grazed twice. On odd-numbered years, Spur Pasture is grazed once in late spring and once in mid- to late summer, while on even numbered years, it is grazed once in mid-summer and once in late fall.

Based on AUMs generated in 1995 (refer to Table 5) it would appear that grazing patterns for Thunderhill and Sun Lake pastures fall within the current carrying capacities for each pasture. The AUMs generated in 1995 for Spur and Dutch pastures are low, indicating that present grazing patterns exceed the capacity of the pastures to support current levels of grazing. It should be noted, however, that cattle grazing on adjacent, unfenced private lands likely account for some of the shortfall in carrying capacities within Spur and Dutch pastures. For example, grazing on Crown land accounts for 29% and 38% of the current usable landbase within Dutch and Spur pastures (refer to Table 1). The only area of heavy grazing noted in these two pastures occurs along B.C. Hydro's transmission line right-of-way.

In 1993, a 5 year grazing permit for Dutch-Findlay Range Unit was issued to Thunderhill Ranch. The permit allows for a maximum of 260 cattle (250 cow/calf pairs and 10 bulls) to be grazed on the four pastures on a rotating basis. In Dutch Creek Pasture, livestock grazing appears to be concentrated along B.C. Hydro's transmission line right-of-way and along roads and trails that provide easy access to forage. Cleared landings are also preferred grazing areas since these areas have been reseeded with highly palatable, non-native species. Areas that have been clearcut or partially cut also provide good forage but salting is usually required to encourage cattle to use these areas. Based on field sampling and discussions with the permit holder (B. McKersie), the transmission line right-of-way is considered to be the only primary range in Dutch Pasture. Forested areas adjacent to the transmission line right-of-way that have been partially cut or

clearcut were considered to be secondary range for livestock. However, logging access roads and

Table 5. See Additional File DFTABLE5.doc (Landscape table)

landings that have been seeded with palatable non-native species were considered to be primary range. Heavily forested areas and the lack of water appear to limit grazing opportunities for cattle in the north and northeast portions of Dutch Pasture.

Like Dutch Pasture, livestock grazing in Spur Pasture also appears to be concentrated along B.C. Hydro's transmission line right-of-way and in forested areas immediately adjacent to the right-of-way. The northeast corner of the pasture does not appear to be used extensively by cattle because of the lack of water. Livestock will graze this area if a water source is present, however, for approximately 8 out of the last 10 years, a suitable water source has been largely absent in the area. If the fence line separating Dutch Creek and Spur pastures was located further south, access to water would be improved and as a result, this area of the pasture would be more actively grazed by livestock (B. McKersie, pers. comm.). Distribution of livestock in Spur Pasture is generally good so limited salting is required. Overall, the best grazing areas in Spur Pasture are located on private land.

Although livestock grazing in Sun Lake Pasture is generally widespread, a significant amount of use is concentrated in the northwest corner which is located on private land. Requirements for salting in this pasture are limited, as distribution of cattle is considered to be good. Since elk movements in the area tend to follow an east-west pattern across private land, Crown land, and the Columbia Wildlife Area, elk also concentrate their grazing activities on private lands northeast of the Sun Lake Pasture during the winter period.

Livestock grazing in Thunderhill Pasture is focused in the west and northwest portions of the pasture where water access is good (B. McKersie, pers. comm.). The southeast corner is less frequently used by cattle because of poor water access. Most of the salting occurs on the west side of this pasture where grazing opportunities are good. A fire in 1985 burned extensive areas of this pasture, and as a result, most of the tree cover was removed. Some burned areas have regenerated to thick pine stands while other areas remain as well-developed grasslands. Since this fire occurred, forage availability has increased considerably, providing good grazing opportunities for cattle in Thunderhill Pasture.

3.4.3 Ungrazed Sites For Potential Monitoring

All primary ranges within the Dutch-Findlay Range Unit appear to have been grazed by livestock to some extent and no grassland areas present could be considered pristine. However, the northeast corner of Spur Pasture appears to be only very lightly grazed, because cattle do not have good access to water. If this grazing pattern continues, the area located near Transect 6

(SPU6) may provide some indication of the potential productivity of grasslands that are grazed primarily by wildlife. The north end of B.C. Hydro's transmission line right-of-way near Dutch Creek may also be a possible benchmark for monitoring livestock grazing along the right-of-way.

3.4.4 Damaged Trails or Watering Areas

Trails throughout the Dutch-Findlay Range Unit appear to be in relatively good condition. No damaged trails or water holes attributable to livestock were noted during the study. In addition, no serious erosion problems were noted along trails or adjacent to watering areas.

3.4.5 Interaction of Alternate Use(rs) with Livestock Management

Abundant wildlife populations, including Rocky Mountain elk, mule deer, white-tailed deer, and moose provides good opportunities for recreational hunters in the Dutch-Findlay Range Unit. In general, conflicts between hunters and livestock have been minimal. The most frequently encountered problem appears to be that gates between pastures are left open, allowing livestock to move into other pastures to graze. These animals must then be located and herded back to the appropriate pasture by the rancher which usually involves extra time and effort. There is also the potential that livestock at large may create additional grazing pressures in closed pastures.

Increased hunting pressure in the area has also resulted in numerous road closures to protect range from unauthorized off-road vehicle use. Dry grasslands are particularly sensitive to off-road vehicle traffic which can quickly damage vegetation. Loss of native vegetation may increase the potential for invasion of weedy non-native species and, if vegetation losses are severe, may also promote erosion.

3.4.6 Current Management Practices

Use of salt to encourage livestock to use underutilized areas is one of the main management practices in the Dutch-Findlay Range Unit. Areas are salted to encourage livestock movement into these areas and away from highly used, primary grazing areas. However, if areas of completely different vegetation types are salted, livestock will typically walk into the area, use the salt and then return to primary ranges without actually grazing the secondary range. To prevent localized overuse by livestock, salt locations are moved each year. As a general practise, salt is also located away from riparian areas which are easily disturbed and sensitive to livestock use.

Over the last twenty years, water diversion and impoundment projects at the south end of Spur Lake, the north end of Sun Lake, and the southwest corner of Thunderhill Pasture have been developed in conjunction with livestock management. Where water development projects have occurred, range use by livestock has been enhanced and overall range utilization has been improved. At present only two areas, the north end of Spur Pasture and the east side of Thunderhill Pasture, appear to have livestock use limitations because of the lack of a reliable water source.

3.4.7 Access Problems

Few access problems for domestic livestock were noted within the Dutch-Findlay Range Unit. Timber harvesting in Dutch Creek and Spur pastures has created a network of roads and trails, providing good access to most of these pastures. B.C. Hydro's transmission line right-of-way, which runs north-south through all four pastures of the range unit, also provides excellent corridor access for cattle. Sun Lake and Thunderhill pastures are also very open and access is good except in areas that have high amounts of woody debris from the 1985 fire.

3.4.8 Wildlife Use

Based on observations of fecal groups during the range inventory, ungulate activity is widespread throughout the Dutch-Findlay Range Unit. Seasonal patterns of wildlife habitat use in the range unit appear to shift from east to west, across Crown land and the Columbia Wildlife Refuge (B. McKersie, pers. com.). Elk are abundant in low elevation grasslands and open forests on private and Crown lands during the winter, but typically move to higher elevations in the Columbia Wildlife Refuge during the summer. Elk spend a large amount of time during the winter on private lands in the northwest corner of Sun Pasture (B. McKersie, pers. comm.).

The degree of forage competition between wildlife (e.g. moose, deer and elk) and livestock on primary range was not determined within the scope of the present study. Maintaining levels of cattle grazing on primary range and leaving forage on secondary range for elk will reduce forage competition, but it is unlikely to eliminate it completely. Moose and deer do not usually conflict with livestock because they tend to use different types of forage and different habitats. Management practices such as salting away from water should be continued to disperse cattle grazing pressure. Limiting stocking rates to carrying capacity provided by primary range will also ensure moderate levels of livestock use and will minimize wildlife competition with cattle.

4.0 RECOMMENDATIONS

Based on the range inventory conducted in 1995, a number of recommendations regarding range management in the Dutch-Findlay Range Unit can be made:

1. Grazing on Thunderhill Pasture could be more evenly distributed if a water source for livestock was available in the southeast corner. Currently most grazing occurs in the west and northwest sections of the pasture.
2. As a result of the 1985 fire, grazing conditions were improved in Thunderhill and Sun Lake pastures. Although some areas are now well-developed grasslands, other areas are gradually reverting to thick pine. The carrying capacity of these pastures for livestock and wildlife will gradually shift as post-fire succession continues. Therefore, burned areas should continue to be monitored and carrying capacities altered, as necessary, to reflect changes in forage availability.
3. Presently, salting is the preferred management technique to attract livestock from primary to secondary ranges, and to obtain a better distribution of livestock use on these ranges. Salt locations are moved each year to prevent localized overuse. All salting should occur on secondary or unutilized range. These salting practices should be continued to effectively use and maintain current levels of rangeland forage.
4. Primary range for livestock in Dutch and Spur pastures are concentrated along B.C. Hydro's transmission line right-of-way. Although the right-of-way is heavily used by cattle, maintaining livestock along this area does not appear to conflict with wildlife use. Thus, the present pattern of use is probably desirable.
5. If a new access road for forest harvesting is constructed in Dutch Pasture, roadside edges should be reseeded with native species that are less palatable to livestock. This will reduce grazing activities along the road and help maintain a better distribution of cattle.
6. Grasslands in the northwest corner of Sun Lake Pasture are beginning to show signs of overgrazing. Perhaps the grazing system could be altered to rest this area or a better placement of livestock could be obtained with a different distribution of salting.

7. The number of AUMs in the Dutch-Findlay Range Unit has remained more or less constant for the past 15 years. Overall, range conditions are good, indicating that this level of use is sustainable. Currently, extensive areas of unfenced private land in Dutch Creek and Spur pastures are used to provide additional AUMs. If, at some future date, this private land base is reduced for livestock use, then use of secondary ranges will be required to maintain current livestock levels.

8. An on-going monitoring program of range productivity and carrying capacity should be maintained with re-assessment conducted on a regular basis. Production and utilization plots should be clipped and assessed on a biennial basis to account for variations in annual precipitation levels.

5.0 LITERATURE CITED

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APPENDIX 1. Locations of sample transects in the Dutch-Findlay Range Unit.

Transect	Latitude °N	Longitude °W
DUT1	50°17.709'	115°54.345'
DUT2	50°17.395'	115°54.198'
DUT3	50°17.414'	115°55.396'
DUT4	50°17.328'	115°54.981'
DUT5	50°18.254'	115°55.081'
SL1	50°10.873'	115°52.747'
SL2	50°10.993'	115°53.135'
SL3	50°11.824'	115°53.444'
SL4	50°12.805'	115°53.623'
SL5	50°12.832'	115°53.756'
SL6	50°11.477'	115°53.268'
SL7	50°11.189'	115°42.862'
SPU1	50°15.610'	115°54.437'
SPU2	Missing Cage	and Location
SPU3	50°15.487'	115°54.407'
SPU4	50°14.931'	115°54.079'
SPU5	50°15.730'	115°53.485'
SPU6	50°16.250'	115°54.063'
SPU7	50°16.362'	115°53.705'
SPU8	50°15.805'	115°54.925'

Transect	Latitude °N	Longitude °W
TH1	50°10.496'	115°52.199'
TH2	50°10.524'	115°52.041'
TH3	50°09.842'	115°52.333'
TH4	50°10.435'	115°52.421'
TH5	50°10.352'	115°52.163'
TH6	50°10.132'	115°51.879'

APPENDIX 2. Species list of plants recorded in the Dutch-Findlay Range Unit, June, 1995.

Scientific Name	Common Name	Acronym
<i>Achillea millefolium</i>	yarrow	achimil
<i>Agoseris glauca</i>	pale agoseris	agosgla
<i>Agrostis stolonifera</i>	creeping bentgrass	agrost
<i>Allium cernuum</i>	nodding onion	allicer
<i>Amelanchier alnifolia</i>	saskatoon	amelaln
<i>Anemone</i> sp.	anemone	anem sp
<i>Antennaria parviflora</i>	Nuttall's pussytoes	antepar
<i>Apocynum androsaemifolium</i>	spreading dogbane	apocand
<i>Arabis holboellii</i>	Holboell's rockcress	arabhol
<i>Arctostaphylos uva-ursi</i>	kinnikinnick	arctuva
<i>Arnica cordifolia</i>	heart-leaved arnica	arnicor
<i>Aster</i> sp.	aster	aste sp
<i>Aster campestris</i>	meadow aster	astecam
<i>Aster ciliolatus</i>	fringed aster	astecil
<i>Aster conspicuus</i>	showy aster	astecon
<i>Aster hesperius</i>	western willow aster	astehes
<i>Aster laevis</i>	smooth aster	astelae
<i>Astragalus miser</i>	timber milk-vetch	astrmis
<i>Betula glandulosa</i>	scrub birch	betugla
<i>Bromus inermis</i>	smooth brome	bromine
<i>Bromus tectorum</i>	cheatgrass	bromtec
<i>Calamagrostis rubescens</i>	pinegrass	calarub
<i>Campanula rotundifolia</i>	common harebell	camprot
<i>Carex</i> sp.	sedge	care sp
<i>Centaurea maculosa</i>	spotted knapweed	centmac
<i>Chenopodium</i> sp.		chen sp
<i>Chenopodium album</i>	lamb's-quarters	chenalb
<i>Cirsium arvense</i>	Canada thistle	cirsarv
<i>Collinsia parviflora</i>	small-flowered blue-eyed Mary	collpar
<i>Conyza canadensis</i>	horseweed	conycan
<i>Crepis</i> sp.	hawksbeard	crep sp
<i>Crepis runcinata</i>	dandelion hawksbeard	creprun
<i>Dactylis glomerata</i>	orchardgrass	dactglo
<i>Descurainia sophia</i>	flixweed	descsop
<i>Dodecatheon pulchellum</i>	few-flowered shootingstar	dodepul
<i>Elaeagnus commutata</i>	wolf-willow	elaecom
<i>Eleocharis acicularis</i>	needle spike-rush	eleoaci
<i>Eleocharis palustris</i>	common spike-rush	eleopal
<i>Elymus lanceolatus</i>	thickspike wildrye	elymlan

Scientific Name	Common Name	Acronym
<i>Elymus repens</i>	quackgrass	elymrep
<i>Elymus smithii</i>	western wheatgrass	elymsmi
<i>Elymus spicata</i>	bluebunch wheatgrass	elymspi
<i>Elymus trachycaulus</i>	slender wheatgrass	elymtra
<i>Epilobium angustifolium</i>	fireweed	epilang
<i>Erigeron compositus</i>	cut-leaved daisy	erigcom
<i>Erigeron pumilus</i>	shaggy fleabane	erigpum
<i>Festuca campestris</i>	rough fescue	festcam
<i>Festuca idahoensis</i>	Idaho fescue	festida
<i>Festuca rubra</i>	red fescue	festrub
<i>Filago arvensis</i>	field filago	filaarv
<i>Fragaria virginiana</i>	wild strawberry	fragvir
<i>Galium boreale</i>	northern bedstraw	galibor
<i>Geum triflorum</i>	old man's whiskers	geumtri
<i>Heterotheca villosa</i>	hairy golden-aster	hetevil
<i>Heuchera sp.</i>	alumroot	heuc sp
<i>Hordeum jubatum</i>	foxtail barley	hordjub
<i>Juncus balticus</i>	Baltic rush	juncbal
<i>Koeleria macrantha</i>	junegrass	koelmac
<i>Lappula squarrosa</i>	bristly stickseed	lappsqu
<i>Larix occidentalis</i>	western larch	lariocc
<i>Lepidium densiflorum</i>	prairie pepper-grass	lepiden
<i>Linnaea borealis</i>	twinflower	linnbor
<i>Linum perenne</i>	western blue flax	linuper
<i>Lithospermum ruderales</i>	lemonweed	lithrud
<i>Medicago lupulina</i>	black medic	medilup
<i>Medicago sativa</i>	alfalfa	medisat
<i>Oxytropis sericea</i>	silky locoweed	oxytser
<i>Parnassia sp.</i>	grass-of-Parnassus	parn sp
<i>Penstemon confertus</i>	yellow penstemon	penscon
<i>Phleum pratense</i>	timothy	phlepra
<i>Pinus contorta</i>	lodgepole pine	pinucon
<i>Plantago major</i>	common plantain	planmaj
<i>Poa compressa</i>	Canada bluegrass	poa com
<i>Poa pratensis</i>	Kentucky bluegrass	poa pra
<i>Poa secunda</i>	Sandberg or Nevada bluegrass	poa sec
<i>Polygonum douglasii</i>	Douglas' knotweed	polydou
<i>Populus tremuloides</i>	trembling aspen	poputre
<i>Potentilla anserina</i>	silverweed	poteans
<i>Potentilla fruticosa</i>	shrubby cinquefoil	potefru
<i>Pseudotsuga menziesii</i>	Douglas-fir	pseumen
<i>Ribe sp.</i>	gooseberry	ribe sp
<i>Rosa woodsii</i>	prairie rose	rosawoo

Scientific Name	Common Name	Acronym
<i>Salix sp.</i>	willow	sali sp
<i>Salix candida</i>	hoary willow	salican
<i>Senecio streptanthifolius</i>	Rocky Mountain butterweed	senestr
<i>Shepherdia canadensis</i>	soopolallie	shepcan
<i>Silene menziesii</i>	Menzies' campion	silemen
<i>Sisymbrium altissimum</i>	tall tumble-mustard	sisyalt
<i>Sisyrinchium montanum</i>	mountain blue-eyed-grass	sisymon
<i>Solidago spathulata</i>	spike-like goldenrod	solispa
<i>Spiraea betulifolia</i>	birch-leaved spirea	spirbet
<i>Stellaria sp.</i>	starwort	stel sp
<i>Stellaria crispa</i>	crisp starwort	stelcri
<i>Stipa nelsonii</i>	Columbia needlegrass	stipnel
<i>Stipa richardsonii</i>	spreading needlegrass	stipric
<i>Suaeda depressa</i>	seablite	suaedep
<i>Symphoricarpos albus</i>	common snowberry	sympalb
<i>Symphoricarpos occidentalis</i>	western snowberry	sympocc
<i>Taraxacum officinale</i>	common dandelion	taraoff
<i>Tragopogon dubius</i>	yellow salsify	tragdub
<i>Trifolium hybridum</i>	alsike clover	trifhyb
<i>Trifolium repens</i>	white clover	trifrep
<i>Triglochin maritimum</i>	seaside arrowgrass	trigmar
<i>Utricularia vulgaris</i>	greater bladderwort	utrivul
<i>Viola adunca</i>	early blue violet	violadu
<i>Viola canadensis</i>	Canada violet	violcan
<i>Zigadenus elegans</i>	mountain death-camas	zigaele
<i>Zigadenus venenosus</i>	meadow death-camas	zigaven

APPENDIX 3. Dutch-Findlay Range Unit. Map polygons of primary and secondary ranges in the Findlay Basin Range Unit.

Pasture	Polygon	Range Type	Community Type	Area (ha)
Dutch	1	2°	CT3	58.1
Dutch	2	2°	CT2	33.2
Dutch	3	1°	CT10	26.0
Dutch	4	1°	CT3	32.0
Dutch	5	1°	CT10	4.2
Dutch	6	2°	CT3	42.3
Dutch	7	1°	CT10	22.9
Spur	1	2°	CT6	56.6
Spur	2	2°	CT3	75.7
Spur	3	1°	CT2	25.5
Spur	4	1°	CT2	71.9
Spur	5	1°	CT2	8.5
Spur	6	2°	CT2	48.5
Spur	7	1°	CT4	15.7
Spur	8	1°	CT4	32.0
Spur	9	2°	CT2	118.3
Spur	10	1°	CT6	31.5
Spur	11	1°	CT2	14.8
Spur	12	2°	CT2	23.3
Spur	13	2°	CT2	6.7
Spur	14	1°	CT6	15.8
Spur	15	1°	CT2	20.9
Spur	16	1°	CT2	19.7
Spur	17	1°	CT2	14.8
Spur	18	1°	CT7	87.2
Spur	19	1°	CT7	30.0
Spur	20	1°	CT2	22.0
Sun Lake	1	1°	CT7	17.0
Sun Lake	2	1°	CT12	2.3
Sun Lake	3	1°	CT2	41.9
Sun Lake	4	1°	CT6	131.2
Sun Lake	5	1°	CT3	84.6
Sun Lake	6	1°	CT2	3.2
Sun Lake	7	1°	CT2	14.6
Sun Lake	8	1°	CT12	8.3
Sun Lake	9	1°	CT1	3.6
Sun Lake	10	1°	CT7	5.1
Sun Lake	11	1°	CT7	9.8
Sun Lake	12	1°	CT3	18.2
Sun Lake	13	1°	CT6	114.6
Thunderhill	1	1°	CT6/CT3	275.9
Thunderhill	2	2°	CT6/CT3	402.4