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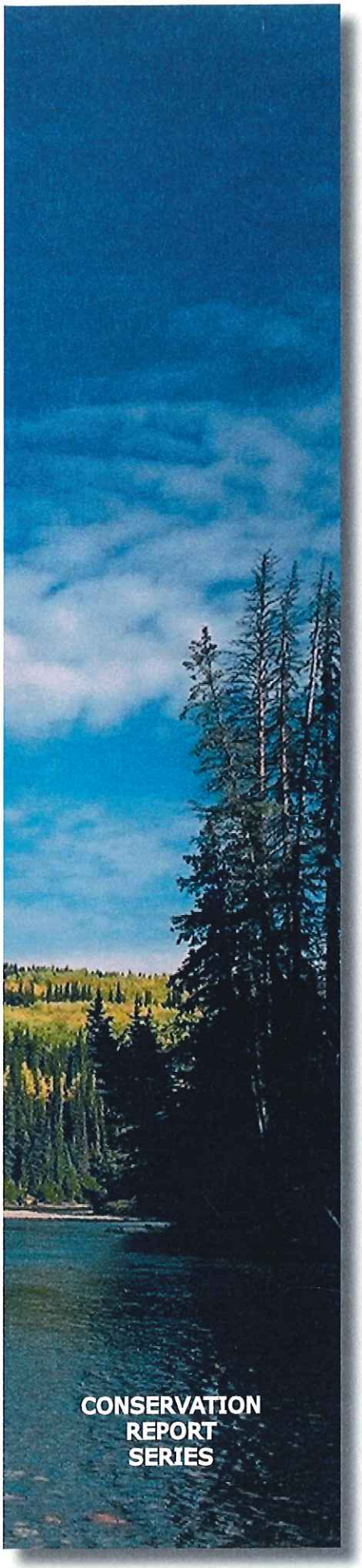

An Initial Review of Browse Conditions on Select Properties in the Aspen Parkland Ecoregion of Alberta

Alberta Conservation Association

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Andy Murphy[1] and Rob Corrigan[2]

[1]Alberta Conservation Association, 404, 4911-51st Street,
Red Deer, Alberta, Canada T4N 6V4

[2]Alberta Conservation Association, 250 Diamond Avenue
Spruce Grove, Alberta, Canada T7X 4C7

Alberta Conservation Association

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Alberta supports a diversity of ungulate species many of which rely on plant browse as an important food resource. The Resource Data Branch (RDB) and Alberta Sustainable Resource Development (ASRD) initiated an evaluation of the browse resource on the Rumsey Ecological Reserve (RER) in 1997. The resulting study completed by Ainsley (2003) demonstrated that the silverberry and willow cover types are extremely important contributors to overall browse production and that annual browse production fluctuates dramatically. The study also suggested that preferred browse species are heavily utilized. Browse consumption exceeded annual browse production for preferred species. In 1999, the RDB and ASRD initiated an evaluation of the browse resources in four sampling blocks (Red Deer East, Camrose-Tofield, Vermilion, and Wainwright South) across the Central Parkland. This evaluation completed by Ainsley (2004) used nearly the same methods as the RER study, but examined just one transect per land parcel. The ACA contributed to these reports by assisting with fieldwork. This ACA report highlights results of the two evaluations, reports some additional browse comparisons, and identifies objectives the ACA may want to address with future browse investigations.

Evaluation of the browse resource across the Parkland Sub-region by Ainsley (2004) demonstrated that the willow-shrub cover type produces significantly more browse than the aspen forest cover type, and that both production and utilization are extremely variable. Maximum browse production at a single transect was more than 53 times as great as minimum production, and the maximum utilization rate (biomass-based for individual transects) was more than four times the minimum rate. The evaluation did not demonstrate significant effects of soil texture, sampling block, or canopy height on browse production. However, it is possible that differences in grazing intensity (both current and past) and/or other environmental variables (slope, aspect or canopy closure) may have obscured real differences. Conservation sites examined did not produce significantly more browse than the randomly selected sites. This suggests that past selection of conservation sites has not effectively exploited the range of productivity that exists in the Parkland.

Based on our review of the results from Ainsley (2003) and (2004), we recommend that additional efforts are required to document spatial and temporal variability in the availability of browse in the parkland region.

1.0 INTRODUCTION

1.1 Study Rationale

Wild ungulates provide Albertan's with highly valued recreational opportunities (Bjorge 2003). These ungulates rely on browse to meet their nutritional requirements through the winter, and various other wildlife species also rely on dense shrub cover. When the browse resources are over-utilized, browse production declines, and habitat quality/suitability is reduced for deer, upland game birds (Schroeder et. al. 2004) and songbirds (DeCalesta 1994). As a result, large reductions in ungulate numbers can occur over the winter period (i.e., die-offs) and damage to hay stacks can be substantial. Plant communities are also known to be dramatically altered by fluctuations in ungulate densities (Tilghman 1989).

The Rumsey Ecological Reserve (RER) supports the highest density of moose in Alberta, and also supports both white-tailed deer and mule deer (Froggatt 2000). Consequently, it is possible that the browse resource on the RER is being over-utilized. The Resource Data Branch (Strategic Corporate Services Division Government of Alberta) initiated an evaluation of the browse resource on the Rumsey Ecological Reserve (RER) in 1997 (Telfer 1997), and , Ainsley (2003) has summarized the results of this evaluation.

The objectives of the Rumsey Ecological Reserve study by Ainsley (2003) were to:

1. Quantify browse production by cover type (vegetation community) with permanent transects that would provide baseline data for future comparisons.
2. Determine the degree of browse utilization by ungulates in this region.
3. Determine browse production and utilization for individual shrub/tree species.

Initial investigations demonstrated that twig diameters were reliable predictors of twig weights and that preferred browse species were being very heavily utilized (Ainsley and Meijer 1999).

In 1999, a second study was initiated to evaluate the browse resource in four general areas (Red Deer East, Camrose-Tofield, Vermilion, and Wainwright South) (Ainsworth 2004). This evaluation used the same methods as the Rumsey Ecological Reserve study

except that different cover types were evaluated, and only one transect was located on any one property. The objectives of the Parkland study were to:

1. Quantify browse production by cover type (vegetation community) with permanent transects that would provide baseline data for future comparisons.
2. Evaluate the effects of block (area), soil texture, and canopy height on browse production.
3. Estimate the browse utilization rate for the Aspen Parkland (an eco-region heavily impacted by intensive agriculture), and to compare utilization rates across different areas ("blocks") within the eco-region.
4. Determine browse production and utilization for individual shrub/tree species.

1.2 Objectives

The specific objectives of this report were to:

1. Summarize the results of Ainsley (2003) and (2004) and review the importance of these results to the ACA and its stakeholders.
2. Compare browse production and utilization in the Rumsey Ecological Reserve with that in the remainder of the ecoregion including areas heavily impacted by agriculture, and to conduct additional comparisons (eg., Conservation Sites versus randomly selected sites) of importance to the ACA.
3. Identify additional conservation efforts to support both habitat conservation and the conservation of ungulates within the Parkland ecoregion.

2.0 STUDY AREAS

The Rumsey Ecological Reserve (RER) is located approximately 40 km south of Stettler (Figure 1). It is a discrete, contiguous block (3,432 ha) of native Parkland vegetation. It is characterized by "knob and kettle" terrain and either dark brown (drier sites) or black chernozemic (under aspen stands) soils (Achuff 1992). All but 60 ha of the RER are grazed annually as part of the same rotational livestock grazing system.

The Parkland browse evaluation was conducted on three clusters of randomly selected sites, one cluster of priority sites located near Vermilion, and several priority sites in the Red Deer area (Figure 1). These clusters or sampling blocks are referred to as the Red Deer East, Camrose-Tofield, Vermilion, and Wainwright South blocks, respectively. Priority sites and conservation sites are sites managed in whole, or in part, by one or more conservation agencies to provide habitat for wildlife. Many of these sites are crown-owned. Others are owned by one or more conservation agencies (ACA, Alberta Fish and Game Association (AFGA), Ducks Unlimited Canada (DUC) or the Nature Conservancy of Canada (NCC)). Some properties have been grazed by livestock for many years, and continue to be grazed annually. Others have been idle for many years. Ainsley (2004) reported results from the conservation sites in the Red Deer area, but did not report data for the conservation sites located in the Vermilion area.

3.0 METHODS

The initial transect design and layout for the RER evaluation was conducted by Telfer (1997). This design was modified slightly in October of 1998 to more adequately sample the silverberry plant community type (Ainsley and Meijer 1999). Sampling transects consisted of 10 points laid out in straight lines at 10m intervals. Within each 90° quadrant around these points, the third nearest browse plant was selected for sampling. Stem densities (Appendix 1) were calculated from independent counts on nearby plots. Browsed and unbrowsed twigs were counted for each of the selected plants, and both browsed and unbrowsed twig diameters were measured. Twigs were collected, measured (diameter), oven-dried, and then weighed. These twig diameters and oven-dried weights were then used to develop predictive equations for species-specific twig weights (Appendix 2) from twig diameters. Additional details of this work are available

in Ainsley and Meijer (1999). These measurements allowed Ainsley and Meijer (1999) to calculate the total biomass of browse produced and utilized in the RER.

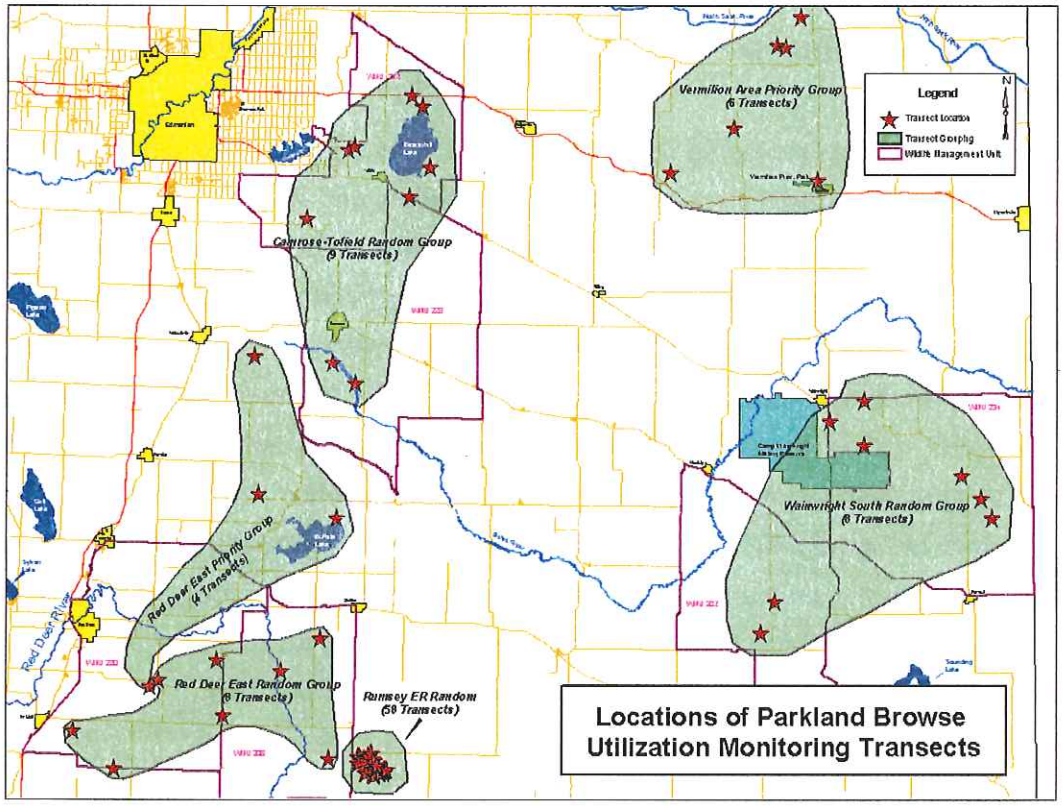

Figure 1. Distribution of browse transects in the Central Parkland Natural Subregion of Alberta.

The Parkland Browse Evaluation used the same field techniques as the RER evaluation (Telfer 1999), except that transects were distributed (1 per site) across sampling blocks. Investigators made an effort to distribute transects across a range of canopy heights, and soil textures. However, site selection was constrained by the need to place transects where both the current and future right of access was reasonably certain (i.e., crown land, municipally owned land, land owned by conservation agencies, and land owned by individuals acquainted with the researchers).

Nearly all statistical tests reported in this report were derived from Ainsley (2003 and 2004). The only statistical tests that we performed were Kruskal Wallis rank sum tests. We chose the Kruskal Wallis rank sum test because the data were not normally distributed (Ainsley 2003 and 2004).

Ainsley (2003 and 2004) did not discuss or employ browse preference, and did not use the term: over-utilization. We use these terms. We define preferred browse species as those with higher use than availability (Wetzel et. al. 1975), and we define over-utilization as utilization that jeopardizes the plant's regenerative capability. Utilization rates exceeding 50-60% reduce the standing biomass, productivity and longevity of tree seedlings (Canham et al. 1994). Consequently, we define over-utilization as any utilization in excess of 55%. While we recognize that browse preference depends on a number of variables (see Nudds 1980 for a review), we also recognize that the availability of preferred browse is an important determinant of habitat quality.

4.0 RESULTS

4.1 Production by cover type in the Rumsey Ecological Reserve

The aspen, willow and silverberry cover types produced 92 kg/ha, 376 kg/ha, and 440 kg/ha, respectively, in 1997 (Table 1). Production from all three cover types fell dramatically in 1998, and remained low in 2001. Average production for these later years was only 30 kg/ha, 150 kg/ha, and 168 kg/ha. Ainsley (2003) attributed low production in these years to drought.

Table 1. Browse production (kg/ha) and utilization (biomass-based) in the Rumsey Ecological reserve, Alberta.

	1997		1998		2001	
Cover type	Production (kg/ha)	Util. rate	Production (kg/ha)	Util. rate	Production (kg/ha)	Util. rate
Aspen	92	0.20	29	0.42	31	0.44
Willow	376	0.15	155	0.42	145	0.56
Silverberry	440	0.30	171	0.80	166	0.81

*Util = browse utilization.

While the aspen cover type composes over 60% of the forest/shrub cover on the RER, it produced less total browse in 1998 and 2001 than the willow cover type, and only slightly more than the silverberry type (Figure 2). These later cover types comprise only about 30% and 9% of the woody cover on the RER.

4.2 Utilization by cover type in the Rumsey Ecological Reserve

Browse utilization rates can be expressed as either: i) the proportion of twigs that are browsed (count ratio utilization rate), or ii) as the proportion of annual production that is consumed (biomass-based utilization rate). Count ratio utilization rates (of the common species) on the RER ranged from 0.18 to 0.54. Biomass utilization rates ranged from 0.37 to 2.13.

Biomass-based utilization rates for all three cover types more than doubled from 1997-1998 to 1998-1999, and all rates increased slightly between the 1998-1999 and 2001-2003 seasons. Utilization of the browse in the silverberry cover type (0.80 in 1998-1999 and 0.81 in 2001-2002) was particularly high. Higher utilization rates in 1989-1999 and 2001-2002 resulted from a relatively stable level of browse consumption (Figure 3) being taken from a dramatically reduced (relative to 1997-1998) supply (annual production).

Biomass utilization rates exceeded count ratio rates by a factor of 2 or more for five species cover type combinations. This indicates that ungulates were removing not only all of the most recent year's browse production, but the production from the previous year as well. This difference in utilization rates demonstrates the importance of calculating biomass-based rates in some situations.

Biomass utilization (3 year average) of *Prunus virginiana* (Table 2) exceeded biomass production in both the aspen and the willow cover types. Utilization also exceeded biomass production for *Amelanchier alnifolia* in the willow cover type.

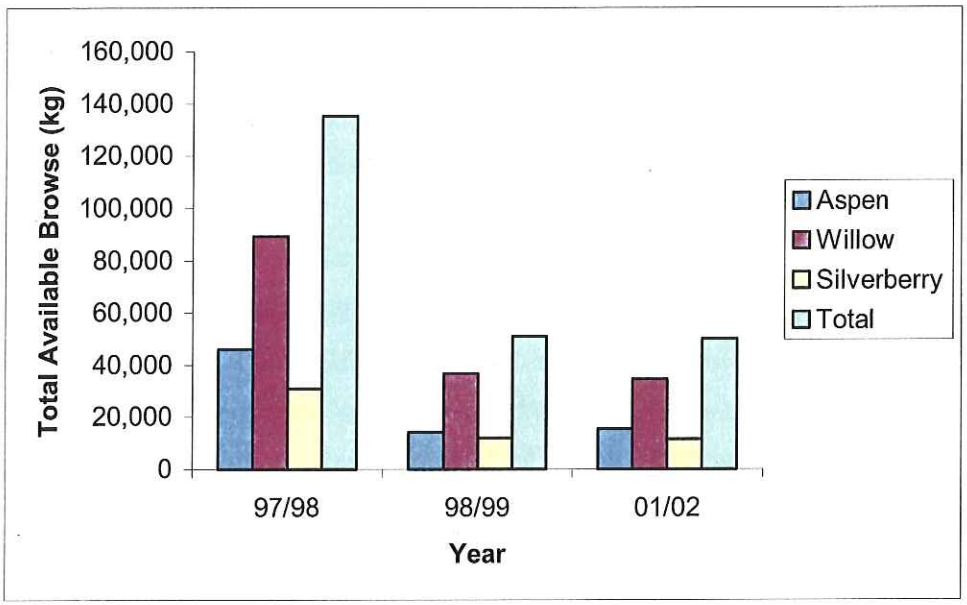

Figure 2. Total available browse production (kg) in the Rumsey Ecological Reserve, Alberta.

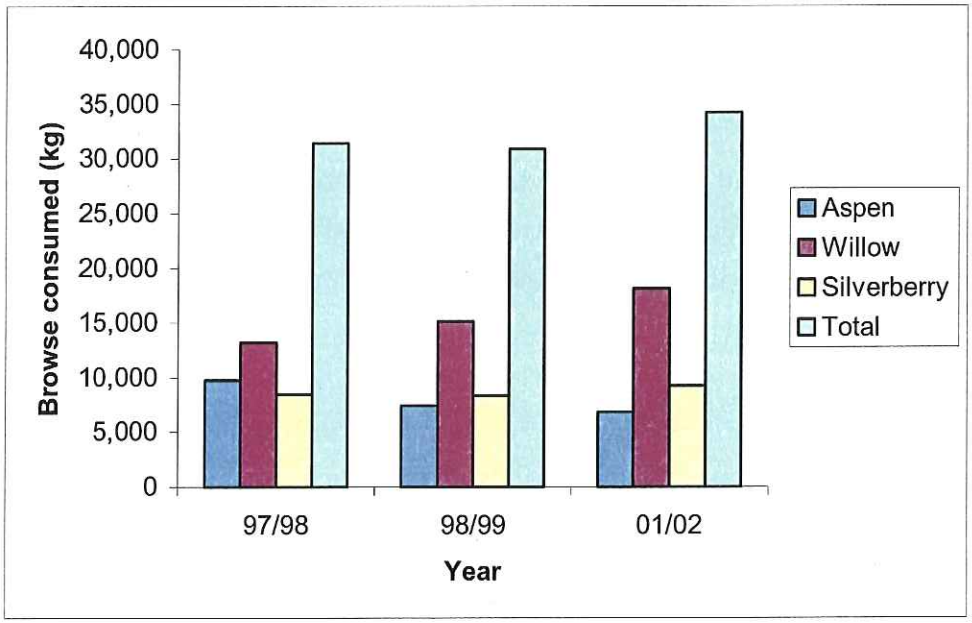

Figure 3. Browse consumption (kg) in the Rumsey Ecological Reserve, Alberta.

Most of the browse available (96.9%), and consumed (92.5%) in the aspen cover type was either: *Populus tremuloides, Salix spp., or Rosa spp.* (Table 2). In the willow cover type, available and consumed browse were both composed almost entirely of willow species (88.5% and 90% - Table 2).

The most heavily utilized species, calculated using both biomass-based and count ratio approaches, were *Prunus virginiana, Amelanchier alnifolia,* and *Eleagnus commutata.* These species collectively comprised just 7.4% and 2.0% of the browse consumed in the aspen and willow cover types respectively (Table 2). In contrast, the preferred species *Eleagnus commutata* composed the vast majority (96.8%) of the browse consumed in that (silverberry) cover type.

4.3 The Browse Resource in the Parkland Ecoregion

While data has been collected in multiple years, Ainsley (2004) presented only the results from the 2003 data collection. In addition, Ainsley (2004) did not include results from the six priority sites (i.e., the conservation sites) located near Vermilion, Alberta.

4.3.1 Parkland Production

Browse production was extremely variable among sites. The highest production recorded (97.1 kg/ha) was substantially greater than the lowest recorded (2.8 kg/ha). Ainsley (2004) reported significant differences among sampling blocks, but his analysis included differing numbers of willow-shrub transects with his randomly selected aspen transects.

Willow (*Salix* spp.) constituted over half (57% - Table 3) of the browse in the 28 Parkland transects (22 aspen cover type transects and 6 willow cover type transects). Together, the three most common species/groups (*Salix* spp., *Cornus cornuta,* and *Amelanchier alnifolia*) constituted 80% of the available browse.

Table 2. Composition (% of available / % of consumed) and utilization (count ratio and biomass-based rates) of common plant species in the Rumsey Ecological Reserve, Alberta.

Cover type and *species*.	Composition % of available/ % of consumed	Utilization rate: Count ratio	Utilization rate: Biomass-based	Utilization rate: Factor (Biomass-based Util./ count ratio Util.)
Aspen Cover Type				
Amelanchier alnifolia	2.2/ 4.4	0.44	0.88	2.0
Populus tremuloides	30.7/ 25.7	0.21	0.37	1.8
Prunus virginiana	0.9/ 3.0	0.51	1.39	2.7
Rosa spp.	42.0/ 32.6	0.47	0.34	0.7
Salix spp.	24.2/ 34.2	0.49	0.62	1.3
Populus balsamifera	NA	0.18	NA	NA
Cornus stolonifera	NA	0.33	NA	NA
Willow *Cover Type*				
Amelanchier alnifolia	0.8/ 1.8	0.56	1.12	2.0
Populus tremuloides	4.0/ 3.1	0.22	0.40	1.8
Prunus virginiana	0.1/ 0.2	0.78	2.13	2.7
Rosa spp.	6.6/ 4.3	0.46	0.34	0.7
Salix spp.	88.5/ 90.7	0.42	0.54	1.3
Populus balsamifera	NA	0.32	NA	NA
Silverberry *Cover Type*				
Eleagnus commutata	93.5/ 96.8	0.37	0.84	2.3
Rosa spp.	6.5/ 3.2	0.54	0.39	0.7

*Data were collected during the period 1997-1998 and 2001-2002. Compiled from Tables 2 and 4 from Ainsley (2003). Util. = browse utilization. NA = not available or not applicable.

Table 3. Overall composition and utilization based on count ratio and biomass-based approaches of the browse resource across the Parkland ecoregion, Alberta.

Species	% Biomass Avail./Consumed	Count Ratio Utilization	Biomass-based Utilization
Eleagnus commutata	1/ 2.2	0.42 ± 0.18	0.53 ± 0.06
Cornus stolonifera.	4/ 7.2	0.34 ± 0.15	0.43 ± 0.06
Amelanchier alnifolia	10/ 17.6	0.35 ± 0.13	0.42 ± 0.08
Prunus virginiana.	2/ 3.4	0.25 ± 0.13	0.40 ± 0.03
Populus balsamifera	4/ 6.0	0.15 ± 0.11	0.36 ± 0.06
Rosa spp.	3/ 4.4	0.29 ± 0.10	0.35 ± 0.05
Populus tremuloides	6/ 8.6	0.26 ± 0.14	0.34 ± 0.08
Cornus cornuta	13/ 14.7	0.32 ± 0.13	0.27 ± 0.07
Salix spp.	57/ 35.9	0.17 ± 0.12	0.15 ± 0.09
Crataegus rotundifolia	T	0.50 ± NA	NA
Sheperdia canadensis	T	0.50 ± NA	NA
Viburnum edule	T	0.30± 0.13	NA
Betula papyrifera	T	0.20 ± 0.15	NA
Viburnum opulus	T	0.07 ± 0.00	NA
Prunus pensylvanica	T	0.03 ± 0.03	NA

*Data are based on assessments of 22 aspen sites and 6 willow-shrub sites. T = trace amounts, NA = not available or not applicable. Compiled from Tables 2 and 4 from Ainsley (2004). Avail= browse availability.

4.3.2 Parkland Utilization

Mean utilization ratios (biomass-based) for individual species ranged from a high of 0.56 to a low of 0.13 (Table 4). Utilization (biomass-based) was similar for the Red Deer East and Wainwright South blocks, but was significantly ($p = 0.002$) lower in the Camrose-Tofield block (Ainsley 2004). However, high browse utilization rates on the Silverberry-East and Silverberry-West priority transects strongly influenced calculations of overall utilization rates (Ainsley 2004).

4.3.3 Parkland Utilization by cover type

Ainsley (2004) reported a trend ($P < 0.062$) toward higher utilization rates in the willow-shrub cover type, but we suspect that Ainsley (2004) meant to report a trend toward greater utilization in the aspen cover type (as indicated by cover type means) (Ainsley 2004).

Table 4. Parkland count ratios and biomass-based utilization rates by cover type.

	Count ratio	Biomass-based	Factor (Biomass Util./ Cons. Ratio Util.)
Aspen			
Eleagnus commutata	0.50 ± 0.17	0.56 ± 0.06	1.1
Cornus stolonifera.	0.40 ± 0.14	0.43 ± 0.07	1.1
Amelanchier alnifolia	0.35 ± 0.13	0.41 ± 0.08	1.2
Prunus virginiana.	0.26 ± 0.13	0.39 ± 0.04	0.7
Populus balsamifera	0.28 ± 0.14	0.34 ± 0.05	1.2
Rosa spp.	0.29 ± 0.10	0.34 ± 0.08	1.2
Populus tremuloides	0.26 ± 0.14	0.29 ± 0.10	1.1
Cornus cornuta	0.27 ± 0.13	0.27 ± 0.07	1.0
Salix spp.	0.09 ± 0.07	0.13 ± 0.09	1.4
Willow-shrub			
Eleagnus commutata	0.23 ± 0.33	0.41 ± 0.11	1.8
Cornus stolonifera.	0.17 ± 0.13	0.44 ± 0.04	2.6
Amelanchier alnifolia	0.44 ± 0.09	0.56 ± 0.04	1.3
Prunus virginiana.	0.21 ± 0.13	0.45 ± 0.02	2.1
Populus balsamifera	0.04 ± 0.02	0.38 ± 0.06	9.5
Rosa spp.	0.32 ± 0.12	0.24 ± 0.06	0.8
Populus tremuloides	0.22 ± 0.17	0.44 ± 0.02	2.0
Cornus cornuta	0.48 ± 0.10	NA	NA
Salix spp.	0.19 ± 0.14	0.15 ± 0.11	0.8

*NA = Not available or not applicable. Compiled from Table 5 from Ainsley (2004). Util. = browse utilization, Cons = consumed.

4.3.4 Parkland Utilization by browse species

Species utilization rates (and presumably ungulate preferences) varied little across sites and habitat types (Table 4). *Eleagnus commutata, Cornus stolonifera, Amelanchier alnifolia* and *Prunus virginiana* were the most heavily utilized (Table 4). These four heavily utilized species comprised only 17% of the available browse from across all transects. In contrast, *Salix* spp., the least utilized species of the common browse species, comprised 57% of the available biomass in the Parkland (Table 3).

Most of the browse available, and consumed on the 28 sites from across the Parkland was from just three species/groups. Together, *Salix* species, *Corylus cornuta* , and *Amelanchier alnifolia* comprised 80% of the browse that was available and 68.2% of the

browse that was consumed. Of these three, only *Amelanchier alnifolia* was a heavily utilized species. The other three preferred (based on high utilization) species *Eleagnus commutata, Cornus stolonifera,* and *Prunus virginiana* comprised only 7% of the browse available, and only 12.8% of the browse consumed.

Count ratio and biomass-based utilization rates from aspen sites across the Parkland were roughly comparable to each other, but biomass-based utilization rates exceeded count ratio rates by a factor of roughly two (or more) for four browse species in the willow/shrub cover type (Table 5). This indicates that ungulates were removing the most recent two-year's growth from the twigs they selected.

The factor relating the biomass-based utilization rate to the count ratio rate for *Populus balsamifera* was extremely high (Table 5). This presumably reflects selection for a few extremely large twigs (sucker shoots) of *Populus balsamifera*. Diameters of sucker shoots of this species are several times greater than its ordinary twig diameters (author's unpublished observations).

4.4 Additional comparisons

4.4.1 Parkland production by block

While Ainsley (2004) combined cover types for his block comparison, we chose to restrict our block comparison to only the randomly selected aspen cover type sites. In addition, we excluded one of Ainsley's (2004) randomly selected aspen sites (the Stonhouse Property) because it is in fact a conservation site managed by the ACA. A two-factor analysis was not possible because of markedly unequal sample sizes. Our comparison (a single factor Kruskal-Wallis test) of browse production from the three sampling blocks failed to demonstrate a significant block effect (Kruskal-Wallis test, $P>0.10$). While not statistically significant, we believe that the trend in differences is noteworthy. The randomly selected aspen sites in the Camrose-Tofield block produced 3.6 times as much browse as the randomly selected aspen sites in the Red Deer East block, and almost 2.6 times as much browse as the sites in the Wainwright South block (Table 5). In addition, one of the randomly selected sites in the Camrose-Tofield block was in a horse pasture that had been exposed to heavy, season-long grazing for many years. Excluding this site (which produced just 2.8 kg/ha , only 8% of block average)

from the Camrose-Tofield block would have increased mean production for that block to 42.6 kg/ha (more than 4.4 times the mean production of the Red Deer sites).

4.4.2 Parkland Production by site type

We pooled the 15 randomly selected aspen sites, and compared production from these sites with the production from the seven conservation sites. While conservation sites produced 1.32 times as much browse (on average) as randomly selected sites (25.4 kg/ha vs. 19.2 kg/ha – Table 5), this difference was not statistically significant (Kruskal-Wallis test, $P>0.10$). In order to remove potential block differences from the site type comparison, we also compared the five aspen conservation sites in the Red Deer East Block (29.1 kg/ha of available browse - Table 5) with the five randomly selected aspen sites in that same block (9.6 kg/ha – Table 5). While the conservation sites produced more than three times as much browse, this difference was not statistically significant, at the 0.05 level (Kruskal-Wallis test, $P = 0.08$). Two of the conservation sites receive light cattle grazing each year. Production from these sites (16.6 kg/ha and 78.4 kg/ha compared favorably with production from ungrazed conservation sites.

4.4.3 Parkland Production by cover type

We also pooled the data from all 22 aspen transects (randomly selected and conservation sites) and compared browse production in this habitat type with production in the six willow-shrub transects (Table 5). Mean production across the six willow-shrub transects (64.4 kg/ha) was three times higher than average production in the 22 aspen forest transects pooled across all regions (21.5 kg/ha) and this difference was statistically significant (Kruskal-Wallis test; $P < 0.05$).

The productivity of the willow-shrub transects in the three different blocks followed the same trend as production in the aspen cover type. Production was greatest in the Camrose-Tofield block, and least in the Red Deer East block. However, the sample sizes for the willow-shrub cover type (3, 2, and 1 – Table 5) are so small that interpretation is unwarranted.

Table 5. Browse production (available kg/ha) and utilization (ratio by estimated biomass) in the Parkland region of Alberta.

	N	Production Mean (Range)	Utilization Mean (Range)
Random Aspen Sites			
Camrose-Tofield	5	34.6 (2.8 – 97.1)	0.30 (0.12 – 0.43)
Wainwright South	5	13.4 (5.5 – 22.7)	0.41 (0.28 – 0.52)
Red Deer East	5	9.6 (2.9 – 12.7)	0.32 (0.21 – 0.45)
All Random Sites	15	19.2 (2.8 – 97.1)	0.34 (0.12 – 0.52)
Conservation Sites (Aspen)			
Wainwright South	2	23.3 (15.5 – 31.1)	0.37 (0.34 – 0.40)
Red Deer East	5	29.1 (4.8 – 78.4)	0.41 (0.27 – 0.56)
All Conservation Sites	7	25.4 (4.8 – 78.4)	0.40 (0.27 – 0.56)
All Aspen Sites	22	21.5 (2.8 – 97.1)	0.36 (0.12 – 0.56)
Willow-shrub Sites			
Camrose-Tofield	1	126.9 (NA)	0.30 (NA)
Wainwright South	3	74.8 (16.7 – 147.5)	0.30 (0.23 – 0.40)
Red Deer East	2	17.6 (11.8 – 23.3)	0.35 (0.34 – 0.36)
All Willow-shrub Sites	6	64.4 (11.8 – 147.5)	0.32 (0.23 – 0.40)
All Sites Combined	28	30.7 (2.8 – 147.5)	0.35 (0.12 – 0.56)

4.4.4 Parkland Utilization

We compared biomass-based utilization rates from just the randomly selected aspen sites within the different blocks. There was a weak and statistically non-significant trend (Kruskal-Wallis test, $P > 0.10$) toward higher utilization in the Wainwright block. We also compared biomass-based utilization rates of the six willow-shrub sites with rates for the pooled (randomly selected and conservation sites) aspen sites. This analysis did not demonstrate a difference between utilization rates in these cover types (Kruskal-Wallis test, $p > 0.30$).

4.4.5 Utilization in the Aspen Cover Type by site type

We transferred one of Ainsley's (2004) randomly selected sites (the Stonhouse Project) to the priority site (conservation site) group, because this property is in fact a conservation site managed by the ACA. We then compared the utilization rates at the seven

conservation sites with those of the 15 randomly selected Aspen sites. The mean utilization rate for the conservation sites (0.40 – Table 5) was 6% higher than the mean utilization rate for the randomly selected aspen sites, but this difference was not statistically significant (Kruskal-Wallis test, $P > 0.30$).

Five of the seven conservation sites are idled, while the other two are lightly grazed each year. Utilization (biomass-based) on the lightly grazed sites 38 % at the Bend Project and 56 % at the Stonhouse Project – Ainsley's transect CT001; Table 3) compared favorably with values from the five idled conservation sites 37 %).

4.4.6 A comparison of production in the Rumsey Ecological Reserve and the Parkland region

In 1998 and 2001, browse production from the aspen cover type on the RER (Table 1) was more than 50% greater than production (2002) from the 15 randomly selected sites across the Parkland (Table 3). In 1997, production from this cover type in the RER was more than 4.5 times the average browse production (2002) from randomly selected aspen sites (from across the Parkland). Production from the RER's willow cover type in 1998 and 2001 was more than double the production from the Parkland willow/shrub sites (2002), and the 1997 production from the RER's willow cover type was more than 5 times the production from the Parkland (2002) willow/shrub sites. Ainsley (2003) attributed lower RER production in 1998 and 2001 (relative to 1997) to drought in the latter years. In light of the RER-Parkland comparison, we suggest that 1998 and 2001 production figures may provide a better estimate of typical RER browse production and that 1997 may have been an unusually productive year in the RER.

4.4.7 A comparison of utilization in the Rumsey Ecological Reserve and the Parkland region.

Utilization rates from the RER (Table 1) were lower in 1997/1998, but higher in 1998/1999 and 2001/2002 than utilization rates for the Parkland in 2002/3 (Table 3). Low utilization rates on the RER in 1997/1998 probably reflect the very high level of browse production from the 1997 growing season. Most of the factors relating biomass-based utilization rates to count ratios in the RER (Table 2) were ≥ 2. In contrast with the RER situation, these factors were approximately 1 for the Parkland (Table 4).

4.4.8 Parkland utilization by site type

The mean utilization rate for the seven conservation sites (0.40 – Table 3) was 6% higher than the mean utilization rate for the randomly selected aspen sites, but this difference was not statistically significant (Kruskal-Wallis test, $P > 0.30$). Five of the seven conservation sites are idled, while the other two are lightly grazed each year. Browse production and utilization (biomass-based) on the lightly grazed sites (16.6 kg/ha and 38 % at the Bend Project and 78.4 kg/ha and 56 % at the Stonhouse Project – Ainsley's transect CT001; Table 3) compared favorably with values from the five idled conservation sites (18.0 + 2 kg/ha and 37 + 0.02 %).

5.0 SUMMARY CONCLUSIONS AND FUTURE CONSERVATION EFFORTS

5.1 Summary

Wild ungulates provide an extremely valuable recreational opportunity (Bjorge 2003). The future of this resource depends on an adequate (both quantity and quality/palatability) supply of browse. This browse supply is threatened by a multitude of human activities and by over–utilization of the most desirable browse species. It is generally accepted that biomass-based utilization rates exceeding 50% are a cause for concern (Canham et. al. 1994). Habitat degradation and increased mortality (winter kill) are often associated with utilization rates higher than this (Ron Bjorge, Alberta Sustainable Resource Development, Red Deer Alberta, pers. com.). While the overall

utilization rates observed in this study were generally below the 50% level, there were four browse species that were used far more heavily than this. In fact, there were several cases of utilization exceeding 100%. Obviously this level of utilization is not sustainable; and is a cause for concern.

The Canada Land Inventory (CLI) capability ratings based on soils, topography and climate for ungulates for the RER are similar to the ratings for the rest of the Parkland, and the RER's capability for agricultural rating is somewhat lower than average capability for the Parkland. Consequently, it is somewhat surprising that browse production on the RER is higher on average than the corresponding values for the Parkland ecoregion. We suggest that cattle impacts such as vegetation trampling, leaf stripping, and soil compaction may have reduced browse density and productivity for many of the randomly selected Parkland sites as demonstrated previously by Weatherill and Kieth (1969). While all but one of the quarters on the RER is grazed annually, stocking rates on the RER have traditionally been much lower than the Parkland average. We speculate that the very conservative stocking rates traditionally employed on the RER explain the greater average browse production there.

While Ainsley (2004) did not provide information on the grazing histories of his sites, we had first hand knowledge of the grazing histories of all the conservation (priority) sites, and several of the randomly selected sites. This information leads us to believe that a great deal of the browse production variability reported by Ainsley (2004) is related to the impacts of past (both recent and historic) livestock grazing on the browse resource, an effect documented by Weatherill and Kieth (1969). We suggest (personal observation) that most of the randomly selected sites (with one notable exception) in the Camrose-Tofield block had not been grazed for many years – while most of the randomly selected sites in the Red Deer East block had been exposed to confinement grazing for many years. We further suggest, that the greater average production of the Wainwright South sites reflects the fact that pastures there typically contain more open, grass dominated areas than pastures in the Red Deer East block; and that cattle preference for the open (grass) areas have spared these woodlots some of the cattle impacts that Red Deer East woodlots have suffered.

While we recognize that confinement livestock grazing typically reduces browse abundance and productivity (Weatherill and Kieth 1969), we want to stress that the

conservation grazing employed at our conservation sites (Stonhouse and Bend properties) does not seem to reduce browse availability at these properties.

Moose and white-tailed deer densities on the RER are at least an order of magnitude greater than Parkland averages (Ron Bjorge, Alberta Sustainable Resource Development, Red Deer, Alberta, pers. com.). In addition, ungulate populations on the RER grew considerably in the period just prior to the commencement of the RER evaluation (Ainsley 2003). Consequently, the unusually high utilization rates observed in 1998-1999 and 2001-2002 may be a rather recent development. If this is true, the current composition of the RER browse resource may reflect the natural (pre-settlement) condition. However, if the over utilization (>100% in several instances) that Ainsley observed in 1998-1999 and 2001-2002 has been routine for many years, then the density/occurrence of the most palatable species (*Eleagnus commutata, Cornus stolonifera, Amelanchier alnifolia* and *Prunus virginiana*) may be substantially lower than it was traditionally (pre-European settlement).

Most of the factors relating biomass-based utilization rates to count ratios in the RER exceeded two (Table 2). In contrast with the RER situation, similar factors for the Parkland were approximately 1. This suggests that for Parkland sites, simple count ratio estimates of utilization rates will normally approximate the biomass-based rates. We speculate that this difference may reflect the unusually high moose population in the RER, and the ability and willingness of moose to consume larger diameter twigs (Peek et. al. 1976). This suggests that twig measurements may not be required for utilization assessments over most of the Parkland eco-region provided that there is little evidence of moose (based on pellet group counts) in these areas.

The low utilization rates observed for some of the Parkland sites may be a reflection of a number of different factors. It is possible that high harvests by hunters (both high densities of hunters combined with high hunting effort) maintains local populations of ungulate at densities well below carrying capacity at these sites. However, there are a number of other potential explanations. It is possible that agricultural food resources are supplying a large portion of the food requirements of the local ungulates. Likewise, it is possible that high disturbance levels discourage ungulates from using some of the selected sites, or that the absence of other habitat requirements (e.g., hiding cover,

thermal cover, connectivity) limit ungulate use of these sites as has been demonstrated at other areas (e.g., Telfer 1978, Compton et. al. 1988, Nixon et. al. 1988).

5.2 Conclusions

In addition to providing the baseline information that was the primary objective of the initial investigations, these studies have highlighted the following points.

5.2.1 Rumsey Ecological reserve

1. While the silverberry cover type comprises only 9% of the woody cover on the reserve, it is an extremely important browse source contributing substantially more browse and far more preferred browse per hectare than either of the other cover types.
2. There are large, consistent differences in species (browse species) specific utilization rates. Biomass-based utilization rates are roughly twice as great as simple count based utilization rates on the RER.
3. Preferred browse species are being seriously over-utilized and are already quite rare in the aspen and willow cover types. Preferred browse species comprise only 7.4% of the total available browse in the Aspen cover type, and only 2% of total available browse in the willow cover type.

5.2.2 Parkland region

1. Browse production was extremely variable among sites. There was a 53 fold difference between minimum and maximum production at a site.
2. Preferred browse species constitute only a small portion of the total available browse in the Parkland. The only preferred species that was reasonably common was *Amelanchier alnifolia.* It comprised 10 % of total available browse in the Parkland. The remaining preferred species (*Eleagnus commutata, Cornus stolonifera* and *Prunus virginiana)* together comprised only 7% of total available browse and only 12.8% of consumed browse.

5.2.3 Additional comparisons

1. When the analysis is restricted to only the aspen cover type sites, there is a trend toward higher production in the Camrose-Tofield block than in the Wainwright or Red Deer East blocks. This trend is also evident in a comparison of the willow cover type, but very low sample sizes preclude a statistical comparison.
2. Browse production from the willow cover type was more than three-fold higher than that from the aspen cover type.
3. There was a trend toward higher browse production on the conservation sites than on randomly selected sites, but the difference between the two average values (approximately threefold) was far less than the maximum variation observed.
4. Browse production from two lightly grazed conservation sites compared favourably with the production from ungrazed conservation sites.

5.3 Implications

1. If the current level of utilization continues, *Prunus virginiana* may be eliminated from the RER, and *Amelanchier alnifolia* may be eliminated from the willow cover type there. This change would almost certainly reduce the suitability of the reserve to support deer, and could eventually result in deer die-offs, especially during severe winters. It may be advisable to consider reducing the moose population of the RER in order to preserve the vegetation community and the viability of the deer populations.
2. Given the observed variability in browse production, it is somewhat disappointing that browse productivity on conservation sites was not significantly greater than productivity of randomly selected sites. Thorough evaluations of the browse resources on potential conservation sites may allow managers to better target land acquisitions, and thereby increase the ungulate habitat value of the sites that are acquired.
3. Of the preferred browse species in the Parkland, only *Amelanchier alnifolia* is common. Hence, management of conservation sites promote this important browse species.

5.4 Future conservation efforts

The objectives of the original browse investigations were to determine the productivity and utilization rates for different cover types - and for particular browse species both in the RER and across the Parkland. Ainsley (2003) accomplished these objectives for the RER, and Ainsley (2004) has begun to meet these objectives for the Parkland.

However, there are additional objectives that should be addressed. Two objectives of considerable importance to the ACA are to:

1. Develop a reliable, cost-effective technique capable of quantifying the relative ungulate wintering value of different land parcels.

2. Gain an improved understanding of the impacts of different management approaches (e.g., idle, conservation grazing, agricultural grazing) on the ability of conservation sites to provide wintering habitat for ungulates.

In addition, the ACA is interested in addressing the following questions:

a. Which cover types, soils and micro-sites (slopes & aspects) supply the best browse production?
b. Which environmental variables have significant impacts on annual browse production, and how accurately do these variables predict annual fluctuations in browse production?
c. Are the more desirable browse species (chokecherry, red-osier dogwood, and saskatoon) declining (in the RER or any portion of the Parkland) as a result of over-utilization and/or livestock grazing?
d. What was the composition of the browse resource prior to European settlement, and what management promotes this composition?

Some of these additional objectives and questions can be addressed, at least in part, using existing data (e.g., data collected from the Vermilion priority (conservation) sites that has not yet been analyzed. It may also be possible to estimate biomass production of particular browse species from stem densities and shrub heights for that species. A multiple regression analysis of the existing data would determine the feasibility of this

approach. If a strong relationship is demonstrated, it may be possible to assess relative ungulate wintering value on the basis of shrub heights and densities without performing labour–intensive twig counts.

We also advocate the collection of species composition and utilization data from all sites (include Vermilion priority/conservation sites) and for all years compiled on a cover type (aspen or willow-shrub) and site type (random or conservation site) basis. In addition, four transects on the RER are located on a quarter section that has not been grazed for many years. We would like to compare the composition and production from these transects to the remaining RER transects (of the same cover type). This will provide an indication of whether or not recent cattle grazing has had an impact on the RER browse resource.

While some additional insight can be obtained from existing data, there is also a need for additional data collections. The ACA should consider collecting and compiling information on land use for each of the Parkland sites. This information is vital to understanding the variation reported by Ainsley (2004).

We also recommend that the ACA analyze intra-site (project) variation of the browse resource across the Parkland, and focus this work on ACA-managed conservation sites. Ainsley (2004) placed just one transect on each site. This doesn't allow a quantitative comparison of the relative value of different conservation sites. We recommend that the ACA establish and monitor multiple permanent browse transects on several of its conservation sites in order to estimate intra-site variation. This will provide site managers with a much better record of how the browse resource on each property is responding to their management, and help them evaluate and adjust their management practices.

The twig count and measurement techniques used by Ainsley (2003 and 2004) are quite labour intensive. We recommend that the ACA, and potentially its partners, work to develop a more efficient means of assessing browse resources. A method that estimates available browse biomass from stem densities and shrub heights may be worth investigating.

While Ainsley's investigation (2004) did not demonstrate significant effects of sampling block, soil texture, or canopy height on browse production, it is possible that significant effects are being masked by differences in current (or possibly historical) grazing activity. The inclusion of continuous independent variables describing both historical grazing intensity and current grazing intensity is recommended. Alternatively, future comparisons could be restricted to sites with similar grazing histories.

While it is not always possible to distinguish between moose and deer browsing on a given plant, additional information collected in these studies (i.e., presence of pellets and maximum diameter of browsed twigs) does make it possible to distinguish sites used by moose from those not used by moose. Separate analysis of these two types of sites may (depending on sample sizes) permit investigators to identify differences between moose and deer preferences (and their impacts on the browse resource). This information is important for the establishment of appropriate target populations (and harvest quotas) that will prevent damage to the browse resource, while maximizing population targets and recreational opportunity.

While the ACA manages only a few properties across the Parkland, the Public Lands Department manages a large proportion of the land that supports ungulate browse. The ACA should make it a priority to identify which grazing systems are most compatible with browse production (especially by the most desirable browse species), and promote these grazing systems to both private landowners and the Public Lands Agrologists who administer grazing leases. A powerful investigation into grazing system effects will require additional transects. The ACA should pursue the establishment of additional transects, but only after it has thoroughly analyzed the existing data.

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7.0 APPENDICES

Appendix 1. Mean stem densities (stems/m2) and twig counts (total and browsed) in the Rumsey ecological reserve, Alberta.

Cover Type & Species	Stem Density	Available Twigs/Stem	Browsed Twigs
Aspen			
Amelanchier alnifolia	0.077	6.19	2.74
Populus tremuloides	0.590	6.68	1.37
Prunus virginiana	0.013	10.47	5.35
Rosa spp.	1.283	5.02	2.34
Salix spp.	0.133	10.51	5.16
Populus balsamifera	0.007	7.00	1.25
Cornus stolonifera	0.000	3.00	1.00
Willow			
Amelanchier alnifolia	0.140	5.97	3.34
Populus tremuloides	0.272	8.88	1.97
Prunus virginiana	0.004	9.20	7.20
Rosa spp.	1.052	4.52	2.08
Salix spp.	3.124	7.69	3.25
Populus balsamifera	0.012	9.40	3.00
Silverberry			
Eleagnus commutata	3.333	16.78	6.21
Rosa spp.	0.900	5.91	3.18

Appendix 2. Oven-dry twig weights (g) predicted from twig diameters at the point of current annual growth (available browse) and point of browsing (consumed browse).

Species	Available	Consumed
Amelanchier alnifolia	0.145	0.289
Eleagnus comutata	0.277	0.625
Populus tremuloides	0.241	0.434
Prunus virginiana	0.210	0.569
Rosa spp.	0.202	0.148
Salix spp.	0.536	0.680
Populus balsamifera	Insufficient Data	Insufficient Data
Cornus stolonifera	Insufficient Data	Insufficient Data

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