SERIES 1. NUMBER 19

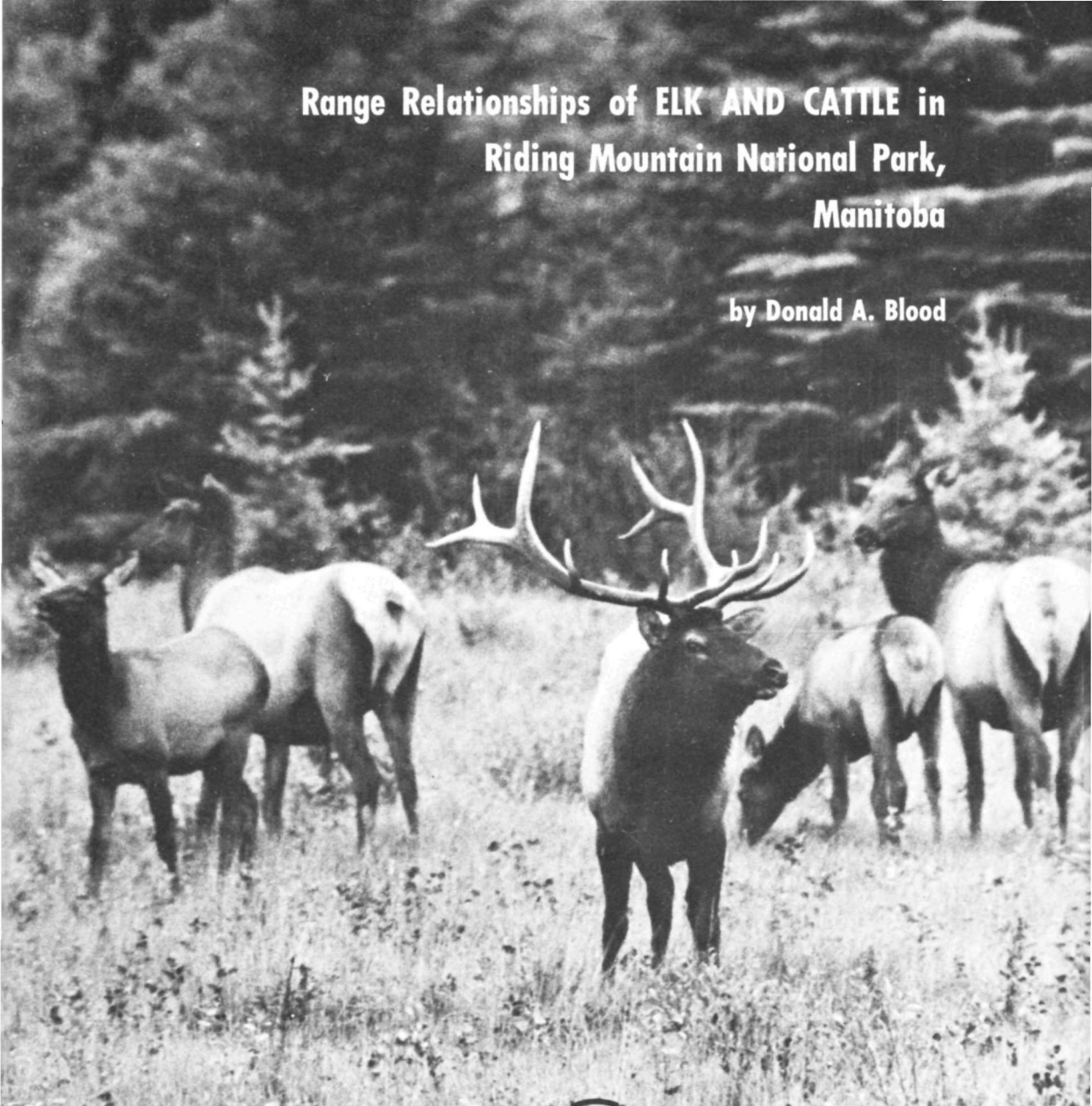
WILDLIFE MANAGEMENT BULLETIN

Range relationships of ELK and CATTLE in Riding Mountain National Park, Manitoba

by
Donald A. Blood

Range Relationships of ELK AND CATTLE in Riding Mountain National Park, Manitoba

by Donald A. Blood



Canadian Wildlife Service

Wildlife Management Bulletin, Series 1, No. 19

Natural and Historic Resources Branch

Department of Northern Affairs and National Resources

Issued under the authority of the
HONOURABLE ARTHUR LAING, P.C., M.P., B.S.A.,
Minister of
Northern Affairs and National Resources

ROGER DUHAMEL, F.R.S.C., Queen's Printer and Controller of Stationery, Ottawa, 1966
Cat. No. R65-1/19

CONTENTS

97860—1½

LIST OF TABLES

LIST OF FIGURES

Figure 1 Segregation of elk foods in the laboratory. (Photos by the author unless otherwise credited.)

Figure 2 Native fescue prairie near Bob Hill Lake.

Figure 3 Area classed as "No. 1 cutting class" on forest inventory maps.

Figure 4 An aspen stand of density class 2.

Figure 5 An aspen stand of density class 4.

97860—2½

Figure 6 An upland shrub site dominated by rose, hazel, and pincherry.

Figure 7 A wet shrub site dominated by willows and dwarf birch.

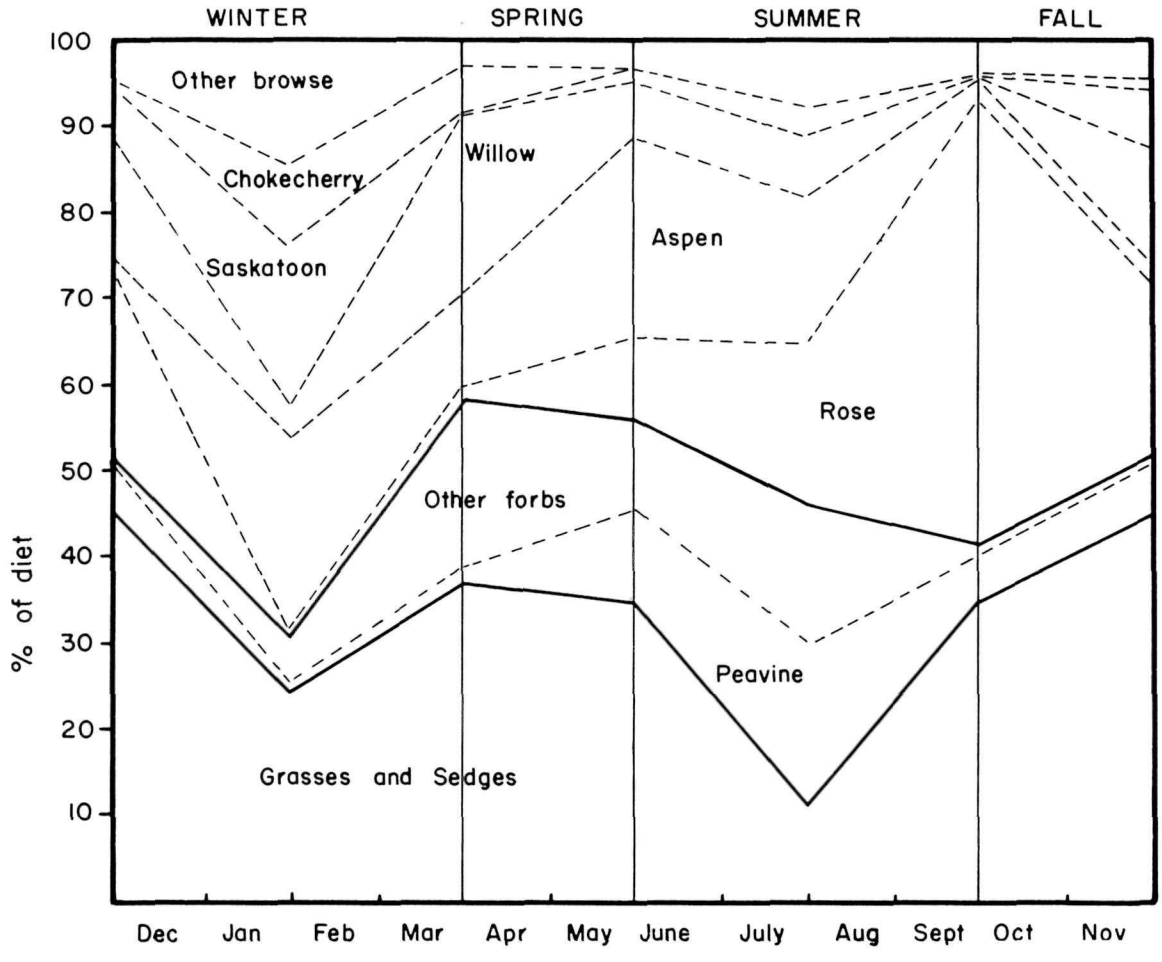
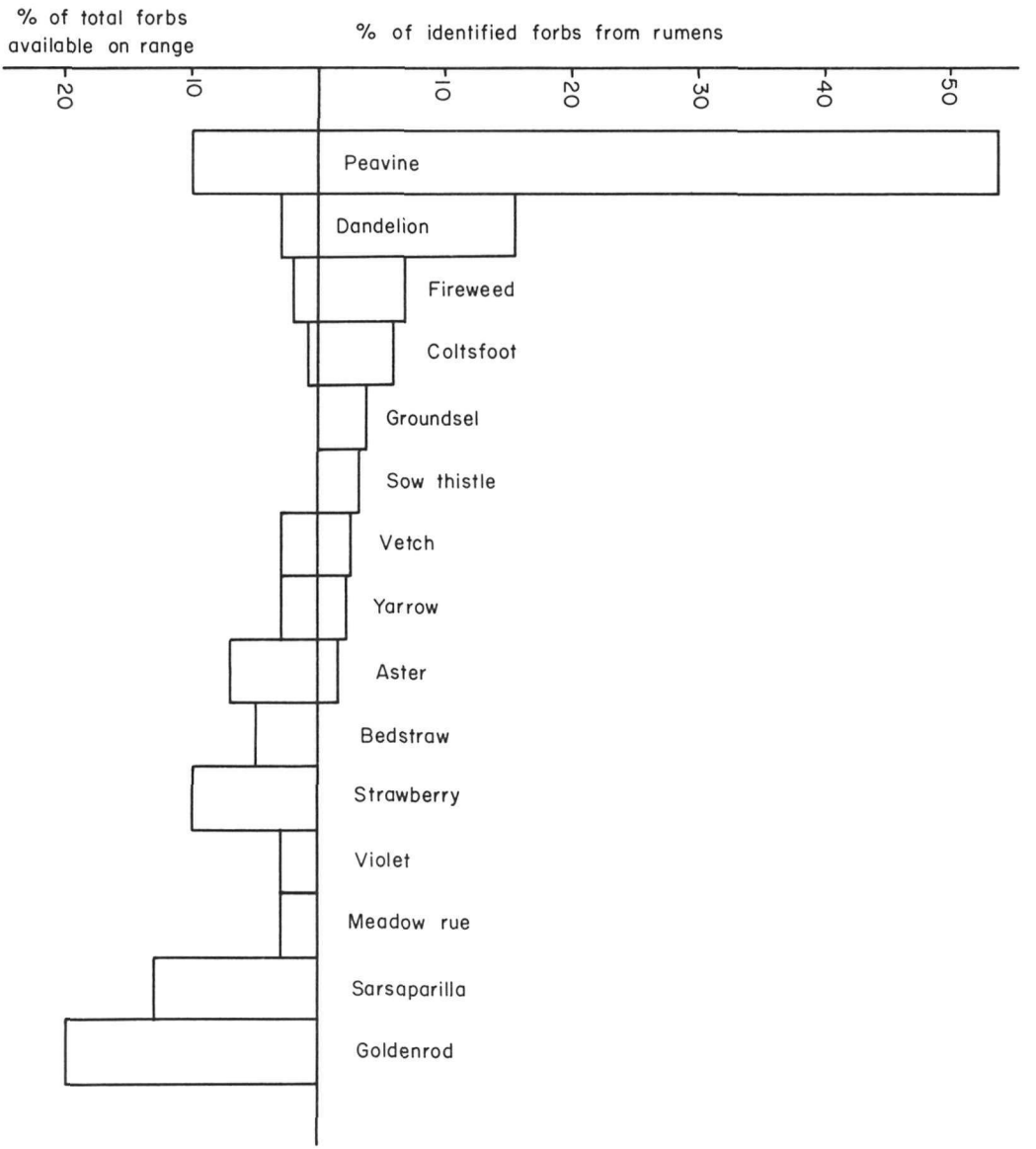


Figure 8 Seasonal food habits of elk in Riding Mountain National Park.

Figure 9 Relationship of use by elk to availability of major forb species encountered in rumen samples and on the range.



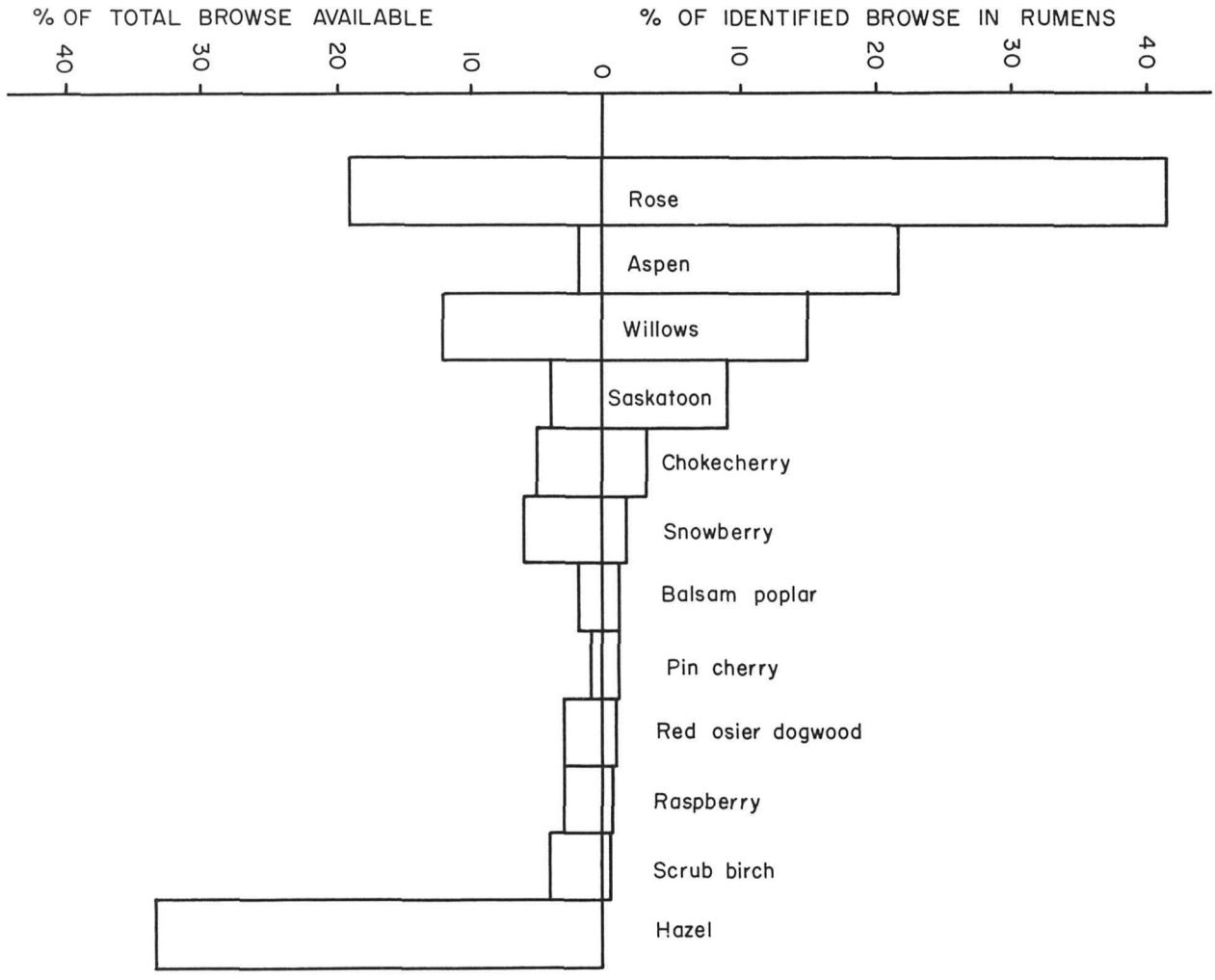
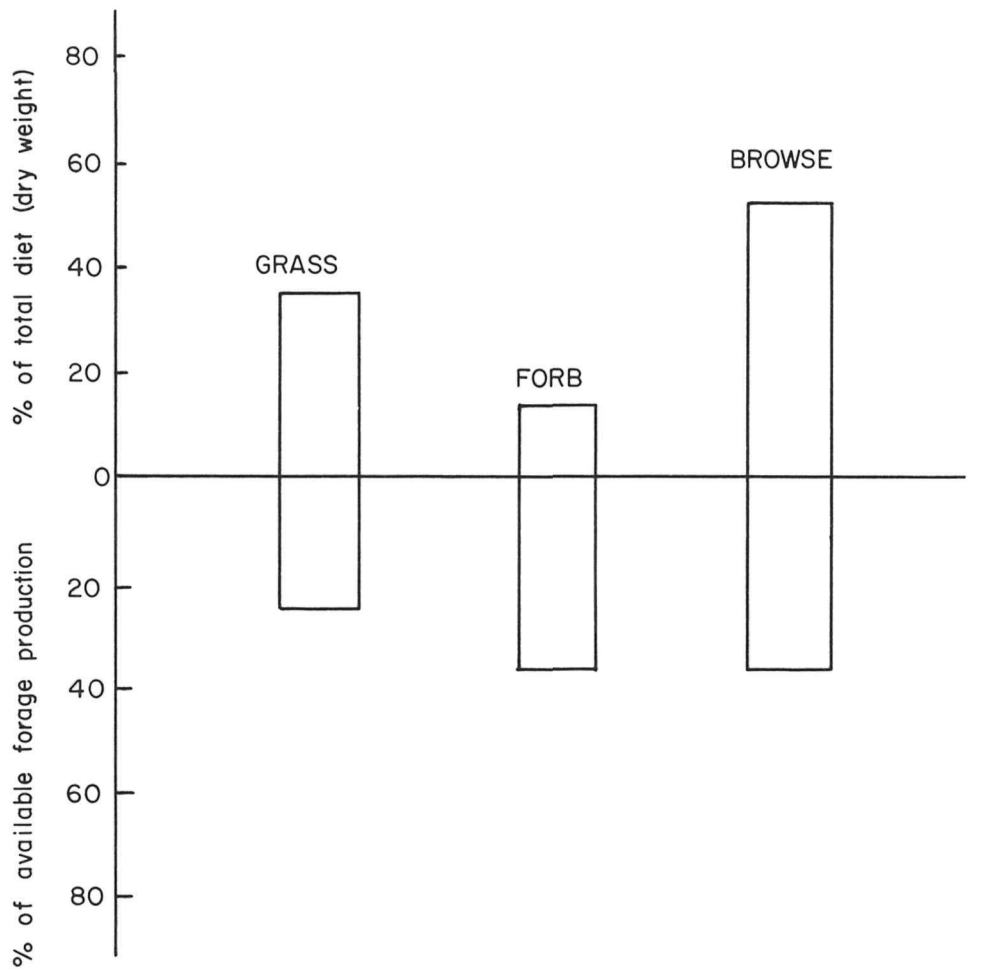


Figure 10 Relationship of use by elk to availability of major browse species encountered in rumen samples and on the range.

Figure 11 The relationship of elk use of the grass, forb, and browse forage classes to their relative availability.



97860—3

Figure 12 Exclosure cage used to determine forage production on grazed areas.

Figure 13 Dense growth of rough fescue in an area along Kennis Creek which is ungrazed by cattle. (Photo by A. L. Lovaas).

97860—3½

Figure 14 Seral bluegrass–dandelion association in Birdtail Valley.

Figure 15 Overgrazing has caused deterioration at this site to the annual weed stage (Photo by A. L. Lovaas).

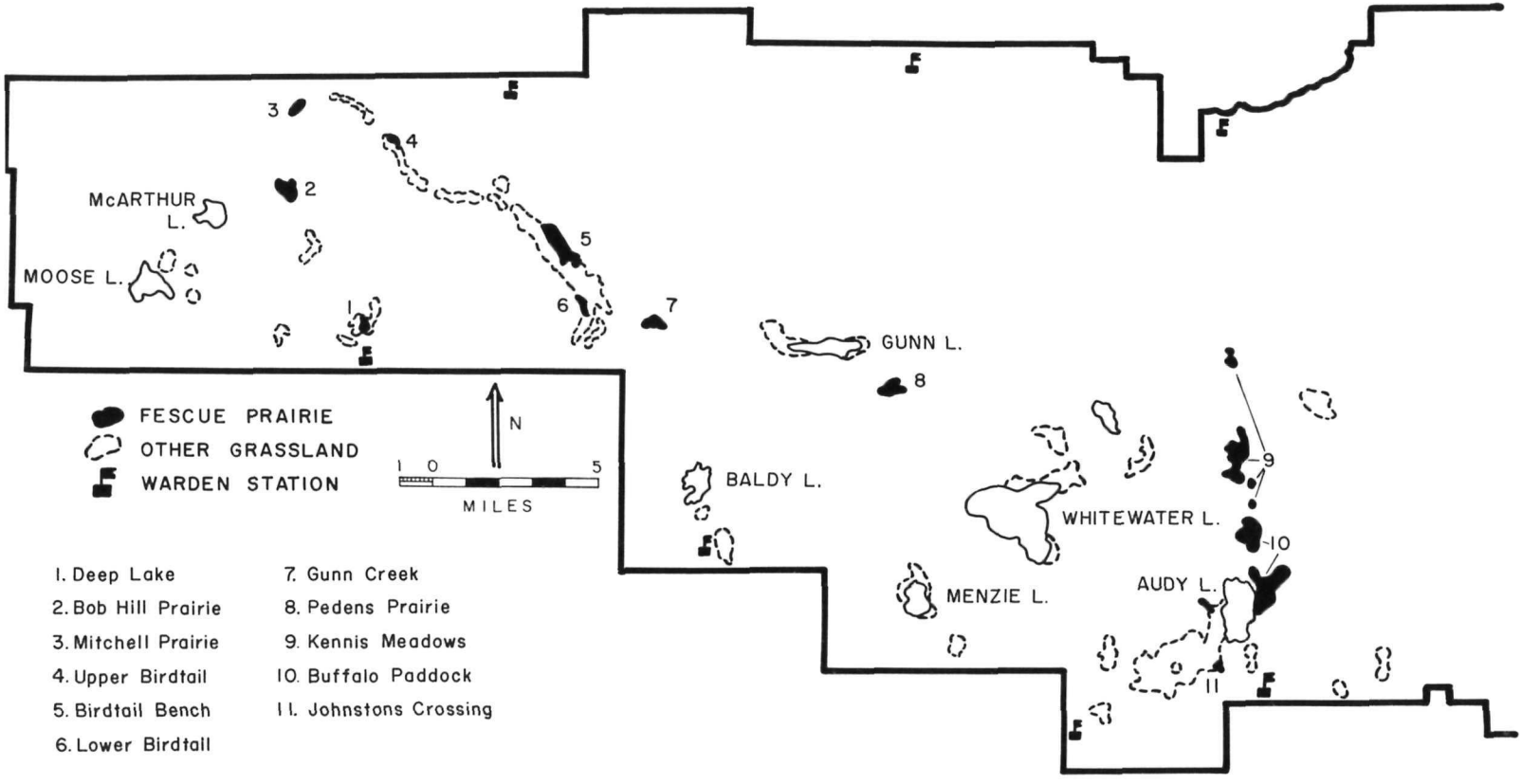


Figure 16 The location of fescue grassland in Riding Mountain National Park.

Figure 17 *Koeleria–Stipa* association near Heron Creek.

Figure 18 Heavy growth of reedgrass on a small wet meadow in the Lake Audy district. This meadow is not grazed by cattle or cut for hay.

Figure 19 Extensive wet meadows at the head of Kennis Creek.

97860—4

Figure 20 A solid stand of thistle around a slough margin in a heavily grazed area near Baldy Lake.

Figure 21 This site west of Lake Audy has been badly trampled by cattle, and weeds are invading.

97860—4½

Figure 22 Obvious destruction of the native plant cover around a salt block in Birdtail Valley (Photo by A. L. Lovaas).

Figure 23 Damage around a salt block after one season's use by cattle.

Figure 24 Dense stand of thistle at an abandoned hay corral.

INTRODUCTION

Riding Mountain National Park, established in 1930, is the only one of Canada's eighteen National Parks in which cattle grazing is still permitted. Livestock grazing there dates back to before the area was a park. In recent years National Parks policy has considered livestock grazing to be an undesirable use of these unique preserves. However, there is considerable feeling among grazing permittees that owing to its long history, cattle grazing in the park has become a right not to be denied them. To attempt to resolve these difficulties the National Parks Service requested the Canadian Wildlife Service to investigate all aspects of cattle grazing in the park. The primary objective was to determine if livestock grazing was adversely affecting the native flora or fauna, and if so, to study possible methods of reducing this conflict.

Field investigations were begun in 1961 by wildlife biologist A. L. Lovaas (Lovaas, 1961), were taken over by the writer in early 1962, and completed in late 1963 (Blood, 1963a, 1964a). Earlier reports on livestock in the park were written by D. R. Flook (1956) and A. H. Corner (1956).

The present report is limited to those aspects of the study involving foods and feeding relationships of cattle and elk (*Cervus canadensis*). Elk have been resident in the area since presettlement times and are the most abundant large mammals in the park. Studies in other areas have indicated that grasses are important elk foods, and that elk may suffer from food shortage in areas grazed heavily by cattle. Therefore, major objectives of this study were to determine if elk and cattle were competing for a limited food supply, and if combined use was adversely affecting park ranges.

Several studies of elk–livestock competition have been carried out in the Rocky Mountain region. However, this relationship has not been studied in detail in the Prairie Parkland zone which differs considerably both in species composition of the range and in topography. It is hoped that results reported here may fill that gap and be broadly applicable in areas of similar vegetation across the northern Great Plains.

ACKNOWLEDGEMENTS

My greatest debt of thanks goes to Mr. A. L. Lovaas, whose planning and field investigations in 1961 provided an excellent background for further study. Thanks are also extended to J. A. Pettis, former Superintendent of Riding Mountain National Park, and Chief Warden Joe Allan (now retired) for their friendly cooperation. Park Wardens Klapp, Thompson, Dumpelton, Mortemore, Andrews, and Thordarson assisted either by familiarizing me with grazing activities in their districts, or in the collection of elk specimens. I am especially indebted to George Klapp and his family for their frequent hospitality. Student assistants J. C. Snyder and K. Casperson, and technician J. R. McGillis helped in the field. G. W. Scotter and D. R. Flook, Canadian Wildlife Service, made many suggestions, particularly during the early phases of the project. Forest cover maps of the park were supplied by Mr. R. G. Ray, Forest Management Division, Canada Department of Forestry. Dr. H. J. Scoggan, National Museum of Canada, identified and verified a number of plant specimens. Shiela Head, G. McCartney, G. McDougal, and S. Sealy assisted with laboratory analyses and map preparation. W. E. Stevens, R. H. Mackay, and D. R. Flook of the Canadian Wildlife Service, critically reviewed either this manuscript or earlier reports on which it is based. The cooperation and help of all those people are gratefully acknowledged.

DESCRIPTION OF THE AREA

Location and physiography

Riding Mountain National Park covers 1,148 square miles of rolling upland in southwestern Manitoba, approximately 140 miles northwest of Winnipeg. Its main axis, with a length of 67 miles, lies east and west and its maximum width is 26 miles.

The eastern extremity of the park contains the Manitoba escarpment, but the majority of the park is situated above the escarpment on what is often referred to as the Second Prairie Steppe of the Great Plains, known locally as the Western Uplands of Manitoba. The eastern escarpment rises from a level of about 1,100 feet at the park's eastern boundary to a maximum elevation of 2,410 feet about four miles inside the park. To the south and west the plateau surface, which averages about 2,000 feet in elevation, slopes away more gradually.

Riding Mountain lies about equally within the watersheds of the Assiniboine and Nelson River systems. Drainage to the north is mainly into Dauphin Lake via the Wilson, Vermilion, Ochre, and Turtle Rivers. The southern slope is drained principally by the Birdtail, Minnedosa, and Rolling Rivers, which eventually reach the Assiniboine. Stream erosion has trenched many deep, rugged valleys, particularly along the slopes of the east and northeast escarpments. Lakes are fairly common, particularly in the southwest part of the park. The park has a total water area of about 37 square miles. There are many small sloughs and bogs.

Geology and soils

Except for limited areas of the east escarpment, the park is underlain by Cretaceous shales of the Riding Mountain formation (Ehrlich *et al.,* 1956). However, owing to transportation of powdered rock and rock fragments by the continental ice sheets, the surface deposits contain material from many of the rock formations which underlie the Riding Mountain shale and reach the surface to the north and east of the park. The soils are thus chiefly of glacial origin. Glacial till materials, consisting of boulders, cobbles, gravel, sand, silt, and clay, also occur as underlying deposits below the lacustrine and alluvial materials of the various basins and depressional areas. In the Riding Mountain area these materials have formed soils ranging from loam to clay loam, with various degrees of stoniness and an irregular topography.

Ground moraine is the most extensive till deposit in this area, and is characterized by low knolls and numerous sloughs. An end moraine, consisting of a narrow range of rough hills formed at the terminus of a glacier, extends along the southern fringe of the Riding Mountain upland north of Erickson, Rackam, and Glen Elmo (Ehrlich, *op. cit.*). Glacio-fluvial surface deposits are next in importance to the glacial till. These deposits of coarse material sorted from glacial till by fast flowing glacial streams have formed outwash plains and alluvial terraces along valley borders of most of the rivers and streams flowing down the southern slopes of the Riding Mountain plateau. Lacustrine, aeolian, and recent alluvial surface deposits are poorly represented.

Unfortunately, detailed soil maps of the park have not been made. However, the soil map of the Rossburn area accompanying Ehrlich (*op. cit.*) shows soil types adjacent to Highway No. 10, the Lake Audy Road, and the Strathclair Trail within the park. The map also gives detailed coverage of areas of similar topography and vegetation immediately adjacent to the south boundary of the park between Wasagaming and the west boundary. Although intensive studies by the Canadian Wildlife Service (1961–1963) were confined to the southwestern regions of the park, some inferences can be made from the information on the Rossburn soil map.

The most extensive soil type appears to be the Waitville clay loam association. These are medium-textured, grey, wooded soils developed on moderately calcareous boulder till. According to Ehrlich (*op. cit.*), "The Grey Wooded soil zone occurs on the upper slopes of the Riding Mountain approximately above the 2,000 foot contour. This upland region is within the mixed wood section of the Boreal Forest and the native vegetation consists of a closed stand of aspen, birch, spruce and tamarack. The forest cover reflects the occurrence of a more humid climate here than in the adjoining areas of aspen grove and grassland, and the soils of this region exhibit a corresponding increase in degradation or leaching. These strongly leached soils are much lower in organic matter content and available plant nutrient supply than the grassland soils. They occur mainly on rough topography and are highly susceptible to erosion if stripped of their protective forest cover."

Of second importance in the southwestern part of the park are soils of the Erickson association of the grey-black subzone. The grey-black soil subzone occurs as a transitional strip on the south slope of Riding Mountain between the strongly leached soils of the grey wooded zone and the slightly degraded black earth soils of the Newdale clay loams. Grey-black soils predominate between the 1,900- and 2,000-foot contours in the southwestern regions of the park. Those soils are assumed to have developed originally under grassland vegetation, but may have been under the influence of a closed forest cover for a considerable period of time. The topography of the Erickson soils is irregular to moderately sloping. Peaty meadow, half bog, and bog soils occur in undrained depressions within this zone. The peaty meadow soils predominate.

A third soil type of some importance here is the Seech coarse sandy loam association, which is a grey-black soil developed on shaly gravel outwash deposits. This soil type underlies most of the true grassland of the park, such as in the Birdtail Valley and Lake Audy areas. Although they occur entirely within the grey wooded zone, those soils exhibit only slight degradation from the black condition. Seech association soils have developed under mixed prairie grasses and aspen vegetation and exhibit black earth and degrading black earth profile characteristics (Ehrlich, *op. cit.*).

Climate

The Riding Mountain area falls into the cool summer humid continental (Dfb) climatic type of the Köppen classification. Winter temperatures are lower, and the annual range of temperature much greater than the world average for the latitude. The area is subhumid, with a definite summer maximum of precipitation. Approximately 80 per cent of the precipitation falls as rain between April and October and the remainder as snow during the rest of the year. Climatic data for representative stations near the park are given in Table 1.

Table 1 Climatic data for stations near Riding Mountain National Park

Station	Years of records	Elevation in feet	Mean temperature, °F			Precipitation, inches		
			Jan.	July	Ann.	Mean ann.	May-July	Ann. range
Dauphin	50	968	0.2	66.7	36.0	18.0	7.5	10.3–28.0
Russell	51	1,873	−3.5	63.4	32.3	16.7		
Minnedosa	70	1,675	−1.4	64.5	33.9	17.4	7.6	9.8–25.3

July is the warmest month and January the coldest. The frost-free period is about 90–100 days and the vegetative season (average length of time that the mean daily temperature is above 42°F) is 170–180 days. June is the wettest month, and December the driest.

No long-term meteorological records are available for the park; however, short-term records of summer precipitation indicate that the hilly uplands receive slightly more rainfall than the surrounding areas. Mean summer precipitation figures (June–September) for Minnedosa and for the south gate of the park (elevation 2,050 feet) for the period 1943–1953 are 11.43 and 12.48 inches respectively. This indicates about 9 per cent more precipitation at the park gate, and presumably precipitation would be proportionately greater in the higher levels (2,200–2,400 feet) of the park. Temperatures should also be slightly cooler on the higher land areas. The more humid climate and greater moisture efficiency of the upland region, resulting from increased rainfall and lower temperatures, is reflected in its forest cover.

Vegetation

Most of the park falls into the mixed wood section of the boreal forest zone (Canadian life zone) according to Rowe (1959). The southwestern fringe of the park appears to belong to the aspen grove section (transition life zone) and a small portion of the extreme eastern fringe, below the Manitoba Escarpment, to the aspen oak section. The higher northern and eastern parts of the park are heavily forested with both mixed and pure stands of aspen (*Populus tremuloides*) and white spruce (*Picea glauca*). Associate species of minor importance, and rarely forming pure stands, are white birch (*Betula papyrifera*) and balsam poplar (*Populus balsamifera*). Balsam fir (*Abies balsamea*) and jack pine (*Pinus banksiana*) are found locally in the eastern reaches of the park. The latter species occasionally forms pure stands on sandy areas and drier till soils. Lower sites and the upper water-catchment areas have developed black spruce (*Picea mariana*) and tamarack (*Larix laricina*) muskeg. The accumulation of peat is not deep, however. Of sporadic occurrence, but more common along the east escarpment than elsewhere, are white elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), Manitoba maple (*Acer negundo*), and bur oak (*Quercus macrocarpa*).

The most widespread cover type is aspen forest, which regenerates readily following fire or other disturbance. The most common shrub associated with the aspen is hazel (*Corylus cornuta*), which often forms dense stands. Willows (*Salix bebbiana, S. candida, S. petiolaris* var. *rosmarinoides, S. serissima*) are abundant and may form dense stands in wet areas, often in association with dwarf birch (*Betula glandulosa*). Common shrubs of open and semi-open forest stands are rose (*Rosa acicularis*), chokecherry (*Prunus virginiana*), pincherry (*P. pensylvanica*), saskatoon (*Amelanchier alnifolia*), cranberry (*Viburnum opulus* and *V. edule*), red-osier dogwood (*Cornus stolonifera*), and buffalo berry (*Shepherdia canadensis*). Those shrubs largely confined to the more open southwestern regions of the park, and often growing on the margin of open grasslands, are snowberry (*Symphoricarpos albus*), shrubby cinquefoil (*Potentilla fruticosa*), bearberry (*Arctostaphylos uva-ursi*), hawthorn (*Crataegus succulenta*), and nannyberry (*Viburnum lentago*).

Grasslands in the park are generally of two types: an upland fescue prairie association and its seral derivatives; and wet sites dominated by sedges (*Carex* spp.) or moisture-loving grasses. Fescue prairie in the park has been described in detail elsewhere (Blood, 1966). The climax dominant is rough fescue (*Festuca scabrella*), and important subdominant grasses are needlegrasses (*Stipa spartea* and *S. richardsonii*) and junegrass (*Koeleria cristata*). Important forbs are asters (*Aster* spp.), goldenrods (*Solidago rigida* and *S. missouriensis*), and yarrow (*Achillea lanulosa*).

Major plant cover types, based on 1961 forest cover maps, are indicated on Map No. 1.

Fauna

Green (1932) briefly reviewed the status of a number of park mammals. Extensive vertebrate faunal surveys of the park were carried out by Soper, who reported on both birds (1953a) and mammals (1953b). Brief additions have been contributed by Tamsitt (1960) and Blood (1964b).

Although Riding Mountain Park is ecologically an island of bushland in a sea of farmland, it is large enough to support a fairly well balanced terrestrial ecosystem. The major animal influent no longer present is the bison (*Bison bison*) (except for a small exhibition herd). Major native animal influents at present are elk (*C. c. manitobensis*) and moose (*Alces a. andersoni*). Recent aerial surveys indicate that about 1,000 moose inhabit the park (about one per square mile). Smaller numbers of white-tailed deer (*Odocoileus virginianus dacotensis*) are found around the park perimeter, but winter snow depths are usually too great to allow their year-round existence on the higher parts of the plateau. Minor animal influents of significance to range use are the snowshoe hare (*Lepus americanus*), beaver (*Castor canadensis*), Richardson's ground squirrel (*Citellus richardsonii*), and pocket gopher (*Thomomys talpoides*). Richardson's ground squirrels were abundant on several heavily grazed meadows in the Baldy Lake and Birdtail areas, and undoubtedly consume considerable forage on those grasslands. Pocket gopher burrows were present in most open areas, both grazed and ungrazed, but no serious range damage was noted.

Several important predatory and semi-predatory mammals still exist in sufficient numbers to exert some influence on the local biotic community. Among the larger are the timber wolf (*Canis lupus*), coyote (*Canis latrans*), black bear (*Euarctos americanus*), and lynx (*Lynx canadensis*). Park wardens estimated, from a census in March 1964, that there were 40 wolves in the park. Black bears and coyotes are common, and while lynx numbers are not known, tracks are regularly seen in winter. In general, a favourable carnivore–ungulate biomass relationship exists, but owing to persecution of carnivores outside the park, their numbers may never reach a level at which they can control ungulate numbers in the park.

THE ELK POPULATION

Numbers past and present

Elk have evidently been continuously present in the Riding Mountain area since presettlement times (Green, 1933). Past estimates of the population, made by park officials and presented by Banfield (1949) are as follows: 1914–500, 1925–2,000, 1933–3,500, 1941–5,000 to 7,000, 1946–12,000. Population growth has not been steady. Severe winter weather in 1935–36 caused heavy losses of elk. The winter of 1946–47 was also severe, and resulting elk mortality was well documented by Banfield (*op. cit.*). More recently, aerial surveys of the elk population were carried out by the Canadian Wildlife Service each winter from 1949–50 through 1957–58 (with the exception of 1953–54). The only surveys since 1957–58 were in 1959–60 and 1962–63 (Blood, 1963b). Aerial survey data for the park elk population are summarized in Table 2.

It appears that the population dropped sharply following its peak in 1946, to about 5,000 in 1949, and has been between 2,000 and 5,000 since that time. The aerial survey of February 1963 is believed to be the most accurate one to date because of its increased coverage and the narrow survey strip used. It indicated a considerable reduction in population in the three years since the previous survey. The decline is attributed to a combination of severe winter weather, the park reduction program, and hunter harvest during the winter of 1959–60. During that winter an estimated 2,298 elk were legally killed outside the park (Table 2), and this, coupled with a park slaughter of 319, and heavy natural winter mortality, probably reduced the elk population by over one half. Park wardens also encountered a number of elk which appeared to have entered the park and died after having been wounded by hunters. The population appears to have been slow to recover, since only 2,000 animals were estimated by aerial survey in February 1963. During March, 1963, park wardens counted 788 elk in their districts and estimated the park population to be 2,700.

To curb damage to crops and haystacks adjacent to the park and to provide sport for Manitoba hunters, the Manitoba Game Branch has periodically allowed open seasons on elk in areas surrounding the park. These seasons have been most successful in years when deep snows and severe crusting have encouraged elk to seek more readily available food, such as haystacks, stooks, or unharvested grain. Data on the elk harvest near the park, extracted from annual reports of the Manitoba Department of Mines

Table 2 Recent aerial survey and harvest data for the Riding Mountain elk herd

Winter	Aerial surveys: % of park sampled	Aerial surveys: Elk pop. estimate	Aerial surveys: Elk per sq. mile	Hunter harvest*	Remarks†
1943–44				368	First open season
1947–48				544	No report of elk damage
1948–49				914	Elk damage "restricted"
1949–50	18.5	4660	4.1		Damage to hay stacks reported
1950–51	18.5	4636	4.0	938	"Major damage to farming interests"
1951–52	19.2	4652	4.1	1,766	No report of elk damage
1952–53	19.2	2460	2.1	935	No report of elk damage
1953–54					No report of elk damage
1954–55	6.2	1132	1.0		Elk count low due to poor weather
1955–56	6.2	5293	4.6	568	Large numbers of elk eating hay stacks
1956–57	6.2	2504	2.2		Few elk left park
1957–58	12.4	2653	2.3		No report of elk damage
1958–59					No report of elk damage
1959–60	12.4	4840	4.2	2,298	Elk damage was a "serious problem"
1960–61					"Very little exodus" of elk from park
1961–62					No report of elk damage
1962–63	24.0	2004	1.7		Wardens estimate 2,700 elk in park
1963–64					Elk damage not a problem

*Estimated from hunter questionnaires (Manitoba 1948–1963).
†Remarks in quotes are from Manitoba (*op. cit.*).

and Natural Resources (1948–1963) are summarized in Table 2. Eight open seasons have been allowed in all, the first in 1944 and the most recent in 1959–60, with a total estimated kill of 8,331 elk. Hunter harvest on areas adjacent to the park appears to be the most desirable means of managing this herd. It provides sport and meat for local hunters and allows cropping of excess elk which may be overbrowsing their range or causing crop damage, while allowing the park itself to remain inviolate. The organized reduction program within the park boundaries, carried out by park officials during the winter of 1959–60, was not nearly as effective as the hunter harvest in removing elk from the Riding Mountain population, largely owing to the much smaller number of hunters involved.

Distribution and movements

Elk may be encountered anywhere in the park, and few areas could be considered entirely unsuitable elk habitat. However, aerial surveys have shown that certain areas are preferred in winter. Areas of lowest elk densities are from the west boundary to Birdtail Creek, and the higher eastern parts of the park south from Edwards and Moon Lakes to Shoal and Ministik Lakes, east to Whirlpool Lake, and southeast to May and Rowland Lakes. Highest elk densities are usually encountered along the east side of Birdtail Creek, north of Gunn Creek and Gunn Lake, in the Kennis Meadows – Lake Audy area, and along the lower reaches of the north and east escarpments. During summer, elk distribution is probably more uniform since snow is not forcing animals to lower elevations. Forest fires also have a marked effect on elk distribution in the park. During the aerial survey of February 1963, the heaviest elk concentrations were noted on areas burned during the bad fire

season of 1961, particularly in the Gunn Lake burn. This appeared to be a response to increased food availability owing to aspen sucker production stimulated by fire (Blood, 1963b). Elk are not particularly abundant on the grassland areas of the southwestern regions of the park during winter, but use those areas considerably in the spring, since new growth appears there earlier than in the forest.

Extensive elk migrations out of the park occur only during winters of above-average severity, and have been most pronounced when the park elk population was at its highest levels. Generally, those years in which a hunter harvest and/or serious agricultural damage by elk are noted in Table 2 were the years of most pronounced elk movement. Elk have been shot over five miles from the park boundaries (Flook, 1950), but most elk movements are local, the animals leaving the park at night to forage and returning again at dawn. Most movement from the park is across the south and east boundaries, particularly in areas where woodland extends uninterrupted across the park boundary.

The elk as an index of habitat conditions

Size and condition

The condition of an animal is often a reliable index of the quantity and quality of its food supply. Anderson *et al.* (1964) and Klein (1964) have shown that size and weight differences between populations of deer (*Odocoileus hemionus*) are directly related to differing levels of nutrition, which in turn are related to quantity and quality of available forage. Riney (1955) found that weight of kidney fat expressed as a percentage of kidney weight is a valid index of physical condition in red deer (*Cervus elaphus*). He noted that this index could be used to detect population differences in physical condition related to range status, as well as seasonal fluctuations in condition in any area. Although data on size and physical condition of elk collected during this study are not extensive, they indicate that the Riding Mountain elk population is suffering no severe stress owing to limited food or overpopulation. Kidney fat indexes (Table 3) indicate the expected period of poor condition in winter and early spring and high fat accumulations in summer and autumn. Bulls appear to lose condition rapidly during the rut. Even though kidney fat indexes of several specimens were quite low, all animals were in good flesh when collected.

Average whole-weights of 777 pounds for eight adult males and 606 pounds for four adult females obtained at Riding Mountain are somewhat greater than average weights of Rocky Mountain elk (*C. c. nelsoni*) recorded in the literature. Murie (1951), and Quimby and Johnson (1951) recorded average adult bull and cow weights of 620 and 510 pounds, and 730 and 562 pounds respectively, at Yellowstone Park. The maximum Riding Mountain elk weights recorded, 1,053 pounds for a bull and 636 pounds for a cow, appear to approach the upper limit of weight for the North American elk within its native range. Quimby and Johnson (*op. cit.*) give average total

Table 3 Whole weights and condition indexes of 19 Manitoba elk

Class	Age		Sex	Month killed	Kidney fat index* (%)	Whole weight (pounds)
	Years	Months				
Calf	0	5	M	Oct.	—	295
	0	8	F	Jan.	39	293
Yearling	1	1	F	June	17	256
	1	6	F	Nov.	225	484
Two-year-old	2	5	M	Oct.	68	641
	2	11	M	Apr.	10	534
	2	8	F	Jan.	72	498
Adult	3	1	M	June	40	634
	3	3	M	Aug.	94	652
	4	4	M	Sept.	120	888
	5	4	M	Sept.	138	811
	6	0	M	Apr.	6	718
	6	6	M	Nov.	12	776
	8	7	M	Dec.	29	1053
	adult†		M	May	11	680
Mean (adult males)						777
	4	2	F	July	—	569
	7	2	F	July	149	588
	14	6	F	Dec.	112	631
	adult†		F	Aug.	106	636
Mean (adult females)						606

*Weight of kidney fat as a percentage of kidney weight.
†Jaw not available for exact age determination.

length measurements of 95.40 and 89.44 inches respectively for adult bulls and cows of *C. c. nelsoni*. These are similar to my measurements of 94.8 and 88.3 inches for *C. c. manitobensis*. Mean hind foot measurements given by those authors, 26.35 inches for adult bulls and 24.89 inches for adult cows, are slightly smaller than the corresponding measurements of 27.3 and 26.3 inches obtained from Riding Mountain specimens.

Parasitism

No diseased or heavily parasited elk were observed during this study, among either those collected or those observed in the field. Lungs and livers of 15 elk specimens were dissected and examined macroscopically in the field. No lung worms or liver flukes were apparent. Adults of the winter tick (*Dermacentor albipictus*) were found on two of fifteen specimens collected, and larvae of the same tick on another. The degree of infestation was light in all cases. Hydatid cysts (larval stage of *Echinococcus granulosus*) occurred in the lungs of only one specimen, but again the infestation was minor, and no gross pathology was evident.

The above data contrast strongly with conditions noted by Banfield (1949) during the winter of 1946–47, when an estimated 12,000 elk in-

habited the park. That winter large numbers of elk died of starvation; the herd "harbored a heavy infestation of winter tick"; and two specimens collected "contained heavy infestations of hair lung worm (*Dictyocaulus viviparous*)". Verminous pneumonia was evidently widespread in the elk herd that winter. The data indicate that the carrying capacity of the park's elk range is in excess of the estimated population of 2,000–3,000 in the winter of 1962–63, but considerably less than the estimated 12,000 animals of 1946. Probably 5,000–6,000 elk (about 5 per square mile) would stock those ranges near their carrying capacity.

ELK FOOD HABITS

Elk food habits were studied primarily to evaluate elk–cattle competition for food. Ideally, elk taken to analyze stomach contents should be collected in areas of range overlap of the two species. Owing to difficulty of access, particularly during winter, and fairly low elk populations during the study, elk often had to be collected where and when it was possible to do so. All were collected over a fairly wide region in the western half of the park, but not all within the area grazed by cattle (Map No. 2). This is probably not a serious limitation however, and the elk food habits data are felt to be representative of elk in the western half of the park.

Techniques

Elk food habits were determined by analysis of rumen contents. Twenty-five elk were collected between April 18, 1961, and April 23, 1963, and a two-quart rumen sample was obtained from each. Two elk per month were obtained, with the exception of March, when only one was collected, and February and April, each represented by three. Rumen samples were preserved in 10 per cent formalin. One quart of material from each two-quart sample was washed with water on a number 8 screen (2.38 mm) in the laboratory, and fine material passing through the screen was collected, oven-dried, and weighed. Material retained on the screen was placed on a pan of water and the identifiable portions removed (Figure 1). Identification to species, genus, family, or forage class was then made by comparison with a reference plant collection. The segregated material was then oven-dried at 70°C and weighed to the nearest 0.001 gram. A total of 1362.396 grams of material (oven-dried) was obtained from the 25 rumen samples, of which 982.571 grams (72 per cent) was fine material which passed through the 2.38 mm screen, 84.809 grams (6 per cent) was not identified, and 295.016 grams (22 per cent) was segregated at least to forage class (grass, forb, browse). Of the material remaining on the 2.38 mm screen, 77 per cent was segregated to at least forage class, and 34 per cent was segregated to genus or species.

Seasonal food habits values were calculated by totalling the weights of each food item before converting them to a percentage of total material for the respective season. This is the aggregate percentage method of Martin *et al.* (1946). Seasonal trends in food habits (Figure 8) were obtained by averaging the food items or classes over two-month periods.

In order to evaluate foods eaten by elk in terms of relative species availability, an area considered to be representative of the region over which the elk rumens were collected was sampled to determine annual production of forage species. The percentage of that area (265 square miles) made up of each of several forest types was calculated from forest inventory maps of the park (Canada Department of Forestry 1961), using a systematic point sampling technique. East–west transects two inches (one-half mile) apart were laid out on the maps, and the vegetative type at each inch mark along the transects was recorded. A total of 2102 points was sampled.

The forest inventory maps recognize six forest subtypes. Only four of those occurred in the sampling area, white spruce, black spruce, balsam poplar – trembling aspen, and white birch. Four density classes are included in each of the above:

1. Very open stand, understocked.
2. Average stand, moderately stocked.
3. Better than average, fully stocked.
4. Dense, overstocked.

Other subtypes present are grassland, shrubland, marsh, bog or open muskeg, muskeg with stunted trees, and an area designated "Number 1 cutting class", which consisted of a mixture of scattered trees, shrubs, and meadow, and was considered to be forest land not restocked after fire. Various combinations were also present on the maps, e.g. grass-shrub, shrub-grass, or poplar-spruce. The predominant type or species was listed first in such mixed cover types. For purposes of vegetation sampling a number of types were lumped, and sampling was finally conducted in the following five types (Figures 2–7):

Type	Per cent of land area
1. Grassland and grass-shrub	14.3
2. Shrubland and shrub-grass	11.0
3. No. 1 cutting class	10.8
4. Poplar density classes 1 and 2	19.0
5. Poplar density classes 3 and 4	30.0
Total	85.1
Other types (muskeg, white spruce, black spruce)	14.9
	100.0

The muskeg and spruce types appeared to produce very little palatable forage and therefore were not sampled. The white birch type was very sparsely represented (less than 1 per cent of area).

The sampling technique used in the field was clipping and weighing of forage, since for comparing the species composition of a plant community on a percentage basis, dry weight is probably the best value (Hanson, 1938; Sprague and Myers, 1945). Measures of weight incorporate all other quantitative expressions of growth, such as height, number, and area, and incidentally provide accurate data on floristic composition (Blair, 1959).

Grass and forb production was clipped in circular 9.6-square-foot plots at five sites in each of the five types. Location of sampling sites depended considerably upon accessibility, although an attempt was made to scatter the sites throughout the study area. The usual method was to select an area accessible by road on a forest cover map, with the help of aerial photographs. The procedure then was to walk 100 yards from the road and drive in a stake. Four circular 9.6-square-foot plots were then located, 100 feet north, south, east, and west of the stake. The current year's growth of browse was clipped along a strip one foot wide and seven feet high between the stake and each circular plot. In some areas where shrub growth was dense and fairly uniform, browse was clipped only on every second 10-foot section along the tape. The collected forage was placed in paper bags and weighed green. Some of these samples were also air-dried and weighed so that factors could be calculated for converting green weight to air-dried weight.

To determine available browse, leaf fall was calculated. It was assumed that twigs were available year-round, and that leaves were available for four months (June through September). Leaves and twigs of samples of the browse species were weighed separately to determine the amount made up by each, and year-round availability figures calculated. From 65 to 85 per cent by weight (air-dried) of the annual growth of the various browse species consisted of leaves (mean = 74 per cent).

Foods eaten

Results of the food habits analysis are given in Table 4 and Figure 8.

Grasses and grasslike plants were fairly important throughout the year, making up from 22 to 54 per cent of the seasonal diets. Greatest use of grasses was in spring (April and May) and early winter (December). Forbs were abundant in the diet only in summer (primarily June and July). Forbs made up 45 per cent of the rumen contents of two elk collected in July.

Table 4 Seasonal food habits of elk as determined by analysis of 25 rumen samples

Plant	Summer* %	Autumn %	Winter %	Spring %	Annual %	Occurrence† %	Availability‡ (annual %)
Grass and sedges	22	37	31	54	34	100	32
Forbs							
Lathyrus spp.	13	6	1	T¶	5	80	4
Taraxacum officinale	4	—	—	1	2	20	1
Epilobium angustifolium	2	—	—	—	1	8	1
Petasites sagittatus	T	—	—	3	1	8	T
Senecio sp.	—	—	1	T	T	4	T
Sonchus arvensis	1	—	—	—	T	4	T
Vicia americana	1	T	—	—	T	28	1
Achillea lanulosa	T	T	T	T	T	40	1
Aster spp.	T	T	—	—	T	24	3
Smilacina stellata	T	—	—	—	T	12	1
Fragaria glauca	T	T	—	—	T	8	4
Aquilegia canadensis	T	—	—	—	T	8	—

Table 4 (continued)

Plant	Summer* %	Autumn %	Winter %	Spring %	Annual %	Occurrence† %	Availability‡ (annual %)
Potentilla arguta	T	—	—	—	T	16	T
Heracleum lanatum	—	—	T	—	—	4	—
Galium boreale	T	T	T	—	T	20	2
Lysimachia ciliata	T	—	—	—	T	4	T
Agoseris glauca	—	T	—	—	T	4	T
Cerastium arvense	—	T	—	T	T	8	T
Equisetum arvense	T	—	—	—	T	8	T
Unident. forbs	2	—	5	4	3	—	—
Forb total	26	8	7	9	13	—	20
Browse							
Rosa acicularis	18	48	1	T	14	72	4
Populus tremuloides	6	1	6	19	7	84	T
Salix spp.	6	T	8	4	5	68	3
Amelanchier alnifolia	2	2	7	T	3	64	1
Prunus virginiana	T	T	3	1	1	40	1
Symphoricarpos albus	T	2	T	—	1	32	1
Prunus pensylvanica	T	—	1	—	T	16	T
Populus balsamifera	T	T	1	T	T	40	T
Ledum groenlandicum	—	—	1	—	T	8	T
Cornus stolonifera	—	T	1	T	T	32	1
Rubus idaeus	1	—	—	—	T	12	1
Acer spicatum	1	—	T	T	T	20	T
Betula glandulosa	T	—	T	—	T	8	1
Betula papyrifera	T	—	—	—	T	4	T
Arctostaphylos uva-ursi	—	1	—	T	T	8	T
Corylus cornuta	T	—	T	T	T	28	T
Crataegus sp.	T	—	T	—	T	8	T
Ribes spp.	—	—	T	—	T	4	T
Viburnum edule	T	—	—	—	T	4	T
Lonicera glaucescens	T	—	—	—	T	4	T
Alnus crispa	T	—	—	—	T	4	T
Picea glauca	T	—	T	—	T	20	—
Unident. browse	17	—	32	13	19	—	—
Browse total	52	55	62	37	53	—	20
Mushroom	—	1	—	—	—	4	
Other forbs	Available but not found in rumens						25
Other browse	Available but not found in rumens						3
							100

*Summer: June–September, 8 rumen samples.
Autumn: October–November, 4 rumen samples.
Winter: December–March, 8 rumen samples.
Spring: April–May, 5 rumen samples.
†Percentage of the 25 rumens in which the item was found.
‡Percentage of total forage (dry matter available over 265 square mile area sampled (Map No. 2)).
¶Trace = less than .05 per cent.

Fifty-four per cent of all forbs segregated consisted of peavine (*Lathyrus venosus* and *L. ochroleucus*). Four forbs, peavine, dandelion (*Taraxacum officinale*), fireweed (*Epilobium angustifolium*), and coltsfoot (*Petasites sagittatus*) made up 83 per cent of the forbs segregated. Browse was the most important forage class, making up 53 per cent of the annual diet. Its highest occurrence was in autumn and winter. Rose (*Rosa acicularis*)

was the most important browse species, making up about 42 per cent of the browse diet. Rose was particularly abundant in the late summer and autumn diet. Leaves and small twigs of rose were eaten in summer, but mostly only hip fragments and seeds were found in autumn rumens. Aspen, willows, and saskatoon ranked next after rose. Those species with rose made up about 87 per cent of the total browse segregated.

Relationship of food availability to elk use

Animal food habits data assume their greatest significance in terms of what items are available to be eaten, and in what amount. Although elk food habits have been studied by a number of authors (Murie, 1951; Young and Robinette, 1939; De Nio, 1938; Morris and Schwartz, 1957; Cowan, 1947; Troyer, 1960; Murphy, 1963) no attempt has been made at a quantitative assessment of foods eaten in relation to foods available. Such a relationship has been evaluated for other animals, and has been expressed graphically (Hamilton, 1940) and as a forage ratio: per cent of species in animals' food divided by per cent of species in habitat (Hess and Swartz, 1940). Although my food habits data are not extensive, an evaluation of the use–availability relationship has been attempted.

Production of air-dried forage in various vegetation types in the region of the elk collections, and weighted means for production over the entire area sampled (based on the area of each type) are indicated in Table 5. Production by species in each vegetation type is given in Table 9 (Appendix A). Figures 9 and 10 indicate elk use of major forb and browse species in relation to availability. Only species which made up either one per cent or more of total annual forb or browse production, or one per cent or more of total identifiable forb or browse in the diet are included. Figure 11 relates elk use of the forage classes to their relative annual availability.

Table 5 Production of air-dried forage in various vegetation types and weighted means for production over the entire area sampled

Type area	% of study area (Map No. 2)	% of sampled types	Production (pounds per acre)			
			Grass and sedge	Forbs	Shrubs	Total
Grassland	14.3	16.8	883	491	162	1536
Shrubland	11.0	12.9	474	464	828	1766
"No. 1 type"	10.8	12.7	414	655	536	1605
Open aspen	19.0	22.3	220	520	590	1330
Dense aspen	30.0	35.3	113	432	533	1078
Areas not sampled*	15.9					
Weighted means			342	495	502	1379

*Black spruce, muskeg, white spruce, paper birch.

The only browse species which appeared to be used in excess of their relative availability were aspen and saskatoon. Considering the abundance of aspen forest in the park, the lack of aspen saplings available as browse is

striking, and heavy use of this species indicates it has a high preference. Rose, the dominant browse species in the rumen samples, was also quite abundant on the range. The most abundant browse species on the range however, hazel, made up an insignificant proportion of the diet. Willows were fairly common both in the park and in the elk diet. Most other browse species were abundant neither in the study area nor in the elk rumens.

Peavine is a common forb in the area, but was eaten much in excess of its availability relative to other forbs. Other abundant forbs such as goldenrods, sarsparilla (*Aralia nudicaulis*), strawberry (*Fragaria glauca* and *F. vesca*), and asters made up a small or negligible part of the diet. Dandelion and fireweed were also eaten in excess of availability and appeared to be preferred in spring and summer. Coltsfoot, sow thistle (*Sonchus arvensis*), and groundsel (*Senecio* sp.) were not common in the study area and occurred only in isolated rumens, therefore their degree of preference is difficult to determine. Vetch (*Vicia americana*) and yarrow were fairly common both on the range and in the rumen samples.

The relationship of food habits to relative availability of the three forage classes over the study area (Figure 11) indicates that browse is the preferred forage class. Although the forb class had the greatest annual production by weight, it was least used. Although browse appears to be the most abundant forage class in the area, when only annual production is considered, and correction is made for leaf-fall, its contribution to total available forage is not great.

A number of investigators, particularly in the Rocky Mountain region, have noted that elk made considerable use of grass. This had led many people to believe that elk are primarily grazers. Kendeigh (1961) states that "Among big-game mammals . . . wapiti are largely grass-eaters . . .", and Green (1946) says "Elk are essentially grazing ungulates, and if grasses etc. are available browse only lightly upon certain trees and shrubs". Other authors (Morris, 1956; Troyer, 1960) have noted the great versatility of elk with respect to food. Morris (*op. cit.*) states that "While elk are mainly grass-eaters, they can do well on herbs and shrubs, adjusting to the available food supply". Murphy (1963) found that Rocky Mountain elk introduced into Missouri adjusted to a diet consisting largely of acorns. Morris and Schwartz (1957) stated that "The large percentage of grass in the samples of both deer and elk suggests either a high preference for grass or a limited supply of more desirable forage. In the case of elk it is perhaps a matter of preference." The Riding Mountain data suggest that where grass, forb, and browse forage classes all exist in excess of the demands of the elk, browse is the preferred forage.

ELK–CATTLE COMPETITION

An important purpose of National Parks is to provide sanctuary for wildlife species under essentially pristine conditions. Therefore it is important to evaluate interactions such as competition for forage, which could have detrimental effects on the native herbivores. Elk, because of their wide distribution and relative abundance in the park, appeared to present considerable potential for competition with cattle for food. Therefore, a major objective of this study was to evaluate elk–cattle competition.

For forage competition to occur between game and livestock certain conditions must be satisfied (Julander, 1958; Cole, 1958). In terms of elk and cattle they are best stated as follows:

1. that elk and cattle use the same range areas;
2. that elk and cattle eat the same forage plants;
3. that the food plants are an important source of forage for either cattle or elk;
4. that the food plants are in limited supply or deteriorating in production as a result of combined use.

It is not necessary for cattle and elk to use the same area or forage plants at the same time. Use during any one season may affect forage availability during another season. Cattle grazing in the park was mostly confined to the June–September period. Elk appeared to use the cattle-grazed areas significantly only in winter and spring. In 1962, elk did not begin using the open areas which had been grazed by cattle until about November.

Range overlap

Approximately 1500 head of cattle have grazed annually under permit in Riding Mountain National Park in recent years. This does not include stock under six months old, for which a rancher does not require a permit, nor an undetermined number of unpermitted cattle which from time to time have been turned into the park. The distribution of cattle indicated in Map No. 2 was determined from observations of cattle, their tracks, and droppings, and represents the probable maximum distribution of cattle in 1962 and 1963. Cattle graze only 10 to 15 per cent of the park area (125–150 square miles), but this is about 50 per cent of the open grassland in the park. Competition, if it exists, would be limited to this fairly small area.

Elk are well distributed throughout the park, but elk densities on ranges grazed heavily by cattle appear to be lower than average (Map No. 2). During the winter and spring, elk made considerable use of the climax

fescue prairie grasslands, particularly the benchland east of Birdtail Creek, Pedens Prairie, and Kennis Meadows. Their use of seral communities appears to be much less. This is illustrated by elk pellet group and cow chip counts made in 1963. At 16 sites in the Peden Prairie – Whitewater Lake and Kennis Meadows areas, where cattle grazing is negligible or non-existent, elk pellet groups averaged 256 per acre. At 79 sites in areas where summer cattle utilization varied from 22 to 69 per cent forage removal, and various seral stages of vegetation existed, elk pellet groups averaged 72 per acre.

Cattle food habits

Food habits of cattle in the park were evaluated by the feeding minutes technique devised by Dixon (1934). The merits and short-comings of this method have been reported by Buechner (1950). Since in most cases cattle could be approached very closely and binoculars were not needed, the data are considered more reliable than those often obtained for wild species by this method.

Results obtained are presented by forage classes in Table 6. It was often difficult to determine the relative time spent eating grasses and forbs when these occurred in mixed stands. It is apparent, however, that browse made up a very small percentage of the diet of the animals observed. Grasses appeared to be about twice as prevalent as forbs in the diet. The cattle food habits contrasted with elk food habits in that grass, rather than browse, was the most important forage class.

Table 6 Cattle food habits by forage classes, obtained by feeding minutes technique, Riding Mountain National Park

Date	Location	Total minutes	% grass and forbs*	% forb	% grass and sedge	% browse
July 9	Bob Hill	83	80.6	10.8	8.0	0.6
July 10	Upper Birdtail	178	93.8	0.0	5.0	1.2
July 11	Lower Birdtail	120	17.5	24.9	51.0	6.6
Aug. 3	Flat Lake	112	45.5	46.4	7.1	1.0
Aug. 9	Moose Lake	127	0.0	7.1	90.3	2.6
Aug. 10	Deep Lake	116	65.5	0.0	21.6	12.9
Aug. 13	Menzie Lake	159	100.0	0.0	0.0	0.0
Totals		905	402.9	89.2	183.0	24.9
Means			57.6	12.7	26.1	3.6

*Undifferentiated grass, sedge, and forb.

Examination of sites grazed by cattle provided some indication of which plant species were eaten. Most of the cattle ranges support seral communities due to a long history of cattle use. Bluegrass (*Poa pratensis*) is the most abundant grass on those areas and in the cattle diet. Other grasses in the cattle diet were slender wheatgrass (*Agropyron trachycaulum*), junegrass, hairy wild rye (*Elymus innovatus*), and timothy (*Phleum pratense*). Cattle use of forbs was almost entirely confined to the legumes (*Lathyrus venosus, L. ochroleucus, Vicia americana*) and dandelion. Although forbs were of minor importance in the diet of both elk and cattle, competition for those

species could result since they appear to be preferred by both groups of animals. Shrubs made up an insignificant part of the cattle diet, but a variety of species was nibbled at, their approximate order of importance being rose, saskatoon, hazel, and chokecherry.

Degree of forage utilization

Whether or not the food plants are in limited supply or are deteriorating in production as a result of combined cattle–elk use depends largely on the degree of utilization. Despite range overlap and similarities in food habits, competition will not occur if the plants eaten are available in excess of the demands of the competing species.

A cage exclose technique was used to assess summer forage removal by cattle, and over-winter elk utilization within the range of cattle in the park. Cages of the type used by Jones (1960) to evaluate elk–cattle competition in Wyoming were used (Figure 12). Only non-forested areas were sampled. These included, as well as the more extensive grassland ranges, small openings in the forest and around the margins of sloughs. Because cattle distribution was not accurately known at the start of the study, a few cages were placed on meadows not grazed by cattle. Areas which showed evidence of heavy past use by cattle, such as Birdtail Valley, were sampled most intensively.

Utilization of forage at each site was calculated by subtracting the weight of forage clipped from an unprotected 9.6-square-foot plot from the weight of forage taken from a 9.6-square-foot plot centered under the cage. The vegetation obtained was separated to grasses and forbs, placed in individual paper sacs, and weighed (air-dry) on a 500-gram-capacity spring scale. A third plot at each cage site was clipped in the spring to give a measure of over-winter elk utilization.

Production and utilization data for 1962 and 1963 are summarized by range unit in Table 7. Forage production appeared to be relatively constant on similar sites within and between range units. However it varied somewhat with successional displacement, condition, soil moisture, and variations in the proportion of grasses to forbs. Forbs, many of which are unpalatable, made up from 22 to 46 per cent of cage site production in different areas.

Summer utilization varied considerably from cage site to cage site, and between range units. This was primarily a result of variation in intensity of use by cattle. Game animals appeared to contribute little to summer utilization at the cage sites, and were rarely observed on open ranges during that season. Except in very heavily and very lightly used areas, utilization by cattle was often irregular and "patchy" and carry-over varied considerably within the immediate environs of a cage. Utilization data are most meaningful when averaged over fairly large areas, but individual cages served to indicate the general degree of use at the site (nil, light, moderate, or excessive). Very heavily utilized areas, the places of most concern in this study, were usually grazed uniformly, therefore estimates of forage removal for them are believed to be quite accurate.

Table 7 Forage production, forage utilization and animal use data by range units

Range unit	Number of cages	Mean* production 1962	1962 utilization, %			Droppings†		Mean production 1963	Summer utilization 1963, %
			Summer	Winter	Total	Elk	Cow		
Moose Lake	10							3060	72
Flat Lake	5	2104	28	39	67	16	381		
	8							1521	33
Deep Lake	10	1989	22	41	63	87	207	1810	9
Upper Birdtail	30	2284	47	30	77	31	666		
	14‡							2540	67
Lower Birdtail	10	2158	22	38	60	169	333	2460	17
Baldy Lake	10	2467	51	29	80	29	351	3090	58
Menzie-Peden	3	1587	69	—	—	—	—		
	6							2960	57
Audy-Heron	14	2245	51	19	70	129	567	2840	32
Kennis Meadows	10	2514	10	42	52	292	7	—	—
Whitewater	6	1741	8	24	32	197	0	2390	<10

*Air-dried weight of all grass and forb production in pounds per acre.
†Elk pellet groups and cattle chips per acre.
‡Central part of Birdtail Valley, heavily used by cattle.

Relative utilization of forbs and grasses varied from place to place, and apparently was related to differences in species composition of the range, particularly in the case of forbs. Many of the forbs present were not eaten by cattle. However, when all cage sites were averaged, mean utilization of the grass and forb classes was about the same.

According to Campbell *et al.* (1962), carry-over of grasses, or the amount that is left when the grazing season ends, should be from 40 to 50 per cent of the total growth. This means that proper utilization is from 50 to 60 per cent. On the basis that 60 per cent utilization or greater is beyond proper use, 27 of 96 cage sites were over-utilized in 1962. Results were similar in 1963. The percentage of total sites over-grazed varied from zero in the Deep Lake and Kennis Meadows range units to fifty in the Upper Birdtail area. Areas on which forage removal was excessive, and therefore areas on which competition could be occurring, are indicated on Map No. 2.

The techniques employed did not appear to give a realistic measure of winter elk utilization. No other animals are thought to contribute materially to over-winter utilization. Winter use values in Table 7 appear higher than expected, considering the rather sparse distribution of elk on areas used by cattle, even in winter and spring. It seems that winter weather factors such as wind, rain, and snow cause some shattering and breakdown of the dried mature forage, which then becomes part of the residual litter. When plots were clipped in the spring the litter was not included, and thus forage weights then were lower than those for autumn, regardless of grazing intensity. This explanation is supported by elk pellet group data in Table 7. The four range units having the lowest pellet group counts and thus presumably the least elk use had a mean winter "utilization" of 35 per cent of the forage, while four units with the highest pellet counts had a slightly lower value of 31 per cent.

Severity of elk-cattle competition

The data on elk and cattle food habits, range overlap, and degree of forage utilization can now be evaluated in terms of the previously listed conditions necessary for competition to occur. The following factors appear fairly well substantiated:

1. Elk and cattle in Riding Mountain National Park use a limited area of range in common.
2. Elk and cattle in the park eat largely different forage classes.
3. Only in relatively small areas are the forage species in limited supply or deteriorating in production as a result of combined use.
4. Although a few species eaten in common (*Lathyrus venosus, Vicia americana, Rosa acicularis*) are an important source of forage for elk, they appear to be present in excess of the demands of the animals.

Therefore, under prevailing levels of elk and cattle stocking, forage competition between those two species does not appear to threaten the welfare of either.

IMPACT OF GRAZING ON THE PLANT COMMUNITIES

Although cattle grazing has not materially altered forage production at Riding Mountain, it has brought about severe changes in the species composition of many areas. Such alterations are incompatible with National Parks policy that the parks should be left in their natural state, unimpaired for the use and enjoyment of future generations. Climax associations have been replaced by less palatable seral ones in many areas having a long history of cattle use. This is because the effect of grazing certain species in a community is to handicap those species and encourage others. Under range conditions, where the animals cannot be controlled as they are in pastures, the effect of selective grazing is commonly to reduce the proportion of palatable species.

The *Festuca scabrella* association (fescue prairie) appears to be the dominant grassland cover on upland sites in the park (Figures 2 and 13). Where moderately to heavily grazed over a long period of time this association is replaced by a seral bluegrass–dandelion association (Figure 14), in which shrubby cinquefoil may also be abundant. This appears to have happened in the central part of Birdtail Valley, which is now occupied by the latter association. However, the seral association gradually gives way to the climax association on lightly grazed or ungrazed areas in the northwest and southeast of the valley. When severely overgrazed and trampled, the fairly productive bluegrass–dandelion association may give way to a weedy stage in which there is abundant dandelion and exposed soil, and little grass (Figure 15). Although there may be little or no decline in forage productivity from the rough fescue to the bluegrass–dandelion associations, the decline is rapid if displacement from the climax proceeds much further, that is, to the annual weed stage.

The fescue prairie association is not extensive in Manitoba, and its existence there has not been widely recognized. Several investigators have studied fescue prairie in Alberta and Saskatchewan (Coupland and Brayshaw, 1953; Moss and Campbell, 1947), but do not mention its occurrence in Manitoba. Evidently the grassland of southwestern Manitoba has not received the attention of ecologists since Bird (1927, 1930) reported 35 years ago. Bird (1930), in discussing the vegetation of the aspen parkland of Western Canada, did not mention fescue prairie. His field observations were made primarily in southwestern Manitoba. Although he described the association in a later publication (Bird, 1961), he did not mention its occurrence in

Manitoba. There appears to be no reference in the literature to the occurrence in Manitoba of grasslands dominated by *Festuca scabrella*. The late recognition of this association there, as in other areas, may be partially attributed to the infrequent production of culms by the dominant species, *F. scabrella*, as has been suggested by Moss (1955).

Table 8 Species composition and productivity of the *Festuca scabrella* association in Riding Mountain National Park

Species	Pounds per acre (dry matter)	Per cent of forage class	Frequency in 16 plots
Festuca scabrella	707.9	71.9	16
F. ovina var. *saximontana*	7.9	0.8	4
Stipa spartea var. *curtiseta*	141.8	14.4	12
S. richardsonii			
Agropyron trachycaulum	36.4	3.7	8
A. smithii			
Bromus inermis	9.8	1.0	4
Koeleria cristata	41.3	4.2	13
Other grasses*	7.9	0.8	
Carex spp.	31.5	3.2	7
Total grass and sedge	984.5	100.0	
Cerastium arvense	15.6	3.2	5
Thalictrum occidentale	18.9	3.9	14
Fragaria glauca	12.6	2.6	11
Geum triflorum	6.3	1.3	1
Potentilla arguta	17.9	3.7	10
Vicia americana	12.1	2.5	13
Polygala senega	9.9	2.0	6
Lithospermum canescens	12.0	2.5	8
Monarda fistulosa	14.4	3.0	10
Galium boreale	21.7	1.5	13
Campanula rotundifolia	7.4	1.5	10
Agoseris glauca	10.5	2.2	5
Achillea lanulosa	58.3	12.1	15
Artemisia gnaphalodes	7.1	1.5	6
Aster laevis	31.6	6.5	14
Aster spp.	89.0	18.4	
Erigeron spp.	8.9	1.8	8
Solidago missouriensis	46.9	9.7	13
S. rigida	54.6	11.3	
Other forbs*	27.9	5.8	
Total forbs	483.6	100.0	
Amelanchier alnifolia	12.4	7.3	3
Rosa acicularis	7.3	4.3	5
Arctostaphylos uva-ursi	140.1	82.7	5
Other shrubs*	9.7	5.7	
Total shrubs	169.5	100.0	
Grand total	1,637.6		

* Those species contributing less than five pounds of dried matter per acre (listed below).

Grasses:

Poa pratensis, Danthonia intermedia, Agrostis scabra.

Forbs:

Smilacina stellata, Stellaria longipes, Comandra pallida, Anemone canadensis, Heuchera richardsonii, Lathyrus venosus, Viola sp., *Zizia aptera, Agastache anethiodora, Liatris ligulistylis, Taraxacum officinale.*

Shrubs:

Potentilla fruticosa, Prunus virginiana, Symphoricarpos albus.

Because of the uniqueness of fescue prairie, its rarity in Manitoba, and the threat of its destruction by cattle grazing at Riding Mountain, data on the composition and distribution of climax tracts of this association in the park are presented in Table 8 and Figure 16. Fescue prairie presently covers only about 1,500 acres of the total 735,000 acres in the park. According to Campbell *et al.* (1956), *Festuca scabrella* "is palatable and is grazed out fairly readily".

Cattle grazing may also be affecting, or threatening, the status of certain other grassland associations on upland sites in the park. For example, a unique meadow dominated by junegrass was noted along Heron Creek at Johnsons Crossing (Figure 17). Grasses made up an estimated 90 per cent of total production there, with about 70 per cent of grass production accounted for by *Koeleria cristata.* Subdominants were *Stipa richardsonii, Vicia americana,* and *Aster* sp. That site was lightly grazed in 1963 (25–30 per cent forage removal), and therefore might be a sub-climax stage in which *Koeleria cristata* rather than *Poa pratensis* is dominant owing to local soil conditions. Unfortunately, little is known of soil types in the park.

Wet meadows in the park are normally dominated by various combinations of sedges, timothy, reedgrass (*Calamagrostis canadensis*), and slough grass (*Beckmannia syzigachne*) (Figures 18 and 19). In many heavily grazed areas those species have been replaced by seral stages in which weedy species such as Canada thistle (*Cirsium arvense*) (Figure 20), wild barley (*Hordeum jubatum*), and rough cinquefoil (*Potentilla norvegica*) are abundant.

Heavily used salt block sites have been trampled until large areas of soil are exposed (Figures 21, 22, and 23). Some have been invaded by dense stands of undesirable weeds. Severe trampling of small water courses and slough edges has damaged native vegetation and contributed to the general unsightliness of many areas. The traffic of cattle, horses, tractors, hay racks, and other farm vehicles into the western regions of the park has promoted the introduction of large numbers of exotic weeds, particularly along roadsides and around hay meadows (Figure 24). Chief among these are Canada thistle, sow thistle (*Sonchus arvensis*), hawk's-beard (*Crepis tectorum*), blue lettuce (*Lactuca pulchella*), flixweed (*Descurainia sophia*), and wild barley. Other introduced species are curled dock (*Rumex crispus*), sweet clover (*Melilotus alba* and *M. officinalis*), alfalfa (*Medicago sativa*), plantain (*Plantago major*), and clover (*Trifolium* spp.).

SUMMARY

1. Cattle grazing has a long history in Riding Mountain National Park. Approximately 1,500 head of cattle, plus calves and unpermitted stock, have grazed annually in the park in recent years. The Canadian Wildlife Service carried out studies from May 1961 to September 1963 to determine the relationship of those animals to the native park biota.
2. Elk are the most abundant ungulates in the park. The park population reached a high of about 12,000 in 1946, but was estimated at 2,000–3,000 in early 1963. About 8,300 elk from the Riding Mountain population have been harvested outside the park during periodic emigrations between 1944 and 1962. About 1,000 moose co-inhabit the park ranges.
3. Competition between elk and cattle for range forage was investigated in terms of the amount of range overlap, food habits, and degree of range utilization.
4. Cattle graze on about 15 per cent of the park area, but on about 50 per cent of the park grassland. Elk are widely distributed in the park, but, on the basis of aerial surveys, ground observations, and pellet group counts, they appeared to prefer burned-over forest to climax forest, and climax grassland to the seral stages which have resulted from cattle grazing.
5. Of the grass, forb, and browse forage classes, browse was most abundant in the elk diet and grass in the cattle diet. Elk also ate a considerable amount of grass, but this was present in excess of their demands. Forbs were abundant in the elk diet only in June and July. Major forbs eaten by elk were peavine, dandelion, and fireweed. Rose made up 42 per cent of the elk diet of browse. Aspen, willows, and saskatoon ranked next after rose. Cattle ate small amounts of forbs and browse, although certain species such as peavine and dandelion were preferred where available. All species eaten in common appeared to be available in excess of the animals' requirements.
6. Forage production and utilization on the area grazed by cattle were determined by the cage exclosure technique. On the basis that 60 per cent utilization or greater is beyond proper use, 27 of 96 cage sites were over-utilized in 1962. Results were similar in 1963. The percentage of total cage sites overgrazed in each of nine range units varied from zero to fifty. Therefore, elk food plants are in limited supply, or are deteriorating in production as a result of combined use, only in relatively restricted localities. Those areas are indicated on Map No. 2.

7. It was concluded that under prevailing levels of elk and cattle stocking, forage competition between those two species can largely be discounted as a factor threatening the welfare of either.
8. Vegetation types in the area in which elk rumen samples were collected were sampled by a clip-and-weigh technique to assess elk food habits in terms of species and forage class availability. Aspen and saskatoon were the only browse species which were used in excess of availability. Rose was prominent both in the elk diet and on the range. Hazel, by far the most abundant browse species on the range, was scarcely eaten. Peavine, the most abundant forb in the diet, was eaten out of proportion to its availability. Dandelion and fireweed were also preferred forbs. The relationship of availability of the three forage classes to their use indicates that browse is preferred. Although the forb class had the greatest annual production by weight, it was least used.
9. A brief discussion is included of the impact of cattle grazing on species composition of climax plant communities. In some areas climax fescue prairie has been modified to a bluegrass–dandelion association by a long history of livestock use. Many weedy species have become established on overgrazed sites.

LITERATURE CITED

Anderson, A. E., L. G. Frary, and R. H. Stewart. 1964. A comparison of three morphological attributes of mule deer from the Guadalupe and Sacramento Mountains, New Mexico. J. Mammal. 45:48–53.

Banfield, A. W. F. 1949. An irruption of elk in Riding Mountain National Park, Manitoba. J. Wildl. Mgmt. 13:127–134.

Bird, R. D. 1927. A preliminary ecological survey of the district surrounding the entomological station at Treesbank, Manitoba. Ecology 8:207–220.

——— 1930. Biotic communities of the aspen parkland of central Canada. Ecology 11:356–442.

——— 1961. Ecology of the aspen parkland of western Canada in relation to land use. Research Branch, Can. Dept. Agr., Publ. No. 1066, 155 p.

Blair, R. M. 1959. Weight techniques for sampling browse production on deer ranges. *In* Techniques and methods of measuring understory vegetation. Forest Service, U.S. Dept. Agr.

Blood, D. A. 1963a. Progress report, Riding Mountain National Park range management studies. Can. Wildl. Serv. typewritten report, 38 p.

——— 1963b. Aerial game survey, Riding Mountain National Park, February 1963. Can. Wildl. Serv. typewritten report, 13 p.

——— 1964a. Riding Mountain National Park range management studies, 1961–1963. Can. Wildl. Serv. typewritten completion report, Project Ml-1-4, 91 p.

——— 1964b. Notes on the birds of Riding Mountain National Park, Manitoba. Can. Field-Nat. 78:204–205.

——— 1966. The *Festuca scabrella* association in Riding Mountain National Park, Manitoba. Can. Field-Nat. In press.

Buechner, H. K. 1950. Life history, ecology and range use of the pronghorned antelope in Trans-Pecos, Texas. Amer. Midl. Nat. 43:257–354.

Campbell, J. B., K. F. Best, and A. C. Budd. 1956. Ninety-nine range forage plants of the Canadian Prairies. Can. Dept. Agr. Publ. No. 964, 99 p.

——— R. W. Lodge, A. Johnston, and S. Smoliak. 1962. Range management of grasslands and adjacent parklands in the Prairie Provinces. Can. Dept. Agr. Publ. No. 1133, 32 p.

Cole, G. 1958. Big game – livestock competition on Montana's mountain rangelands. Montana Wildlife, April 1958:24–30.

Colls, D. G. 1952. Surveys of elk and other wildlife in Riding Mountain National Park, Manitoba, 1950–51 and 1952. Can. Wildl. Serv., Wildl. Mgmt. Bull. Ser. 1, No. 6, 25 p.

Corner, A. H. 1956. Report on blackleg outbreak among domestic cattle, Riding Mountain National Park. Report to Chief, National Park Service, Aug. 22, 1956.

Coupland, R. T., and T. C. Brayshaw. 1953. The fescue grassland in Saskatchewan. Ecology 34:386–405.

Cowan, I. McT. 1947. Range competition between mule deer, bighorn sheep and elk in Jasper Park, Alberta. Trans. N. Amer. Wildl. Conf. 12:223–227.

De Nio, R. M. 1938. Elk and deer foods and feeding habits. Trans. N. Amer. Wildl. Conf. 34:421–427.

Dixon, J. S. 1934. A study of the life history and food habits of mule deer in California. Calif. Fish Game 20:181–282.

Ehrlich, W. A., L. E. Pratt, and E. A. Poyser. 1956. Report on reconnaissance soil survey of Rossburn and Virden map sheet areas. Can. Dept. Agr., Man. Dept. Agr. and Univ. of Man., Manitoba Soil Survey, Soils Report No. 6, 121 p. + 2 maps.

Flook, D. R. 1956. Range conditions and livestock grazing Riding Mountain National Park. Can. Wildl. Serv. typewritten report, 8 p.
——— 1960. Aerial census of big game, Riding Mountain National Park, November, 1959. Can. Wildl. Serv. typewritten report, 11 p.
Green, H. U. 1932. Mammals of the Riding Mountain National Park, Manitoba. Can. Field-Nat. 46:149–152.
——— 1933. The wapiti of the Riding Mountain, Manitoba. Can. Field-Nat. 47:105–111, 122–132, 150–157, 172–174.
——— 1946. The elk of Banff National Park. Can. Nat. Parks Bur. mimeographed report, 32 p.
Hamilton, W. J., Jr. 1940. The feeding habits of larval newts with reference to availability and predilection of food items. Ecology 21:351–356.
Hanson, H. C. 1938. Ecology of the grassland. Bot. Rev. 4:51–82.
Hess, A. D., and A. Swartz. 1940. The forage ratio and its use in determining the food grade of streams. Trans. N. Amer. Wildl. Conf. 5:162–164.
Jones, D. A. 1960. A salable approach to the elk–cattle competition problem. Trans. N. Amer. Wildl. Conf. 25:387–394.
Julander, O. 1958. Techniques in studying competition between big game and livestock. J. Range Mgmt. 11:18–21.
Kendeigh, S. C. 1961. Animal ecology. Prentice-Hall, Englewood Cliffs N. J. 468 p.
Klein, D. R. 1964. Range-related differences in growth of deer reflected in skeletal ratios. J. Mammal. 45:226–235.
Lovaas, A. L. 1961. Progress report on Riding Mountain National Park grazing studies. Can. Wildl. Serv. typewritten report, 19 p.
Manitoba. 1948–1963. Annual reports of the Department of Mines and Natural Resources.
Martin, A. C., R. H. Gensch, and C. P. Brown. 1946. Alternative methods in upland gamebird food analysis. J. Wildl. Mgmt. 10:8–12.
Morris, M. S. 1956. Elk and livestock competition. J. Range Mgmt. 9:11–14.
——— and J. E. Schwartz. 1957. Mule deer and elk food habits on the National Bison Range. J. Wildl. Mgmt. 21:189–193.
Moss, E. H. 1955. The vegetation of Alberta. Bot. Rev. 21:493–567.
——— and J. A. Campbell. 1947. The fescue grassland of Alberta. Can. J. Res. C 25:209–227.
Murie, O. J. 1951. The elk of North America. Stackpole Co., Harrisburg, Pa., and the Wildlife Management Institute, Washington, D.C. 376 p.
Murphy, D. A. 1963. A captive elk herd in Missouri. J. Wildl. Mgmt. 27:411–414.
Quimby, D. C., and D. E. Johnson. 1951. Weights and measurements of Rocky Mountain elk. J. Wildl. Mgmt. 15:57–62.
Riney, T. 1955. Evaluating condition of free-ranging red deer (*Cervus elaphus*), with special reference to New Zealand. New Zealand J. Sci. Tech. Sec. B, 36:429–463.
Rowe, J. S. 1959. Forest regions of Canada. Canada, Northern Affairs Nat. Resources, Forestry Branch, Bull. 123, 71 p. + 1 map.
Soper, J. D. 1953a. The birds of Riding Mountain National Park, Manitoba, Canada. Can. Wildl. Serv. Wildl. Mgmt. Bull. Series 2, No. 6, 54 p.
——— 1953b. The mammals of Riding Mountain National Park, Manitoba, Canada. Can. Wildl. Serv. Wildl. Mgmt. Bull. Series 1, No. 7. 34 p.
Sprague, V. G., and W. M. Myers. 1945. A comparative study of methods for determining yields of Kentucky bluegrass and white clover when grown in association. J. Amer. Soc. Agron. 37:370–377.
Tamsitt, J. R. 1960. Some mammals of Riding Mountain National Park, Manitoba. Can. Field-Nat. 74:147–150.
Troyer, W. A. 1960. The Roosevelt elk on Afognak Island, Alaska. J. Wildl. Mgmt. 24:15–21.
Young, V. A., and W. L. Robinette. 1939. A study of the range habits of elk on the Selway game preserve. Univ. Idaho Bull. 34.

APPENDIX

Table 9 Annual production of air-dried forage in pounds per acre in five cover types in the region of collection of the elk rumen samples

Species	Grass-land	No. 1 type	Shrub-land	Open aspen	Dense aspen	Weighted means for entire area
Grasses						
Festuca scabrella	550	—	—	—	—	
F. ovina	5	9	—	—	—	
Stipa spartea	123	19	1	—	—	
Agropyron trachycaulum	29	77	75	22	15	
Elymus innovatus	—	127	65	15	9	
Poa spp.	99	39	42	—	3	
Bromus inermis	7	—	—	—	—	
B. ciliatus	—	5	6	5	8	
Schizachne purpurascens	—	67	—	32	19	
Phleum pratense	—	6	26	—	—	
Koeleria cristata	37	4	—	—	—	
Unidentified grass	—	—	4	92	21	
Sedges and rushes						
Carex spp.	25	61	232	54	38	
Scirpus sp.	—	—	24	—	—	
Grass total	875	414	475	220	113	
Forbs						
Equisetum arvense	—	tr.	1	7	tr.	2
Smilacina stellata	1	7	15	13	7	8
Orchis rotundifolia	—	3	tr.	4	17	7
Comandra pallida	4	9	—	—	—	2
Cerastium arvense	20	—	—	—	—	3
Anemone canadensis	2	8	16	7	2	6
Thalictrum occidentale	16	12	40	11	7	14
Fragaria glauca	10	87	34	63	43	46
Geum triflorum	10	—	—	—	—	2
G. aleppicum	—	3	7	6	3	4
G. rivale	—	3	7	6	3	4
Potentilla spp.	15	1	1	1	—	3
Rubus acaulis	—	2	5	12	2	4
Lathyrus venosus	3	115	11	65	48	48
L. ochroleucus	—	6	1	6	2	3
L. palustris	—	—	10	5	—	2
Vicia americana	10	14	13	26	13	16
Polygala senega	8	—	—	tr.	—	1
Viola spp.	1	15	2	12	18	13
Epilobium angustifolium	—	2	13	36	2	11
Aralia nudicaulis	—	1	3	60	136	62
Sanicula marilandica	—	9	—	—	14	6
Lithospermum canescens	10	—	—	1	—	2
Mertensia paniculata	—	—	7	2	—	2
Agastache anethiodora	2	9	4	4	4	4

Table 9 (continued)

Species	Grass-land	No. 1 type	Shrub-land	Open aspen	Dense aspen	Weighted means for entire area
Monarda fistulosa	13	—	—	tr.	—	2
Stachys palustris	—	—	1	—	5	2
Plantago major	—	tr.	2	—	10	4
Galium boreale	19	26	28	36	20	25
Campanula rotundifolia	7	1	tr.	—	—	1
Agoseris glauca	20	5	—	4	—	5
Taraxacum officinale	30	20	15	4	7	13
Achillea lanulosa	54	25	9	7	1	15
Artemisia gnaphalodes	6	—	—	—	—	1
Aster laevis	25	—	—	—	—	32
Aster spp.	72	29	14	28	10	32
Cirsium arvense	—	6	12	—	12	7
Erigeron spp.	7	4	1	—	—	2
Petasites sagittatus	—	3	10	4	2	3
Solidago missouriensis	38	—	—	—	—	97
S. rigida	53	—	—	—	—	97
Solidago spp.	—	229	168	83	36	97
Forb total	456	651	443	514	423	479
Shrubs						
Populus tremuloides	—	23	35	6	1	9
P. balsamifera	—	21	5	6	10	8
Salix spp.	—	11	364	50	1	60
Betula glandulosa	—	—	136	2	—	18
Corylus cornuta	—	233	70	202	295	188
Ribes spp.	—	1	12	2	3	3
Amelanchier alnifolia	10	53	10	30	8	21
Crataegus succulenta	—	4	—	—	14	5
Potentilla fruticosa	2	—	17	—	—	3
Prunus pensylvanica	—	5	14	3	8	6
P. virginiana	4	76	3	23	22	24
Rosa acicularis	8	65	83	144	108	88
Rubus idaeus	—	1	—	12	26	12
Rhamnus alnifolia	—	—	23	8	—	5
Cornus stolonifera	—	5	—	45	14	16
Arctostaphylos uva-ursi	135	3	—	1	—	3
Symphoricarpos albus	3	32	55	45	7	25
Viburnum edule	—	—	—	tr.	9	3
V. opulus	—	—	—	7	—	1
Browse total	162	533	827	586	526	498
Miscellaneous plants*	43	7	21	10	16	
Grand Total	1536	1605	1766	1330	1078	

*Plants producing less than 5 lbs. per acre in all types (listed below).

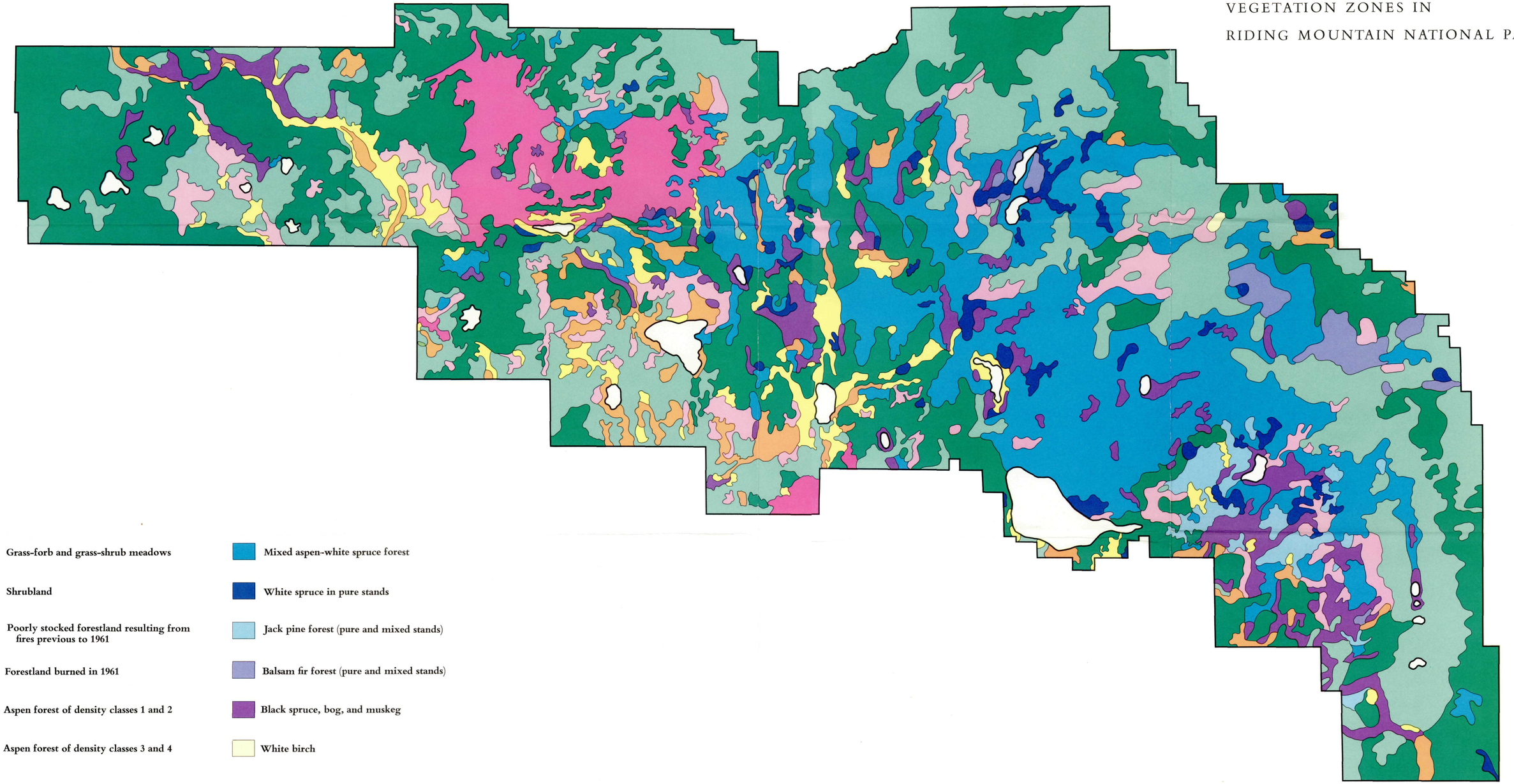
Grasses: *Danthonia intermedia, Agrostis* sp.

Forbs: *Disporum trachycarpum, Maianthemum canadense, Stellaria* sp., *Actaea rubra, Descurainia sophia, Heuchera richardsonii, Zizia cordata, Cornus canadensis, Pyrola asarifolia, Lysimachia ciliata, Apocynum androsaemifolium, Mentha arvensis, Scutellaria galericulata, Castilleja mineata, Galium triflorum, Sonchus arvensis, Liatris ligulistylis, Rudbeckia hirta, Antennaria* sp.

Browse: *Betula papyrifera, Alnus crispa, Spiraea alba, Acer spicatum, Shepherdia canadensis, Lonicera* sp., *Viburnum lentago.*

MAP NUMBER 1

VEGETATION ZONES IN RIDING MOUNTAIN NATIONAL PARK



- Grass-forb and grass-shrub meadows
- Shrubland
- Poorly stocked forestland resulting from fires previous to 1961
- Forestland burned in 1961
- Aspen forest of density classes 1 and 2
- Aspen forest of density classes 3 and 4
- Mixed aspen-white spruce forest
- White spruce in pure stands
- Jack pine forest (pure and mixed stands)
- Balsam fir forest (pure and mixed stands)
- Black spruce, bog, and muskeg
- White birch

NATIONAL PARKS OF CANADA

CANADA
MINES AND TECHNICAL SURVEYS
SURVEYS AND MAPPING BRANCH

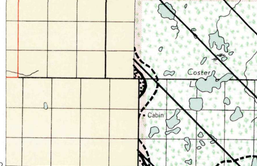
MAP NUMBER 2

SHOWING DISTRIBUTION OF CATTLE AND ELK,
AND ELK FOOD HABITS STUDY AREA

THIRD EDITION

MCR 207

THE DECLINATION OF THE COMPASS NEEDLE JANUARY 1953.



The declination of the compass needle at any place along a red line is the declination given on that red line. At other places the declination is between those given on the neighbouring red lines: thus at the place marked A, because it is halfway between the two red lines marked N. 13° E. and N. 14° E., the declination of the compass needle is N. 13° 30' E.
The declination of the compass needle is decreasing 3½ minutes annually.

Compiled, drawn and printed at the office of the Surveyor General, April 1932.
Reprinted with corrections 1939.
Revised at the Surveys and Mapping Branch, Ottawa, 1954.

REFERENCE

- Railway
- Main road
- Other roads
- Pack trail or path
- Telephone along road or trail
- Telephone not along road
- Boundary: Park
- Boundary: Indian reserve

RIDING MOUNTAIN PARK
MANITOBA

Scale 3 miles to 1 inch or 1:190,080

Miles 1 0 5 10 Miles

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

REFERENCE

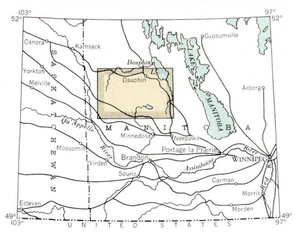
- Post office
- Village, railway station and post office
- Village, railway station without post office
- Warden's cabin
- Lookout tower
- Fire tower
- Height in feet 1875
- Woods
- Marsh, bog or open muskeg

LEGEND

- Low elk density
- Medium elk density
- High elk density
- Boundary of cattle distribution
- Sites heavily grazed by cattle
- Boundary of elk food habits study area
- Elk collection sites

RANGE UNITS

1. Moose Lake
2. Flat Lake
3. Deep Lake
4. Upper Birdtail
5. Lower Birdtail
6. Baldy Lake
7. Menzie Lk. Peden Lk.
8. Lk. Audy Heron Creek
9. Round Lake
10. Kennis Meadows
11. Sugarloaf



NATURAL AND HISTORIC RESOURCES BRANCH ● DEPARTMENT OF NORTHERN AFFAIRS AND NATIONAL RESOURCES

CANADIAN
WILDLIFE
SERVICE