Potential for Game Ranching in Boreal Aspen Forests of Western Canada

EDMUND S. TELFER AND GEORGE W. SCOTTER

Highlight: *Portions of western Canada, which include the boreal mixedwood, aspen parklands, lower foothills, and the montane forest regions, contain large expanses of aspen. These regions are favorable for consideration as game ranching areas because of a shallow snow cover, productive soils, variety of vegetative types, and a variety of native wild ungulates, including bison (*Bison bison*), moose (*Alces alces*), elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), and white-tailed deer (*O. virginianus*). Those parameters discussed, which are relevant to game ranching, include range carrying capacity, sex ratio, management during winter, scale of operation, interspecific competition, and behavioral intolerance, disease and parasites, harvesting, and multiple use management.*

In North America, interest in game ranching is increasing, probably because the world's potential for red meat production is considered to be limited. An increased ecological knowledge, such as the niche specialization of multi-species assemblages, and the need to use our land resources to the best possible advantage (de Vos, 1967), have led to changed viewpoints.

Game ranching may be defined as the keeping of wild mammals, principally large ungulates, either in fenced enclosures or under close surveillance, so that efficient, systematic harvesting of meat is possible. The animals thus kept in semidomestication may be either exotic or native species, but "game ranching" usually refers to the latter. Game ranching has been widely studied and implemented in Africa, where a diversity of large mammals has survived (Dasmann, 1964; Parker and Graham, 1971). Management of big game, as practiced in European countries, approaches the intense husbandry associated with game ranching. In the light of European and African experiences, it is possible that sections of North America might support game ranching operations.

We will discuss the ecological setting for game ranching in the boreal *Populus* forests of northwestern Canada and comment on those aspects of game ranching influenced by biological factors, hopefully avoiding those pitfalls of sentimentality described by Parker and Graham (1971).

The Boreal Aspen Forests of Western Canada

The region (Fig. 1) includes areas described by Rowe (1972) as "aspen parkland," "oak-aspen parkland," "boreal mixedwood," "lower Foothills," as well as a small "montane" region in Alberta. These areas are characterized by large components of *Populus* species, principally trembling aspen (*P. tremuloides*) and balsam poplar (*P. balsamifera*) (Fig. 2). The southern part of the boreal aspen forest is interspersed with

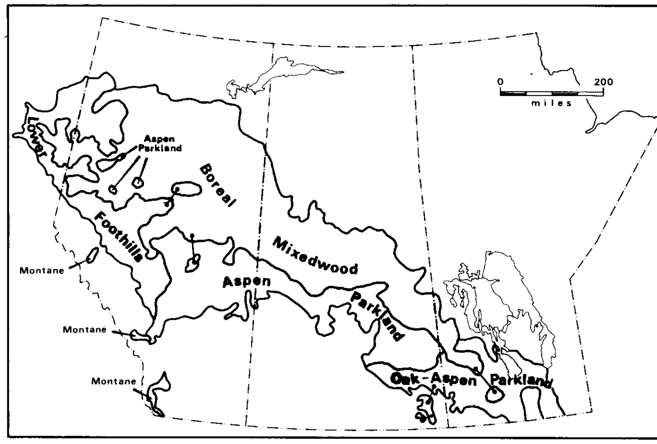

Fig. 1. *Map showing the aspen-dominated regions of western Canada (After Rowe 1972).*

grassland patches and has been heavily developed for agriculture. Its ecology has been described by Bird (1961). More northerly portions contain nearly climax forests of spruce (*Picea glauca*) and jack pine (*Pinus banksiana*), together with extensive muskeg areas.

The predominance of *Populus* forests in the region has been ascribed to frequent burning (Rowe, 1972). The *Populus* species, generally referred to collectively as "aspen," comprise a seral stage in forest development following disturbance or fire. Later stages contain more conifers.

The boreal aspen forest region has the following characteristics which are valuable for game ranching:

Fig. 2. *In the boreal mixedwood regions of western Canada, mixed spruce and aspen stands are interspersed with stands of willow and of pure aspen.*

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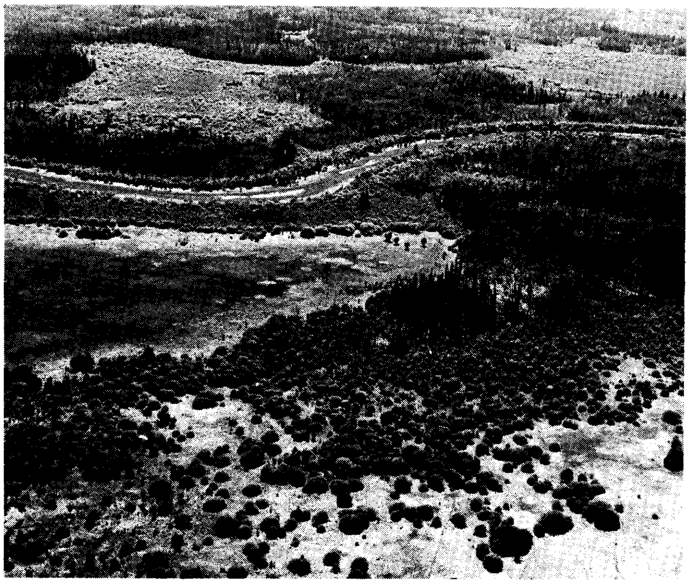

Fig. 3. *Extensive wet meadows dominated by sedges occur in the boreal mixedwood region of western Canada.*

Fig. 4. *Aspen forests have a well-developed shrub understory, yielding on the order of 100 pounds of browse per acre per year.*

Fig. 5. *Relatively mild snow conditions in the boreal aspen forests permit general use of all browse-producing areas by cervids during most winters.*

1. A relatively shallow snow cover, with median depths for January 31 ranging from 4 to 20 inches (Potter, 1965, chart 18), and only a 20% chance of having a maximum snow depth of more than 20 inches (calculated from depth frequencies for 12 stations in the region reported by Potter, 1965). Snow densities range from .13 to .20 g/cm^3 in those forest feeding areas used by barren ground caribou in northern Saskatchewan (Pruitt, 1959) to .10 to .45 g/cm^3 at the Winnipeg airport, averaging less than .25 g/cm^3 50% of the time (Williams, 1958). Snow hardness ranges from 6.5 to 60 g/cm^2 in forested caribou range (Pruitt, 1959) to 100-2500 g/cm^2, with values of less than 300 occurring 50% of the time at Winnipeg (Williams, 1958). The snow cover is shallow, soft, and loose compared to many other regions of Canada, thus facilitating animal movement to available forage (Fig. 5). Close to the Rocky Mountains, the montane region is subject to föhn winds (chinooks) that often melt much of the snow cover, thereby reducing the severity of winter for ungulates.

2. The soils of the region are relatively productive. The parkland and montane regions are underlain by black, thin black, and dark grey wooded soils, and the adjacent boreal mixedwood by a grey-wooded soil (Green and Laycock, 1967). Variants of those soil groups occur intimately intermixed in the parkland region (A. W. Bailey, pers. comm.). The soils were formed on glacial till materials which originated from the weathering of underlying sedimentary bedrock and have a better nutrient status than the soils on the Canadian Shield.

3. The region contains large native ungulates, including bison (*Bison bison*), moose (*Alces alces*), elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), and white-tailed deer (*O. virginianus*).

4. The landscape is an undulating plain with low hills interspersed with small lakes and marshy areas (Fig. 3). This diversity of terrain produces a varied microclimate that influences the distribution of the large mammals both directly and indirectly by controlling plant distribution. As a consequence, their winter range is intimately interspersed with their summer range.

5. The aspen forests are rather thin-crowned, when compared to coniferous forests, thus permitting the development of an understory of shrubs, forbs, grasses, and sedges (Fig. 4). The aspen is often interspersed with willow (*Salix* spp.), an excellent food for browsing mammals. In addition, the understory species in the forests and other species of the interspersed openings are also highly palatable. They include sedges such as *Carex atherodes* for bison, shrubs such as Saskatoon serviceberry (*Amelanchier alnifolia*) and aspen saplings for deer, and grasses such as bearded wheatgrass (*Agropyron subsecundum*), slender wheatgrass (*A. trachycaulum*), northern reedgrass (*Calamagrostis inexpansa*), fringed brome (*Bromus ciliatus*), and bluegrass (*Poa* spp.).

Negative factors also exist. Predators, principally the grey wolf (*Canis lupus*), occur over most of the boreal mixedwood zone. Coyotes (*Canis latrans*) are also common and in winter may prey on deer. Moose neurologic disease occurs in the eastern part of the region. It is caused by a parasitic nematode *Parelaphostrongylus tenuis,* which is carried harmlessly by white-tailed deer. The parasite can attack both elk (Carpenter et al., 1973) and moose (Anderson, 1972) with fatal results.

Table 1. Standing stock of forage remaining after summer grazing. North of Highway 16, Elk Island National Park, August, 1972, (lb/acre oven-dry).

Kind of forage and cover type	Yield lb/acre ± 2 std. errors	Area of type		Total yield (lb)	Approx. % grass and sedge	Weight of grass and sedge (lb)
		Acres	Percent			
Herbage yield						
Upland grass	1,718 ± 288[1]	2,938	10.8	5,047,484[2]	74.5	3,760,376
Wet meadow	3,320 ± 430	2,938	10.8	9,754,160	90.3	2,202,002[3]
Shrub meadow	1,241 ± 338	4,275	15.7	5,305,275	69.9	3,708,387
Dense *Populus* forest	224 ± 13	17,139	62.7	3,829,136	42.4	1,623,554
Totals		27,290	100.0	23,946,055		11,294,319[4]
Browse yield[5] (all cover types)				1,805,440[4]		

[1] 1 lb/acre = 1.12 kg/ha.
[2] 1 lb = 0.454 kg.
[3] Reduced to ¼ because much of the biomass of large sedges is either unpalatable or unavailable.
[4] Utilizable surplus: grass and sedge, 11,294,319 X .50 = 4,647,159 lbs
winter browse, 1,805,440 X .60 = 1,083,264 lbs
[5] Total yield, 1971, of woody twigs, 2-8 ft above ground, of 10 preferred species.

Elk Island National Park—a Representative Area

General Description

Elk Island National Park is located in central Alberta on a dead ice moraine known as the Beaver Hills. The region is considered to be an outlying area of the mixedwood forest region and is surrounded by aspen parkland (Rowe, 1972). The park is thus a rather typical section of the boreal aspen forests. Elk Island was established as a federal game reserve in 1906 to protect a relict herd of native elk. In 1907 plains bison were introduced there and a semidomestic population of bison has persisted to the present. In 1930 the area was established as a national park. The original fenced area included a few moose as well as the elk, and mule deer were also common. Under protection, all of these species increased until, by 1937, it was deemed necessary to reduce their numbers. Since then the animals have been periodically removed to protect their range, reduce winter mortality, and prevent disease problems that could affect neighboring agricultural areas.

The present area of Elk Island is 75 miles^2, of which approximately 62.9 miles^2 are available ungulate range. It consists of two portions, one of approximately 50 miles^2 north of Highway 16, which we will describe further, and another section of over 25 miles^2 south of the highway. The area to the south of the highway is currently used as a rearing enclosure for rare wood bison (*Bison bison athabasceae*).

Ungulate Populations

In spite of herd reductions in the past, the population of ungulates at Elk Island has at times been high. Holsworth (1960) estimated that there had been maximum densities of 33 bison, 27 elk, and 13 moose per mile^2 in the park, all at the same time. During his studies in 1959, he believed that there were 14 bison, 13 elk, and 7 moose per mile^2. Since that time the moose have attained populations that approached 12 per mile^2 on the north side of the Park (Blood, 1973) and may have reached 20 per mile^2 on the south side (J. McGillis, pers. comm.). Subsequently, the southern population was reduced by mortality from range overuse, and by a program of controlled slaughters. By February, 1972, an aerial survey of the north side of the park showed a population of 4.8 moose and 10.0 elk per mile^2. At the same time, the Park records provided an estimate of 4.3 bison per mile^2.

The dense population of bison that existed in past decades was, to some extent, supported by a regular program of winter feeding. Other ungulates, notably the elk, also made use of the hay provided for the bison during winter. During the past few years the Park policy has been to reduce bison populations on the north side to 300 or 400 animals, and to eliminate winter feeding except during unusual winters. Such feeding has occurred in only two of the past eight winters (R. Jones, pers. comm.).

Range Surveys and Carrying Capacity Estimates

Biological data have been collected by personnel of the Canadian Wildlife Service in order to determine the optimum level of stocking in the pastures at Elk Island. Although internal reports suggested optimum stocking rates for bison (Flook, 1968) and for cervids (Flook and McGillis, 1968), recent problems with elk mortality led to more detailed studies of the range (Telfer, 1972). The results of those studies have allowed the calculation of the usable surplus of forage (Table 1), and the biomass of ungulates that this surplus would support (Table 2).

In estimating the carrying capacity of Elk Island National Park from Telfer's range survey, the following assumptions were made:

1. A carry-over of 50% of the net yield of the grasses and sedges at the end of the previous growing season was considered desirable (Stoddard and Smith, 1955).

2. A large amount of grass and sedge was available in the wet meadow type. However, many meadows around the fringes of sloughs and in glacial kettles are small and are seldom used by bison. On the other hand, some of the large wet meadows are heavily used. It therefore seemed advisable to reduce the weight of usable herbage in the wet meadow type to 25% of the total. That reduction, while arbitrary, reflected the current situation, and it is possible that greater densities of bison might result in increased use of the smaller patches of wet meadow.

3. Winter browse was considered to be the twigs of woody plants found between the heights of 2 ft and 8 ft above the ground. Twigs below 2 ft in height would be buried in the snow during an average winter, while little feeding occurred above 8 ft. Browse estimates included twigs of the ten species of woody plants most important for ungulate browse [hazel

Table 2. Carrying capacity of ungulates on portion of Elk Island National Park, north of Highway 16. (An example using theoretical proportions of moose, bison, and elk.)

Kind of animal	Average weight lbs	Average weight kg	Theoretical carrying capacity (number of animals[1])	Number per unit area mile²	Number per unit area km²	Live biomass lb/mile²	Live biomass kg/km²	Annual yield[2] lb/mile²	Annual yield[2] kg/km²
Bison	992	450	798	18	6.9	18,240	3192	3,648	638
Moose	666	302	525	12	4.4	7,992	1399	1,598	280
Elk	532	242	540	12	4.4	6,384	1117	1,276	223
Total						32,616	5708	6,522	1141

[1] In autumn prior to harvesting.
[2] Annual yield/acre = 10.2 lb (11.4 kg/ha), worth $4.08 at $40/cwt live weight.

(*Corylus cornuta*); aspen; balsam poplar; cranberry (*Viburnum edule*); dogwood (*Cornus stolonifera*); willows; Saskatoon serviceberry; chokecherry (*Prunus verginiana*); buffaloberry (*Shepherdia canadensis*); and white birch (*Betula papyrifera*)]. The estimates are conservative because twigs of a few other species will be eaten, particularly at higher ungulate densities, and some food will be obtained above and below the height range studied. However, extra browse thus obtained would be counterbalanced by the likelihood that not all willow species are palatable.

4. A utilization factor of 60% for browse was employed in the carrying capacity estimates. The factor is higher than the 40% used by Murphy and Crawford (1970). Utilization in parks and commercial forests must be restricted, but the results of several studies led us to believe that where maximum production of animals is desired, the aspen forest plants will withstand utilization at the higher rate. Studies by Telfer (unpublished) in the montane aspen region have suggested that browsing up to 100% of the year's growth on willow and Saskatoon serviceberry did not reduce the next year's growth. Julander (1937) reported that aspen could almost maintain itself when browsed 70 to 75%, while at 65 to 70% use, a fair recovery could be expected. In as much as aspen reproduction generated from root sprouts, nutrients can be translocated from the parent tree for sprout growth even under repeated heavy browsing of the sprouts. In clearcut areas, however, heavy browsing of aspen reproduction for 3 years successively will result in few new sprouts being produced (Julander, 1937; Smith et al., 1972).

Aldous (1952) reported that willow produced well over moderate to heavy browsing. Young and Payne (1948) suggested a 60% level of use could be sustained by Saskatoon serviceberry. Browsing up to between 60 and 75% will stimulate growth of some shrubs (Julander, 1937; Garrison, 1953). This increased response results from removal of apical dominance when the terminal bud is removed. Lateral buds are then released from hormonal suppression until a new terminal bud develops. It appears that the key browse species of the northern poplar forest can withstand heavy browsing and can maintain their yield over several years. However, data on the ability of the plants of the boreal aspen forest to withstand browsing are inadequate, and suggested carrying capacities should be tested with due regard to range and animal condition.

5. The food requirements of the ungulates at Elk Island were assumed to be 2.2 lb/100 lb of estimated body weight. This estimate of intake is approximate because certain cervids, especially moose (Knorre, 1959) and white-tailed deer (Silver et al., 1969) restrict their food intake during winter and limit their activity to compensate for this reduced intake of energy.

Sex and Age Ratios

Other biological parameters besides range carrying capacity are relevant to game ranching. One of the more important is the determination of a desirable ratio of male to female animals. If meat production is the goal, it would be advantageous to maintain only as many males of any species as are required to ensure that all the healthy females become pregnant.

The values for annual yield of meat per mile^2 in Table 2 represent a harvest of 20% of the biomass. This level of harvest is derived from net productivity estimates for moose at Elk Island (21–24%, Blood, 1973) and from the actual harvest rate (22%) for elk in herd reductions between 1947 and 1960 (Flook, 1970). Net productivity could be increased to 30% for cervids and 40% for bison if the proportion of adult males in the population were reduced to the minimum number necessary to ensure pregnancy. One bison bull for each ten cows has been found as a suitable ratio on some bison ranches in the United States (R. Richmond, pers. comm.).

The effects of different sex ratios on moose productivity are thought to depend on the density of the population (Markgren, 1971). Markgren cited Russian literature that reported impaired reproduction with fewer than one male per two females, and reported similar problems in Swedish Lapland, where moose densities were only 0.4 per mile^2. However, for Alaska, he cited data which showed that where moose densities exceeded 5 per mile^2, productivity remained high, even with only one bull per ten cows. In most situations, neither moose nor deer congregate in herds for breeding and, although moose may mate with many females under high densities, they are considered to be only "conditionally polygamous" (Markgren, 1971).

With elk, the normal sex ratio in unhunted populations may be within the range of 15 to 40 males/100 females (Flook, 1970). Because of the social nature of the elk, and because of the formation of breeding herds, the proportion of males to females could probably be reduced below these natural levels under controlled conditions.

Management During Winter

Winters are severe in the boreal aspen forests, and in a game ranching operation it would be necessary to take climatological phenomena into account. Winter losses could be minimized by harvesting all surplus animals at the beginning of the cold season or, in unusually severe winters, supplements could be fed. Cured hay will sustain bison and elk because they usually feed on grasses and sedges, but distribution of the hay to them could be difficult. When hay is distributed in Elk Island Park, however, almost all of the bison will make their way to the feeding areas within a week or so. Possibly experience with such feeding prompts them to check past feeding locations.

With deer and moose, the problem of winter feeding is more serious. These animals can accept hay only if they are being fed on it year round. There are many examples of deer mortality from well-meaning winter feeding programs where the animals were unable to digest hay, probably because their rumen flora could not adapt quickly enough to break down such food in an emergency situation (Dasmann, 1971). The diet of deer and moose might, when necessary, be supplemented with digestible pelletized rations, although Knorre's (1961) cautions about feed supplements to moose should be considered.

Scale of Operation

Livestock may be handled in relatively small pastures because they can be herded with little difficulty. Wild or semiwild animals cannot be handled easily in most cases, although bison are more tractable than the cervids. The breeding herd on a game ranch must be large enough to ensure genetic diversity, and also to fully utilize the range. The initial 16 miles^2 (Holsworth, 1960) of Elk Island permitted the establishment of a large population of elk, bison, and moose. The isolation area south of Highway 16 (approximately 17 miles^2 of usable range) has also proven adequate for a viable population of moose, elk, and bison. A variable number of white-tailed deer also live in the Park but seem to go under or through the boundary fences with ease. Currently, studies with moose in square-mile pens are under way in Kenai National Moose Range in Alaska. It will be of interest to see whether viable populations can be maintained on such small units. Domestication of moose, as reported in Russia by Knorre (1959) and Yazan and Knorre (1964), may reduce the unit area required for their husbandry.

Interspecific Competition and Behavioral Intolerance

Ungulates may compete for food. White-tailed deer appear able to exclude mule deer from most areas where their ranges overlap (Krämer, 1972). Elk in high densities may also be able to exclude both mule and white-tailed deer. An example of a mule deer die-off in the face of a rising elk population is cited by Cliff (1939). For many years the northern portion of Elk Island National Park contained a high elk population and few deer. On the south side the majority of elk were removed recently in order to isolate the wood bison herd from any possibility of transmission of disease. As a consequence, the white-tailed deer have become very plentiful, probably having a present density of between 10 and 20 per mile^2 (R. Jones, pers. comm.).

The mule deer were the original deer at Elk Island until white-tailed deer invaded the region in the 1940's (R. Jones, pers. comm.). Within a decade they had largely superseded the mule deer, and today the latter are rare. Whereas elk and deer seem to do poorly together, moose and elk apparently complement one another, because high moose and elk populations have existed on the north side of Elk Island at the same time. Apparently, bison do not compete with moose or elk because high populations of bison have existed with those species at Elk Island in the past.

Snowshoe hares (*Lepus americanus*) may periodically exert considerable pressure on the browse resource. Hares are subject to cyclic increases and decreases in population (Meslow and Keith, 1968), often with an amplitude of 20 to 1 in northern Alberta. Recent research suggests that the peak level to which hare populations can rise is set by the amount of digestible forage that is available (L. B. Keith, pers comm.). It would appear, therefore, that in certain circumstances, hares may represent formidable competition to the ungulates for browse.

Disease and Parasite Problems

Both brucellosis and tuberculosis have been a problem in bison at Elk Island National Park, and also in other parks and reserves where bison have been held. Brucellosis has also been found in elk and moose. Corner and Connell (1958) reported that 42.27% of the bison tested at Elk Island reacted positively for brucellosis. At the same time, none of the 124 moose showed a positive reaction, but 13.12% of 192 elk did. More recently, ungulates in the Park have been heavily culled in an attempt to control and remove those diseases. During the years 1969 to 1973, several hundred serum samples from elk and moose were tested and no positive reactors to brucellosis were found (E. Broughton, pers. comm.). It may be assumed that brucellosis and tuberculosis are no longer prevalent at Elk Island and likely have been eliminated. However, on most other reserves there is a fairly high level of infection among bison and it might prove difficult to achieve a completely brucellosis-tuberculosis free herd. In addition, anthrax is known to occur in Alberta, and it might be necessary to try to vaccinate animals on a game ranch.

The presence of *Parelaphostrongylus tenuis* in Manitoba has been mentioned earlier. *P. tenuis* does not present a problem in the absence of white-tailed deer, so considering the greater suitability of moose and elk for game ranching, deer populations might have to be maintained at low numbers. The problem is compounded by the ability of white-tailed deer to go under and over ordinary fences.

The high ungulate population densities at Elk Island may explain some unusual parasite relationships among moose and deer (W. Samuel, pers. comm.). Moose have been found carrying *Zygocotyle lunatum,* a parasite previously reported among mammals only from muskrats (*Ondatra zibethicus*) (W. Samuel, pers. comm.). Samuel also found *Seteria* spp. in moose, possibly due to the proximity of bison, and a fairly high incidence of *Echinococcus granulosus* in elk, apparently with the coyote as the definitive host, although in other regions wolves appear to be the more usual definitive host. However, little parasitic illness has been reported at Elk Island, and only a small percentage of carcasses have been condemned by Agriculture Canada inspectors during the ungulate herd reductions.

No instance of muscle cysticercosis has been reported from Elk Island. The condition is caused by the tapeworm *Taenia krabbei,* the larval stage of which encysts in the heart and skeletal muscles of wild herbivores. It is fairly common in wild ungulates in sections of Alberta where wolves are the alternate host (W. Samuel, pers. comm.). Muscle cysticercosis could become serious in game ranching because it could lead to rejection of carcasses as unfit for human consumption.

It is likely that, in order to reduce the incidence of parasitic diseases and to prevent high predation losses, wolf numbers would have to be controlled on game ranches. On the other hand, the potential value of wolves as game animals, the high

Table 3. Comparison of year-long biomass of wild ungulates and domestic stock from several areas of the world.

Type of range and location	Stock	Biomass (kg/km²)	Reference
Partly overgrazed, overstocked savanna in Albert National Park	wild ungulates (11 species)	7,574 and 20,469 (two areas)	Bourliere and Verschuren (1960)[1]
Savanna, East Africa	wild ungulates	12,260	Talbot & Talbot (1963)[1]
Themeda–Acacia grassland East Africa	10 species of wild ungulates	4,386 to 5,624	Petrides (1956)
Prairie, South Dakota, U.S.A.	Bison and other wild ungulates	2,450 to 3,500	Ruth (1939) Cahalane (1952)[2]
Prairie, Oklahoma, U.S.A.	cattle	3,685	Ruth (1949)[2]
Mostly open plains Nairobi National Park	wild ungulates and cattle	5,250 to 12,600 (over 6 years) est. carrying capacity ±6,300	Foster & Coe (1968)
Uganda	elephants	4,758	Petrides & Swank (1966)
Elk Island National Park estimated maximum density prior to 1959 (with some winter feeding)	bison, elk, deer, moose	9,821	Holsworth (1960)
Estimated 1959 population at Elk Island (some winter feeding)	bison, elk, deer, moose	4,429	Holsworth (1960)
Estimated 1967 population at Elk Island (some winter feeding)	bison, elk, deer, moose	4,589	T. L. Ross, Supt. (correspondence)
Estimated 1972 population at Elk Island (no winter feeding and after large reductions)	bison, elk, deer, moose	2,251	Telfer (1972)
Elk Island carrying capacity, based on a conservative estimate	bison, elk, moose	5,708	This paper

[1] From de Vos (1969).
[2] From Petrides (1956).

price of their pelts, and the service they render in eliminating unhealthy animals might enable wolves to pay their way on a game ranch.

Harvesting

Biological as well as economic factors influence the techniques for harvesting ungulates. Sport hunting for trophy animals can be remunerative, as described for African conditions by Johnstone (1971). If production of trophy males is desirable, the sex ratios discussed above should be altered to permit the maintenance of a larger proportion of bulls. Under those circumstances, it might be advisable to reduce the total population density of each species because males are more vulnerable to winter mortality on heavily used ranges than females, as demonstrated for elk by Flook (1970).

Intensive management would require culling of nontrophy animals. Culling should be efficient and humane. It has been found at Elk Island that bison can be drawn to selected areas by supplemented food, then herded into holding pastures where they can be segregated and driven to corrals. Similar methods have proved to be inefficient for corralling elk, deer, and moose in the forest habitat found at Elk Island. It has been necessary to harvest those species by shooting with rifles. Ordinary sporting considerations (aside from making quick, clean kills) have no place in culling. Johnstone (1971) reported that African ungulates are most efficiently killed by the use of a spotlight on dark nights. Survivors did not appear to associate the shooting with man, remaining tamer than animals subjected to normal day-time hunting. Baiting with salt or supplementary rations might also be employed to increase harvesting efficiency. Helicopters have been used effectively at Yellowstone National Park to drive elk herds toward waiting hunters, and in Wood Buffalo National Park to drive bison into corrals. Adaptations of the traditional Indian method of funnelling animals into "pounds" or corrals with a "v" of wing fences might be employed, as might whale nets strung between trees to entangle driven animals.

In cattle ranching operations, the segment of the population "harvested" each year consists mainly of the young of the year and a few superannuated breeders. In cervids, an over-winter loss of young animals has been noted—10 to 25% in Newfoundland moose, according to Pimlott (1959); at least that great a loss of elk in Alberta may be inferred from Flook (1970). It would therefore increase the yield of meat if calves were heavily culled each year. A heavy mortality of 2-year old male elk was also documented by Flook (1970), emphasizing the need for careful control of herd structure, as well as total numbers, in any ungulate ranching program.

Both elk and moose are more vulnerable to hunting as calves and yearlings than when older (Pimlott, 1959; Flook, 1970). While interspecific vulnerability is governed to some extent by relative numbers of animals present, experience at Elk Island suggests that moose are more vulnerable to hunting than elk. The designated number of moose at each slaughter is usually obtained first, while a concerted effort is required to obtain the quota of elk.

During the 1973 herd reduction at Elk Island, costs of harvesting animals, moving carcasses to the abattoir, skinning, dressing and hanging the meat were about 10 cents/lb of live weight, or 22 cents/lb on the weight of the four quarters. During 1971 and 1972, organized caribou hunting in the Northwest Territories provided meat at an average cost of nine cents/lb.

Multiple Use Possibilities

Game ranching has excellent potential for integration into schemes for multiple land use. The proportion of Elk Island National Park in dense mature aspen types is approximately three times the area in shrub stands (there are also many areas of wet meadows, some areas of upland grassland, and extensive water bodies). If such an area were managed for the production of aspen wood fiber on a 40-year rotation, about 25% of the area would be stands younger than 10 years. In aspen forests, complete overstory removal will produce dense stands of 35,000 to 60,000 suckers per acre. Because only 1,000 to 6,000 suckers per acre are needed for full stocking (Graham et al., 1963; Sorensen, 1968), a large supply of good quality browse is available for use by ungulates. In the Lake States, clear cutting of aspen forest may provide 100 to 150 deer-days of forage/acre (Westell, 1954). Moreover, Dietz et al. (1962) reported the crude protein content of aspen sprouts averaged 20% on the Cache La Poudre range, Colorado. Tew (1970) also reported crude protein values as high as 20%, although his mean values were substantially lower.

Considering the tremendous sprouting capacity of the species of the genus *Populus,* it appears that heavy browsing on coppice regeneration is unlikely to cause serious retardation of the next crop over the larger proportion of the forest area, although some "sacrifice" areas would have to be accepted. It therefore seems entirely possible that intensive production of aspen fiber could be combined harmoniously with game ranching.

Other multiple uses could include the viewing of wildlife, including the animals being ranched, as well as general outdoor recreation. Elk Island National Park supports heavy public use by nature lovers, picnickers, canoeists, boaters, and general day visitors during the summer. In winter, cross-country skiing and snowshoeing are popular. There have been few instances of adverse interactions between people and the large ungulates in the park, although people have been chased by bison when they approached too closely or suddenly annoyed the animals. In addition, people on horseback have been charged by moose during the rut. Even so, it appears that intensive game ranching is quite compatible with intensive recreational use.

In Africa considerable revenue is derived on game ranches by the outfitting of sport hunters, who harvest the better trophy animals from the ungulates on the ranch, with the meat also being sold (Johnstone, 1971). In South Dakota the Oglala Sioux Indians are producing native game for recreational fee hunting, charging the following rates for trophy male animals: elk, $1,200; bison, $1,200; deer, $375; and for one pronghorn and one deer, $550 (Cole, 1974). Hunter demand at those prices exceeds the supply of harvestable animals. The native game animals produced for fee hunting returned as much profit to the Indians as would domestic livestock.

Game ranching combined with aspen production on suitable areas would result in a natural landscape pleasing to the eye. Blocks of aspen cut at any one time should be kept relatively small in order to provide patches of food near patches of cover; thus permitting maximum utilization of the forage. The habitat thus created would have an excellent interspersion of cover types and would provide suitable habitat for a large variety of bird and small mammal species. Any excess damage to aspen regeneration caused by browsing could be offset by increasing the size of clear-felled areas to as much as 100 acres.

There is one nongame species that should receive consideration as a meat producer within the aspen zone. Feral horses survive and increase in numbers and appear well adapted to our severe winter conditions. Horse herding for meat has been developed in the steppe, semidesert and far northern regions of Russia (Andreyev and Konnikov, 1970). They reported that horses require little feeding or care and can be raised where cattle would be uneconomical.

Productive Potential of the Boreal Aspen Forests

The projected carrying capacity for Elk Island National Park (Table 2) is relatively high, even when compared to such famous big game areas as East Africa and the more southerly parts of the Great Plains of the United States (Table 3). The proposed biomass of 5708 kg/km^2 is high in the range of values quoted by Petrides (1956) and de Vos (1969).

While herd reductions at Elk Island over the years were not intended to produce maximum amounts of meat, the results are an indication of possible yields from the boreal aspen forests. Flook (1970) reported that between 1947 and 1966 slaughters removed 2,462 elk for an annual mean of 68,160 lb live weight, using mean weights from Table 2, or 1,588 lb/square mile of usable range (more than the suggested yield in Table 2). Between 1959 and 1973, 1,180 moose were removed from the Park (Blood, 1973) for a mean annual harvest of 56,134 lb (live weight), or 892 lb/mile^2. In 1973, weight of the four quarters of cervids when dressed was 0.423 of live weight. Using this value, past annual yields of meat per mile^2 were 672 lb of elk and 377 lb of moose. Those large yields were obtained during an intensive reduction program aimed at preventing serious range deterioration and should not be considered sustainable without further information.

The southern boundary of Elk Island National Park is contiguous with the Blackfoot Grazing Association lease.

Table 4. Herbivore numbers and animal unit month (AUM) equivalents at Elk Island National Park and on the Blackfoot grazing lease in 1966, per square mile on a 12 month basis.

Species	Animal unit equivalents[1]	Elk Island No. animals	Elk Island AUM's	Blackfoot No. animals	Blackfoot AUM's
Elk	0.75	4.56	41.07	1.30	11.70
Moose	0.75	7.89	70.97	3.18	28.62
Deer	0.20	2.31	5.53	1.67	4.00
Bison	1.00	9.38	83.96[2]	–	–
Cattle and horses	1.00	–	–	10.5	126.00
Totals			201.53		170.32

[1] Stoddart and Smith, 1955.
[2] Reduced to allow for supplemental hay and green feed given to bison.

Fig. 6. *Moose browsing and cratering for herbage by bison occur side by side at Elk Island National Park, Alberta.*

Fig. 7. *Grasslands, and wet meadows form excellent range for bison in the boreal mixedwood forest.*

Cover type and range conditions of the two areas are similar, allowing comparisons of the animal unit months (AUMs) of grazing per mile. At Elk Island National Park in 1966, an estimated 14,475 AUMs were removed from the 62.9 miles^2 of usable range for an average of 202 AUMs/mile^2 (Table 4).

Approximately 510.5 tons of hay and 28.5 tons of greenfeed were fed to bison at Elk Island during 1966, the equivalent of 1,800 AUMs or 28.6 AUMs/mile^2. In contrast, the cattle lease of the Blackfoot Grazing Association had a stocking rate of 4,821 AUMs on 38.4 miles^2 in 1966, or 126 AUMs/mile^2. The area was grazed from 4 to 6 months by 437 cows, 837 yearlings, and 20 horses. The average stocking rate over a 21-year period from 1948 through 1968 was 134 AUMs/mile^2. The Blackfoot Grazing Association lease was also utilized by 3.18 moose, 1.30 elk, and 1.67 deer/mile^2 during 1966. That was equivalent to approximately 44 AUMs/mile^2. After correction for supplemental feeding, Elk Island National Park supported roughly 45% more grazing by wild herbivores than the Blackfoot Grazing Association lease did cattle, and 18% more than for the cattle and wild herbivores in combination on the latter. In the light of subsequent studies it appears that the 1966 stocking of bison on the Park was low (Table 2) and the absence of winter feeding might not have caused serious mortality (Canadian Wildlife Service, unpublished data).

The higher carrying capacity for wild herbivores derives from their complementary forage preferences (Fig. 6). Elk utilize browse and grasses, particularly from upland sites; moose utilize browse and aquatics; bison prefer grasses and sedges (Fig. 7); and deer primarily use browse and forbs, although they may feed heavily on grasses and sedges during winters with moderate snow depths. Domestic livestock use several species of grasses and some forbs. Thus, the five wild herbivores make a much more complete use of the available forage resource.

Table 5. Protein, fat, and caloric content per 100-g sample of caribou and moose compared with standard and prime grade beef (from Anonymous, 1972).

Kind of meat	Protein	Fat	Calories
Fresh caribou	27.22	4.7	120
Fresh moose	25.01	0.9	123
Standard grade beef	29.4	15.8	225
Prime grade beef	13.6	41.0	428

Social Considerations

Game ranching in western Canada could be beset with legal and administrative problems (de Vos, 1967). Perhaps foremost among those problems would be changing the game laws to allow the sale of wild ungulate meat from ranches. At present, such sale is forbidden, except for bison meat, which can be sold throughout Canada. Only in the Northwest Territories is the sale of the meat of other big game species legal. Health of animals regulations, abattoir and storage facilities, and government inspection and grading of meat may prove prohibitively expensive unless regulations can be modified. Such legislative changes would be possible only after research to establish that public health would not thereby be threatened.

Social attitudes towards the consumption of big game meat are not always positive. However, with the strong European influence in Canada, many people traditionally use and prefer game meat, as do most Canadian big game hunters. A sizeable market probably exists for game meat if prices can be made comparable to those of other red meats. In addition, with proper promotion a certain amount of such meat could be sold in the luxury market at premium prices.

Meat from game ranching operations should prove to be attractive to people on low calorie or low cholesterol diets. Table 5 compares the protein, fat, and caloric content of caribou and moose with standard and prime grade beef. Protein content of caribou and moose compares favorably with standard grade beef, but caloric content is considerably reduced. Prime grade beef provides only half the protein content of caribou and moose and more than three times as many calories, mostly in the form of fats.

Big game hunters and sportsmen's associations, unless well informed of the goals and objectives of game ranching, may object to such operations, as may cattlemen. As a consequence any proposal for the systematic and widespread introduction of game ranching should be part of a much broader land use program under which provision also would be made for wildlife management areas for public recreational hunting, wilderness preservation, and for other categories of recreational opportunities. The social and economic relationships necessary to integrate game ranching with other compatible land uses, and the spatial relationships implied, should be explored with the help of rural sociologists, geographers, and the general public. If initial pilot projects, public and private, showed promise a wider program could be initiated as part of a broad scheme to reorient our approach to the exploitation of the Canadian boreal forest. Such a reorientation must, however, provide an arrangement that is satisfactory to the widest spectrum of user groups.

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