ELEMENTS OF CONTROVERSY CONCERNING RESOURCE EXPLOITATION ON THE WELFARE OF NATIVE NORTH AMERICAN UNGULATE POPULATIONS

by

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Edmonton, Alberta

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INTRODUCTION

Controversies concerning the effects of resource exploitation on North American ungulates have raged "hot and heavy" for several generations. David Thoreau sounded the warning in the 1800's but the public did not really heed the advice of conservationists until the passenger pigeon and bison were eradicated and statesmen such as Theodore Roosevelt and Gifford Pinchot demanded protection of remnant ungulate populations during the first decade of the 1900's.

At first it seemed there was no end to big game populations and for over 300 years rural Americans fed themselves with their guns. Often ungulate populations were enhanced as homestead clearings opened up portions of the great forests permitting the growth of desirable grasses, forbs and shrubs. The meat was not only abundant but free and held in trust for the people by the Crown. Settlers did not waste the game but used what was needed to feed and clothe their families.

However, as roads improved, cities grew and railways pushed westward, wild game became a cash crop. During the last half of the 19th Century we developed the markets, the railroads, the manpower and the guns to really exploit game supplies. The eradication of the millions of bison by hunting was the most spectacular and by 1887 they were gone except for a handful saved, ironically, by a Mexican. "In 1887, the year the bison vanished, there were no white-tailed deer left in Pennsylvania; by 1900 there were only 500,000 deer left in all the United States of the incalculable millions that had once existed .... Elk had dwindled from about ten million animals and a coast-to-coast distribution to some 50,000 wapiti that clung to a few pockets of wilderness in seven western states .... In the following year, 1908, there were less than 25,000 pronghorn antelope in North America .... Between 1885 and 1910, our original big game supplies had faded by more than 80 percent." (Madson and Kozicky, 1971)

The history of exploitation by year-long, indiscriminate hunting for food, sale and sport is well known and I will not belabour the matter further in this discussion. Rather, I choose to examine the controversy and impact of seven current forms of resource exploitation on native ungulates which are of paramount importance today and which must be adequately understood if wise multiple-use decisions are to be made in the future. The land-use developments which I will discuss are as follows:

1. Forest Logging Practices
2. Livestock Grazing
3. Roads and Railways
4. Mining
5. Dams and Diversions
6. Arctic and Sub-Arctic Resources Development
7. Military Training

Each of these activities is having a pronounced influence on the abundance, distribution and well-being of native ungulates throughout North America. In many cases they threaten the very existence of populations over large tracts of their range. Modern technology, the trend to unilateral or single-use land management, and the tremendous increase in rate of resource exploitation, create a demand for an immediate and thorough knowledge of the impact of resources exploitation on ungulates, if catastrophies to this important segment of our faunal biomass are to be prevented.

Although a harmonious multiple-use management plan can be achieved among renewable, non-renewable, and native ungulate interests, it is not being practiced in North America today except for a few token lip-service attempts. A new land-ethic approach must be developed by politicians and land managers if true multiple-use philosophies are to be implemented. The following synthesis of current knowledge on resource exploitation effects of native ungulates and the associated controversies could lead to a better understanding of present dilemmas.

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RESOURCE EXPLOITATION AND ITS EFFECTS ON NORTH AMERICAN UNGULATES

Preamble

Major changes in land-use practices and philosophies have occurred in recent times, especially since 1945. In the 1950's notable changes in forest, farm, range, and fire management practices brought about apparent responses in floral-faunal ecosystems throughout the United States and Canada. Intensive land management practices replaced earlier poor silviculture, farming, and range practices. Shrubfields and fencecrows in farming areas, as well as deciduous shrub and tree cover on foothill and mountain rangelands began to disappear. Livestock grazing of foothill and mountain ranges increased. Pulpmills with their extensive clearcut logging practices became more plentiful, with less emphasis placed on saw timber harvested by selective or small patch-cut logging operations. Hunter access via roads and trails increased tremendously.

The result during the past two decades has generally been an increase in white-tailed deer and, in some areas, moose, but a decrease in elk and mule deer. Associated with this change has been a pronounced forest successional trend to mature pine, spruce, or poplar forests due to fire suppression, as aptly described for northern Idaho by Trout and Leege (1971). As the valuable big game grasslands and shrublands shrank in size and a corresponding increase in livestock grazing pressure and hunting activity adjacent to these parks occurs, there has been a definite crowding of wild ungulates onto the remaining critical grass-shrub ranges. Elk, mule and white-tailed deer have become more abundant on sub-alpine and alpine ranges and several conflicts with bighorn sheep are evidenced. Since 1960, elk have invaded alpine-tundra ranges in Alberta and British Columbia to the apparent detriment of mountain caribou herds. A major concern, especially since 1945, has been the sale of critical winter ranges of big game to private enterprise for farming, industrial or commercial purposes. Homes, orchads and noisy recreational activity (particularly by motorcycle and powertoboggans) are making vast deer, elk and moose winter ranges uninhabitable to these game species. To counteract these deleterious trends, government and private conservation groups are purchasing and reserving winter ranges for wild ungulate purposes, restricting access and vehicular use and transplanting ungulates to suitable but unpopulated ranges. Unfortunately this defensive action is progressing at a much slower rate than the depletion of ungulate ranges. Major controversies occur between conservation agencies and groups primarily concerned with the future well-being of native ungulates, and the government-private enterprise segment whose major concerns are for immediate human needs rather than for wildlife.

1. LOGGING, FIRES AND OTHER FOREST MANAGEMENT PRACTICES

It is agreed that forest management practices influence ungulate numbers, however the results are viewed as a mixed blessing by wildlife biologists. Tremendous increases in forage production during the first 10 to 20 years following logging are impressive and lead wildlife managers to be optimistic and to anticipate significant increases in ungulate numbers. In addition, winter logging operations in hardwood forests have provided additional forage on critical winter ranges. Logging activities have increased hunter access thus enabling more effective harvests of surplus animals.

Dense forests make poor deer habitat. Mature coniferous forests on the West Coast often support no more than two deer per square mile (Dasmann, 1959). This is true of dense stands of timber elsewhere and also applies to elk and moose populations. The low ungulate density and inferior productivity results from the monopoly of sunlight and soil nutrients by the established trees which permits only a small amount of low-nutrition herbaceous and shrubby forage production. The value of timberland for deer, moose, and elk is proportional to the degree that it is broken and interspersed with openings which support low growing, palatable shrubs, grasses and forbs.

The basic need for native ungulates is suitable habitat which varies with the species according to their food preferences and cover needs. What is done to land and its cover largely determines how much wildlife can be produced and maintained.

Recent studies have shown that logging is not always beneficial and many cases of population declines, especially where extensive clearcut logging has been employed on elk ranges. The recent concern over the effects of logging is most apparent in the Temperate Region where adequate shelter may be as critical to ungulate survival as adequate forage. However, biologists and foresters agree that a paucity of knowledge exists on ungulate behaviour and seasonal habitat requirements associated with various logging and postlogging practices.

a. Changes in Forage Production and Ungulate Numbers -

Studies in eastern Canada (Telfer, 1970), in western Alberta (Stelfox, 1962), in coastal stands of Douglas-fir (Lawrence, 1969), in Montana (Lewis, 1967 & Lyon, 1969), Idaho (Pengelly, 1961 and Hungerford, 1969) and others have shown that forage production increases rapidly following the logging of forests with most regenerating stands reaching their peak in forage production between 10 and 20 years following logging. It has been shown that on a ponderosa pine site in Washington that the critical canopy density was between 10 and 55 percent (Eddleman, 1969). Up to a 10 percent canopy, herbage production was comparable to that on open grasslands. Where the canopy exceeded 50 percent density, herbage production was so light that it contributed little as a forage supply. When the ponderosa pine canopy exceeded 45 percent, forbs produced more dry matter than grasses, whereas below 45 percent canopy, grasses were the superior producers. Major factors affecting herbage production (in addition to canopy) were reported to be soil depth and texture, effective moisture, shrub density, basal area, age and size class of the tree cover, and the abundance of desirable perennial grasses (Eddleman, 1969).

Similarly, a number of studies have shown that the old logging practices (selective, small patch-cuts) have been associated with marked increases in white-tailed and mule deer, moose and elk.

A study of Roosevelt elk-forest relationships in the Douglas-fir region of the southern Oregon Coast Range, showed that the greatest elk use in clear-cuts occurred five to nine years after logging (Swanson, 1970). Burning and heavy soil disturbance delayed brush development and prolonged the optimum period for elk. The tractor-logged settings were preferred by elk over the high-head settings because of easier travel along skid trails on gentle terrain.

Following extensive patch-logging and slash-burning in Douglas-fir stands on Vancouver Island, British Columbia, deer numbers increased dramatically in response to increased production and quality of food from as low as 5 per square mile to as high as 150 per square mile in a few years (Blood and Smith, 1969). However within another 20 years they are expected to be back to the former level due to regrowth of forest cover.

In southwestern Oregon, it was found that following the logging of Douglas-fir stands, elk grazing on cutover areas was light the year after timber removal, peaked from six to eight years after logging, and became light within 11 to 12 years. However, soil disturbance during logging and slash burning after logging extended forage production and elk grazing (Harper, 1969).

One study, in the Douglas-fir - ninebark forest in Idaho showed that the shrub component of the vegetation increased for 15 years after logging and then decreased as follows: unlogged - 22 percent, 11 years post logging - 81 percent, 15 years - over 100 percent, 20 years - 80 percent, 35-40 years - 55 percent, 45 years - 40 to 45 percent, and 50 years - 35 percent (Pengelly 1961). The study showed that preferred forage species were in greatest abundance about 15 years after logging, but were still more abundant than in the unlogged forest up to 30-40 years after logging. A study in the Douglas-fir - pinegrass and the spruce - fir forests in western Montana revealed an increase in production of pinegrass (Calamagrostis rubescens) and elk sedge (Carex geyeri) following clearcutting. Both plants species provide important summer forage for mule and white-tailed deer as well as elk (Lewis, 1967).

Both Lawrence (1969) and Lyon (1969) have correlated forest carrying capacities for deer with forest succession periods following logging and burning. Lawrence (1969) developed a carrying capacity model for black-tailed deer in coastal stands of Douglas-fir. In his model, carrying capacity varied from four deer per square mile in an old growth forest to 70-100 deer per square mile for cutover lands some 15 to 20 years after logging. After reaching that peak, the capacity declined rapidly to fewer than 10 deer per square mile for the balance of the rotation. Shortening the forest rotation period from 80 to 40 years supposedly doubles the forest carrying capacity for deer. In the 80 year rotation, the capacity of less than 10 deer per square mile lasts for about two-thirds of the rotation, compared to less than one-half of the rotation in the 40 year rotation. Thus the productive period with 10 deer or more per square mile, increases from 25 percent of the 80-year rotation to somewhat over 50 percent of the 40-year rotation. By shortening the rotation, the sustained yield of deer increased from one deer per 42 acres over an 80-year rotation, to one deer per 21 acres over a 40-year rotation. Figures 1 and 2 from Lawrence (1969) show the expected carrying capacities from the two logging rotations.

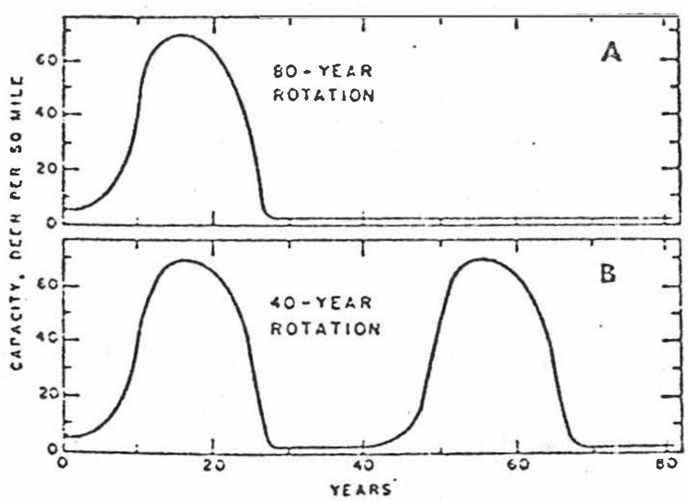

Figure 1. Carrying capacity for black-tailed deer for the coastal Douglas-fir forest type between harvests.

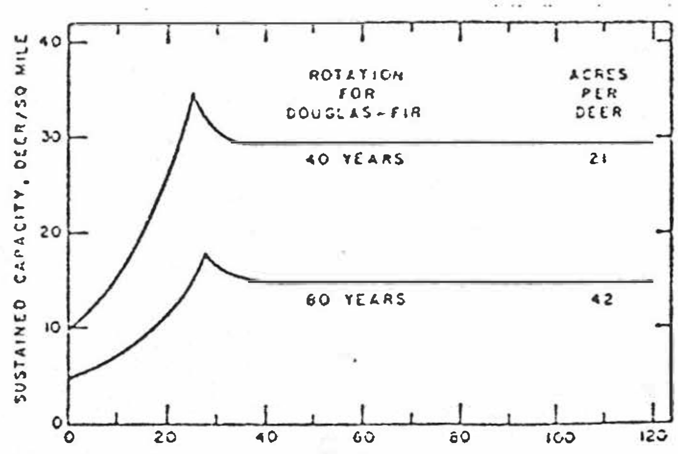

Figure 2. The sustained carrying capacity for black-tailed deer of a Douglas-fir forest compared for an 80-year and a 40-year rotation, under the assumption that twice as many acres are harvested in the 40-year plan as in the 80-year plan.

There is a similarity in the above model which shows the period of greatest deer abundance being 15 to 20 years following logging, and Figure 3 from Lyon (1969) which shows that following a fire, deer numbers increase and peak at about 15 to 20 years, then decline to the lowest level some 50 to 75 years after the fire as the amount of available shrubs, forbs and grasses wanes.

Conversely, woodland caribou are more abundant in old coniferous forests (Cringan, 1956). Fires, logging, and human contact have been the principal factors causing declines and/or the disappearance of woodland and mountain caribou (Evans, 1960).

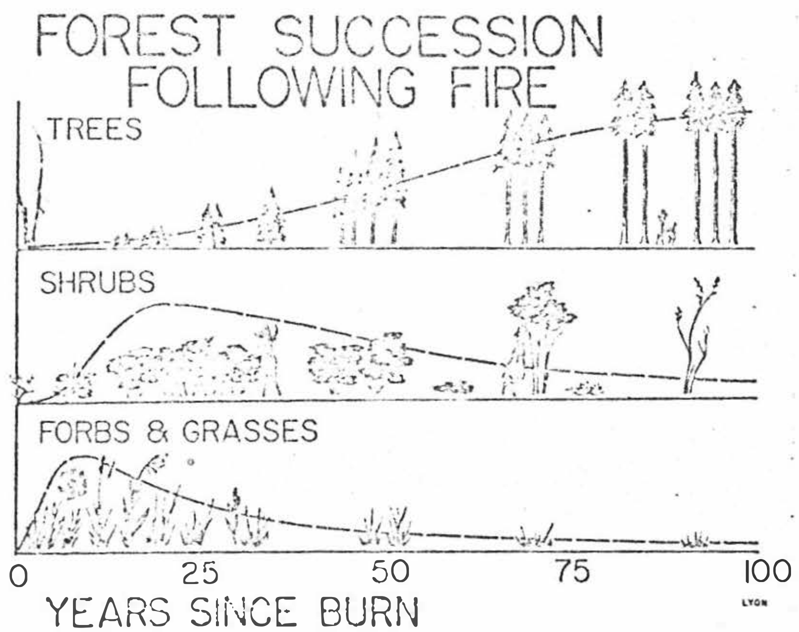

FIG. 1. Hypothetical model of forest succession following fire.

Figure 3. Hypothetical model of forest succession following fire. From Lyon (1969).

Hungerford (1969) pointed out that a "boom and bust" economy of a deer population results when large areas of commercial timberland are clearcut within a short time, or following large burns. The supply of food for browsing usually peaks about 8 to 15 years after an area is clearcut, and is correlated with an increase in deer populations coinciding with the increase in food supply. He recommended that these boom and bust deer fluctuations could be modified, or stabilized, by clearcutting in blocks so that the browse food production is stabilized, with different clearcuttings coming into peak production at different times. He emphasized the need for close cooperation between the forester and the biologist in determing when and where clearcutting will be done, especially in areas such as northern Idaho where there is only one acre of winter range for each 50 acres of summer range. Studies in northern Idaho by Hungerford and associates showed that when the forest management practice of thinning polesize stands of Douglas-fir is employed, that 25 to 30 percent of the basal area should be removed to create a significant response of various kinds of forage species for white-tailed deer and ruffed grouse.

Ungulate populations do not always increase following logging as evidenced on Vancouver Island with regard to Roosevelt elk populations. Regional Wildlife Biologist I.D. Smith (Nanaimo, B.C.) reported that elk have not noticeably boomed following logging, even in early times (personal comm.). He believes that historically there was a good balance between summer and winter range on the Island, and that both habitat types would have to be increased to have increased the elk population. The elk appear to be much more specific than deer in their habitat requirements on Vancouver Island, requiring bog habitat and/or seepage sites, generally with good patches of salmonberry (*Rubus spectabilis*) which appears to be their preferred food. Although logging probably increased summer range, winter range could not be increased over the historical situation since it consisted of tall trees in valley bottoms and all inhabitable valley bottoms were occupied by the time logging began, according to Smith. Logging was therefore detrimental as it removed valley bottom range. In some areas elk populations dropped following logging, in others they did not; but in no instance did the population increase.

Smith's opinion was that logging initially aided the deer, but that over-logging caused their decline. If the initial logging had followed different patterns (i.e. patch-logging rather than clear-cutting) he surmised that the original deer boom would have been higher, and perhaps more sustained. This biologist thought that mountain goats are limited by summer range as are deer on Vancouver Island and that logging could increase their summer range. He had witnessed mountain goats using the slash areas at low elevations in Knight Inlet in late summer. Being vulnerable to hunting, like the elk, he thought the goats would never increase rapidly following logging although some increases could be expected if they were given protection. He expected them to crash dramatically if their winter range was completely logged.

b. Changes in Cover, Shelter, and Snowpack Conditions -

Recently biologists have recognized that an adequate supply of forage for ungulates is not enough and that cover and shelter requirements may in many instances be of more importance. This is especially true as harassment from machines, forest workers and hunters becomes excessive, and winter weather conditions are severe. This realization has sparked a major controversy that large clearcut areas become devoid of big game life because shelter-cover requirements are inadequate though an abundance of forage exists. Similarly many biologists contend that adequate winter shelter in the form of mature coniferous forest blocks is paramount to the survival of deer, elk, and moose.

Studies in Maine (Gill, 1957), in northern Idaho (Hungerford, 1969), and eastern Canada (Telfer, 1970) have shown that the critical winter ranges are those with the shallowest and least crusted snow conditions and where wind-chill factors are lowest. These conditions are associated with dense, coniferous cover.

Studies in Pennsylvania showed that whitetails require good cover on winter range. Whitetails increase in weight when supplied average to good quality food when the temperature remains above 40°F, but they lose weight rapidly no matter how nutritious the forage at temperatures below 30°F. During periods of intense cold or heat, when snow depths mount, or predators and hunters increase, then the deer's need for cover increase. During periods of cold, especially when accompanied by high winds, deer seek shelter in coniferous or other heavy cover, usually on the leeward side of ridges (Dasmann, 1971).

In northern Maine, whitetails select nearly pure stands of mature conifers with all but closed canopies as winter yarding areas. The amount of forage on adjacent areas determines the number of deer the yard will support. A pattern of narrow strips of mature pine, spruce, or other conifers separated by lanes of open bushy cover about 100 yards wide approaches the ideal winter range for deer. Several paper and lumber companies in northern New England arrange their cutting operations to leave uncut strips of heavy coniferous cover along stream courses and lake shores to provide necessary cover for deer (Dasmann, 1971).

Telfer (1970) pointed out that despite the increase in big game browse following logging, often there was inadequate cover left for deer. Figure 1 from his article correlates moose and deer distribution with snow depths in eastern Canada.

In zones A and B (snow depths up to 20 inches) of Figure 1, Telfer reported that the diversity of forest types and the lower probability of confining snow covers reduced the harm caused by logging but local deer populations could be seriously affected. In zones C, D, and E (20 to 30 inch snow depths), cover removal could cause drastic reductions in deer populations. These are zones of severe snow conditions which lie in a boreal forest region where extensive stands of softwoods were being logged for pulp on a large clear-cut basis. In all zones except zone F and some of zone E, logging left sufficient cover for moose. Telfer (op. cit) pointed out the importance of delineating and giving special attention to critical winter range for deer,

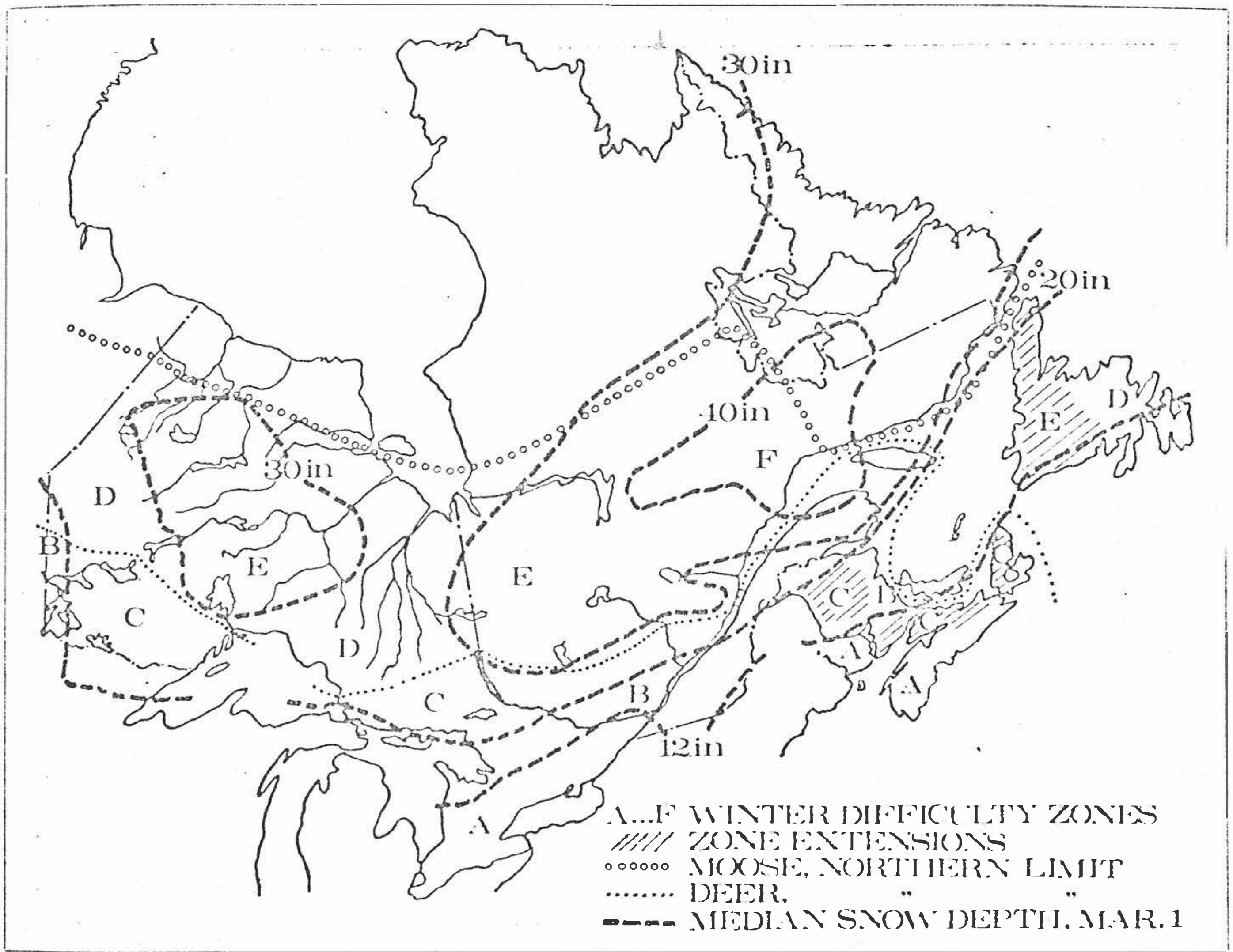

FIG. 1. Median snow-cover depths in eastern Canada at the end of February are superimposed on map of moose and white-tailed deer ranges. The letters indicate approximate zones of winter survival difficulty for moose and deer. Zone A. Deer and some moose; in most winters neither concentrate. Zone B. Deer and moose. Deer have to concentrate in half the winters and are often confined. Moose sometimes concentrate. Zone C: Deer and moose. Deer concentrate in most winters and are confined in half the winters. Moose are occasionally concentrated and confined. Zone D: Moose, and deer are scarce or absent. Moose concentrate in some winters. Zone E: Moose only (except in Gaspe and Anticosti). They concentrated in more than half the winters, and are often confined. Zone F: Moose only. They are confined in more than half the winters.

as their winter range in eastern Canada comprised only 5 to 15 percent of the forest land.

Drifting and compaction resulting from wind action in the large clear-cuts made it generally more difficult for reindeer to feed in these areas in undisturbed forests (Klein, 1971).

c. Changes in Access, Behaviour, and Harassment -

Although it was originally supposed that logging would be beneficial in providing hunter access thus permitting hunters to crop excess animals, it is now realized that the degree of access associated with modern clearcut methods becomes excessive and big game populations, especially elk, often decline.

Elk and deer populations in the Schwartz Creek - Iris Point area in Montana were reduced to a point of scarcity because of increased hunter access and visibility due to logging (Janson, 1970).

In discussing elk-logging relationships in the northern Rocky Mountains, Allen (1971) reported that logging can affect elk in two basic ways - " ... the physical and vegetal changing of elk habitat; and, increased access and associated human disturbances resulting from logging road systems ... The overall elk-logging relationship is one of degree and is complicated by such factors as pattern of cutting units, rotation periods and checkerboard ownership". Allen indicated that a certain amount of access was desirable and necessary to maintain elk harvests at a level compatible with management goals, but that for each locality at a particular point in time, there was an optimum level of road access. He stated that in some areas of Montana, Oregon and Wyoming there were strong indications of shifts in elk harvest and distribution due to increased access following logging operations.

Regional Wildlife Biologist I.D. Smith (Nanaimo, B.C.) pointed out that the major complicating factor concerning elk declines following logging on

Vancouver Island was the effect of hunting which accompanies logging. Where elk populations disappeared following logging (a rare event), the decline generally occurred in conjunction with hunting. He knew of only one area in which hunting was not believed to have been a factor in an elk population decline on the Island. Even where elk declines did not occur, he thought it possible that hunting prevented the population from making similar gains in density and range expansion noticed in deer populations.

The Chesnimnus elk herd in Oregon was reported to have declined appreciably from 1962 to 1968 (Bartels and Denney, 1969). The authors concluded - "Timber management practices such as logging, road construction, and thinning, are believed to be adversely affecting elk habitat through loss of escape cover and areas where elk can obtain seclusion from human harassment". They recommended that key winter ranges should be left roadless or else use of the roads be prohibited during the winter. Certain timbered fingers which provide necessary escape for elk should be left unlogged, and where mature trees are removed, the damage to associated plant species should be minimized. Thinning of lodgepole pine should be designed to leave scattered patches of unthinned trees to provide cover corridors for wildlife.

d. Effects of Various Forest Cutting Methods -

In considering the effects of various cutting methods on deer populations and use in California, Biswell (1961) stated that deer like to feed in areas that are partially open, and will spend more time feeding where shrubs are separate or at the edge of a patch than where the plants are growing densely. Browse within the dense thickets that often develop after clearcutting tends to be unaccessible and therefore of little benefit to deer, no matter how abundant or palatable it may be.

A study of elk relationships to block clearcutting of lodgepole pine in the Little Belt Mountains of Montana in 1960 and 1961 showed that those clearcuts associated with mesic drainage heads on north slopes, received the greatest use by elk (Kirsch, 1962). In this study the cuts varied in size from 5 to 55 acres, but 74 percent of all groups of elk observed were using cuts in the 15.2 to 25.2 acre size class. Similarly, those block cuts that were seven and eight years old received 57 percent of the total spring, summer and fall usage, although they comprised only 22 percent of the total cut. Elk numbers in clearcuts reached a peak in July, dropped to a minimum in late August and rose again in September. Although the elk used the more mesic sites, deer tended to use the xeric clearcuts of the north and south slopes. The study showed a great increase in forbs and grasses in the clearcut compared to uncut areas, but a sharp decrease in low red huckleberry (Vaccinium scoparium), thin leaf huckleberry (V. membranaceum) and twin flower (Linneae borealis).

The controversy over the clearcut crisis in the Bitterroots of Montana culminated in several articles and publications discussing the effects of clearcut logging on the environment. The task force assigned to appraise the Forest Service's management in the Bitterroot National Forest concluded (Burk, 1970 p. 141). "The hard fact is that the net effect of clearcutting on wildlife numbers in the Bitterroot Valley is not known." The task force was unable to conclude whether big game populations had increased or decreased because of clearcutting in the Bitterroot. It could find no studies that indicate clearcutting by itself has any adverse effect on either elk or deer, but did conclude that the amount of forage for big game and livestock had certainly increased. The force advised that much more information is needed concerning the relation of elk to other resource management activities.

Probably the statement that epitomizes the recent dilemma over the deleterious effects of clearcutting in the Bitterroot on wildlife was stated by Bolle et al. (1970, p. 13) - "Quality timber management and harvest practices are missing. Consideration of recreation, watershed, wildlife, and grazing appear as afterthoughts."

An evaluation of the effects of forestry operations on white-tailed deer populations in the province of Quebec (Pimlott et al., 1968) showed that at that latitude, intensive removal of coniferous cover renders otherwise suitable habitat uninhabitable by deer during the winter. The article pointed out, p. 24 - "There are now more and more instances where forestry operations eliminate rather than improve the winter habitat of deer." In reviewing the sequence of events in areas bordering Quebec, the article compared early and recent logging operations, p.24 - "Early operations frequently removed only the larger pine and spruce for saw timber. They did not remove a number of coniferous species such as balsam fir, hemlock and cedar. The openings created by the removal of the larger trees promoted the growth of shrubs such as mountain maple and many deciduous tree species such as yellow birch which are good deer foods. In addition there were many openings created by logging roads, by construction of logging camps, by farms, which were later abandoned, and by fires. In many areas the result was ideal for deer (Severinghaus and Brown, 1956; Seigler, 1951). The early sequence of events appears to have been very similar in parts of eastern Ontario. In many areas the emphasis has changed from a saw-timber to a pulpwood economy and from small forestry operations to large, often highly mechanised operations. In more and more instances these are resulting in the clearcutting of large areas and many of these are uninhabitable by deer in winter. In Ontario, at least, there is also an increasing tendency to cut species which previously were unmerchantable. Hemlock, which is an important deer food in some areas, provides some of the best winter cover for deer. It is one of the most effective trees in reducing the depth of snow on the ground. In one part of the Parry Sound Forest District of Ontario, during the past decade, a very large deer yard was eliminated when the hemlock was cut." The article pointed out places in northern Quebec where forestry operations had diametrically different effects on the deer range and the deer population. In the deer yards east of the Baskatong Reservoir large areas were clearcut and now unsuitable for deer in the winter. In the Thirty-one mile Lake area, the logging operation was small and progressed slowly across the area, using a method selective both to species and diameter size. Hemlock and cedar were generally not cut and clumps of small spruce and balsam fir were often left. The winter yard was improved by the forestry operation. Pimlott et al. (1968) stated (p. 26) that selective logging of softwood and fir may have considerably reduced the distribution of coniferous forest stands in parts of Labelle County. The predominance of tolerant deciduous forests following logging of coniferous forests was considered to pose a serious barrier to the build up of deer populations following a recent decline.

Both Pengelly (1963) and Lawrence (1969) proposed that shorter logging rotations would benefit deer by producing a continuous supply of new successional growth. Pengelly concluded that early logging activities at low elevations in Douglas-fir zones generally benefitted white-tailed deer in the Northern Rockies by opening up the canopy and producing an abundance of seral shrubs useful as forage. Current (1963) large scale clearcuts at higher elevations in grand fir types were not contributing materially to important deer winter ranges. He advised that small, scattered clearcuts followed by burning may be the best practice for both timber and wildlife production in the Douglas-fir zone. Large block cuts with scattered islands of timber, followed by burning, in grand fir types should provide additional winter ranges for mule deer and elk.

In Maine, a system based on clearcut strips or patches was recommended so that 60 to 80 percent of the area was in an age class of 35 years or older at all times. The strips should be less than 200 feet wide, and Gill (1957) recommended that 100 foot wide strips were ideal for deer in Maine. Verme (1965) suggested that in the Lake States clearcuts should be fairly large (40 to 160 acres) to allow cedar regeneration (a favoured deer food) to escape serious browsing damage. Gill (1957) stated that the forestry practices well suited to deer range improvement in hardwood forests, are short cutting cycles, all-age management in contrast to extensive clearcutting or cutting to low diameter limits.

Dasmann (1971) pointed out that the year-long range of a group of deer may consist of 2,000 acres (3.1 square miles) throughout much of the East. He recommended the maintenance of quality ranges by a series of properly spaced and timed clearcuts; suggesting cutting one-quarter (500 acres) of the area every twenty years to maintain a balance between young and old timber stands.

Both foresters and wildlife managers agree it would be beneficial for the pulpwood industry and for deer to reduce the present 100 year cutting cycle period by one-half. Wildlife specialists recommended that conifer plantings on clearcuts be made in three to five acre blocks separated by open strips of at least 65 feet wide and surrounded by an unplanted perimeter of the same width.

e. Effects of Burning, Spraying, Thinning, and Other Forest Management Practices -

A review of the effects of slash disposal by fire following logging in the Coeur d'Alene Forest in Idaho, showed it to be a useful and inexpensive treatment of mutual benefit to game managers and silviculturists alike (Pengelly, 1966). The practice did not appear to create harmful effects to soil, plant, and animal resources. The game ranges created by slash burning have a productive life span of probably not more than 30 years. This productive period can last considerably longer if proper tree stocking rates are maintained. The value of the big game ranges created by slash fires is severely limited by: (a) inaccessibility due to log jams caused by felling and incomplete burning, (b) poor site selection, such as north slopes at high elevations or extreme distance from game concentrations, (c) cutting in blocks too large for acceptance by animals, especially whitetails, because of insufficient cover and snow accumulation (Pengelly, 1966). Pengelly (1963) pointed out that in Douglas-fir and grand fir regions of western Montana and the northern panhandle of Idaho, p. 739 - "Preliminary studies indicate that removal of slash and other logging debris by broadcast burning rather than bulldozing slash into piles and burning it would foster heavier initial stands of preferred forage. Light, single burns create a very favourable mixture of preferred forage species for white-tailed deer for a period of five to thirty years. Smaller burns are preferred by white-tailed deer but elk and often mule deer will accept almost all the conditions shunned by the white-tailed deer - deeper snows, large open brushfields with patchy cover, steep high slopes, and a wider variety of plants for forage."

Other workers have shown the beneficial effects of wildfires that were commonly associated with early logging activities in the Northern Rockies (Edwards et al, 1956; Lyon, 1969; Stelfox and Taber, 1969, Dills, 1970). The beneficial effects of wildfires in the Northern Rockies on wild ungulates was discussed by Lyon (1969) who stated, p. 214 - "Unusually large fires in 1910 and 1919 created thousands of acres of seral, high quality, brushfield habitat. Deer and elk populations increased in this favourable environment and reached unprecedented highs during the early 1940's. Since that time, normal successional development of forest vegetation has resulted in a variety of problems including deterioration of some ranges under the tree overstory, growth of shrubs beyond reach of big game animals, and damage by overuse of remaining ranges."

The welfare of moose populations are profoundly affected by fires in the boreal forest as shown by Spencer and Hakala (1964) for the Kenai Peninsula of Alaska. Diverse vegetative types developed following the fire, and moose were attracted to the new browse within five years. Maximum browse production occurred about 15 years after the burn with moose forage conditions favourable sometimes up to 60 - 70 years after the burn. However, the duration and volume of browse growth was highly variable with some areas having produced no browse growth following fires. Pengelly (1966) concluded, p.20 - " ... fire is a rough and largely unpredictable tool due to the following variables; time and intensity of burn, homogeneity of burn, kind and availability of fuel and seed source and growing conditions during the first season after the fire."

It is well known that caribou abundance declines as the age of the coniferous forest decreases (Cringan, 1956, Evans, 1960).

Hungerford (1969) surmised that forest thinnings offer one of the best possibilities for solving the problem of fluctuating deer populations. Where the production of browse peaks at 10 to 15 years after logging, thinning at 20 to 25 years would stimulate a secondary peak of deer forage, thus resulting in a good supply of deer forage for 50 to 55 years after logging. He cited the results of thinning stands of western white pine in northern Idaho where the climax is western red cedar and western hemlock. The beneficial effects of this thinning in production of wildlife foods lasted for 30 to 40 years.

A study of herbicide treatment of browse on a big game winter range in northern Idaho (Mueggler, 1966) showed that 2,4-D and 2,45-T chemicals were effective in lowering the live crown and increasing the basal sprouting of browse grown beyond the reach of elk and deer. An application of 3 pounds per acre applied in early or late summer was most effective. Willow sprouted prolifically; rock spirea and maple sprouted moderately; ceanothus and mock orange sprouted poorly. Due to the susceptibility of red stem ceanothus to killing by herbicide application, it was recommended that these chemicals not be used wherever this desirable browse species was abundant.

f. Summary and Conclusions -

In general, it appears that the effect of logging on wild ungulates is basically one of degree. One cut and one road will have little effect, several cuts and access roads in vast tracts of dense mature coniferous forests will likely be beneficial by improving the balance among food-shelter-cover requirements while concurrently affording the opportunity for hunters to harvest surplus populations. Numerous clearcuts and roads which deplete optimum shelter-cover requirements and which induce excessive harassment from humans, vehicles and equipment will generally be detrimental in proportion to the intensity of logging.

As emphasized by Lyon (1966) p. 6, 7 - " ... neither logging nor wildfire is always dependable in producing good wildlife ranges. More often than not the plants that flourish after tree removal are only partially suitable as forage and cover. Clearcut logging, however, does have one vital advantage over wildfire: following logging, it is theoretically possible to control slash disposal on site preparation to favor desirable plants and create high quality game range ... land areas being logged each year could provide habitat for more wildlife than we now have. The missing factor is the combination of knowledge and techniques for managing vegetation so as to produce a superior environment for animals."

As the Montane forest formation of western Canada and northwestern United States has a coniferous climax of species largely unpalatable and out of reach of big game (Cowan, 1952), logging can vastly improve the big game carrying capacity of potential ungulate winter ranges. However, in the northern latitudes and mountainous regions away from the coasts, an interspersion of dense mature coniferous patches with logged areas is required to provide adequate winter shelter for big game species (Stelfox and Taber, 1969, Telfer, 1970).

The effects of logging depend upon the forest cropping system, postlogging treatment, the length and pattern of each cutting cycle, edaphic, physiographic and climatic conditions, as well as the behavioral characteristics and habitat requirements of the ungulate species.

Many authors pointed out the scarcity of information dealing with the effects of logging practices on wild ungulate populations, distributions, winter shelter needs and tolerance, behaviour,,and, to a lesser extent, on forage production and preferences. They recommended more effort on research to provide answers to these logging-ungulate problems.

In summary, then, many authors have suggested that logging has benefitted deer and moose range - Graham (1954), Gill (1957), Pengelly (1961), Stelfox (1962), Crouch (1967), Lyon (1969), Lawrence (1969), Stelfox and Taber (1969), Blood and Smith (1969), Telfer (1970). However, several of these authors, in addition to Reid and Goodrum (1957), Pimlott _et al_. (1968), Bartels and Denney (1969), Swanson (1970), Janson (1970), have shown where excessive logging, improper cutting design or increased hunter access associated with logging have resulted in decreases in wild ungulate populations or their use of logged areas. Authors generally agree that logging and wildfires in coniferous forests are associated with declines in caribou numbers.

Finally, much of the controversy is clouded by the impact which forest succession during the past 50 years has had in converting the extensive pyric-induced grass-shrub lands back into unproductive coniferous forests. The impact of this forest succession must be isolated and evaluated before the controversies of benefits versus deleterious effects of logging on native ungulates can be fully realized.

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2. EFFECTS OF GRAZING BY DOMESTIC LIVESTOCK ON NATIVE UNGULATES

Problems of livestock grazing in mountain and foothill big game ranges are often associated with public land alienation and forest succession, and at times water impoundments. A large portion of livestock-game ranges in the Intermountain Region of northwestern U.S. and Canada are seral shrublands created as a result of extensive logging and wildfires during the late 1800's and early 1900's. In addition, extensive foothill-mountain grasslands were converted to shrub-forb rangelands due to severe overgrazing from livestock during the same period. A classic example is the rangelands of Utah which were so abused by excessive grazing from domestic sheep during the period 1850 to 1910, that shrub vegetation soon predominated and mule deer populations increased markedly. Forest regeneration coupled with other range losses has diminished the extent and quality of seral shrub ranges, while animal concentrations on the remainder and the less extensive native grasslands has produced sharper competition. For wild ungulates this produced a greater stress during the winter when domestic animals were being artificially fed.

The basic grazing management systems are continuous, rotation (or alternate), deferred, deferred-rotation, and rest-rotation. Each of these systems results in variations in wildlife habitat conditions. "The effects of livestock grazing on wildlife may be competitive, beneficial, or neutral, depending upon many variables. Such factors as vegetation types, kinds and combinations of livestock, topography, soils, and availability of water are involved. Competition between livestock and game may be direct where both feed on much the same forage species, as do sheep and deer ... In many cases, however, big game and livestock in moderate numbers do not graze the same areas or the same species" (National Research Council, 1970). Proper grazing rates by livestock at times help to maintain a suitable grass-shrub balance. In eastern Oregon and Washington dual grazing of dry ranges by livestock and deer maintained a desirable level of shrubs, such as bitterbrush (preferred deer browse), which otherwise became depleted from grass competition when livestock grazing was prevented (Eddleman & McLean, 1969). The authors advocated that a sustained yield of big game could be developed, in many cases, by the use of habitat manipulation, forage improvement of depleted ranges, plus integrated use by livestock so as to provide control of animal distribution and time of use. They pointed out that in western Montana cattle will eat browse species intensively, e.g. serviceberry, where forage is limited and after herbaceous plants mature in late summer and early fall; with most species that cattle find palatable being preferred species for deer and elk.

Much of the Northern Great Plains witnessed an increase in sagebrush coverage following years of excessive cattle and horse grazing while moister grassland regions in the foothills and mountains responded to heavy livestock grazing and fire protection, by an increase in aspen, willow, mountain mohogany and other shrubs preferred by deer, elk and moose. Since 1950 there has been an increasing effort by livestock interests to reconvert sagebrush and aspen shrublands to productive grasslands in order to increase livestock grazing units. Such programs will have a deleterious effect on wild ungulates. Antelope herds that were confined to a foothill grassland area lacking in sagebrush near Glasgow, Montana suffered a winter loss of at least 500 pronghorns during the winter of 1964-65. Subsequent fawn production from this herd was only about half that of normal. Antelope near Malta where sagebrush was abundant did not suffer heavy winter losses or a decrease in fawn production during and after this same winter although they were subjected to the same severe winter conditions (Mussehl, 1971). Sagebrush is also one of the three most important mule deer browse species. A Colorado study concluded that removal of large areas of sagebrush on critical deer winter ranges could be the beginning of the end for many deer herds in the West (Mussehl, 1971).

The history of range management in British Columbia has shown an absence of the recognition of wildlife and other recreation based resources. Grazing policies were inherited from a time when wildlife was not an important consideration. This unilateral approach has resulted in commitments to grazing interests, without effective measures to accommodate or retrieve wildlife resource capacities. Conflicts in the use of land for grazing and wildlife will likely increase unless consideration is given to both resources in future land use policies and practices (Demarchi and Smith, 1969). Wild mountain sheep utilize identical ranges as domestic sheep and cattle and also identical plants within these ranges in many areas of southeastern British Columbia. The introduction of large numbers of cattle to East Kootenay ranges resulted in a reduction of available food for bighorn sheep. A reduction in wild sheep numbers was predicted in 1955 by the regional wildlife biologist. The die-off began during the winter of 1964-65 and ended in losses varying from 50 to more than 90 percent of individual herds throughout the East Kootenay Region. The die-off could have been prevented by the exclusion of livestock grazing from critical bighorn sheep winter ranges. The key to suitable winter range and the availability of food is snow depth which is dependent upon such features of the land as slope, aspect and elevation (Demarchi and Smith, 1969). The major problem appears to be forage competition on critical bighorn sheep winter range as cattle and wild sheep do not appear to compete significantly for summer range. The cattle remain near timber fringes and meadows while bighorns usually summer on alpine slopes and ridges. Cattle and bighorns do compete on winter range while deer also use this range in the spring (Eddleman and McLean, 1969).

Typical of the big game-livestock conflict on lands that have undergone tremendous physical changes in recent times was described for the East Kootenay region of southeastern British Columbia by Demarchi (1971), p. 17. "The seral-shrub areas that form the critical big game winter ranges in the Rocky Mountain Trench were formed by forest fires in the early 1900's. These areas are now being reinvaded by conifer trees due to the present forest fire protection program. Reforestation that has occurred since 1930 now occupies 301 square miles, while only 170 square miles remain as seral-shrub areas (critical big game winter range). This same big game winter range is also overgrazed to the extent that 103 out of 170 square miles are classified as critically overutilized. Thus only 57 square miles of seral-shrub areas remain in good condition and presently unforested. The limited grassland ranges of the area, though not capable of the same degree of reforestation, are seriously overgrazed ... Finally, 28.1 square miles of grassland, seral-shrub, conifer and deciduous forests and riparian habitat will be inundated when the Libby Reservoir is flooded in 1972."

A major problem stems from the disproportionate amount of range available to wild ungulates in the winter compared to the summer, and the failure of land managers to grasp the significance of this fact. Often managers are concerned about livestock-game competition during the summer when the former are free-ranging. Livestock owners feel they are being fair to big game interests if the livestock summer only on the lowlands and lower mountain slopes leaving the higher slopes and plateaus for big game forage. However, the crux comes as winter approaches and livestock are at least partially subsidized on artificial forage. The big game animals are forced to move downward by inclement weather conditions in the higher ranges onto the lower ranges only to find that the forage has been depleted by summer livestock use. The alternatives are either starvation or else to turn to artificial forage on, or adjacent to, the preferred winter ranges. Livestock owners have not been willing to share their winter forage nor to reduce summer grazing to the point where adequate food remains to support the big game population through the winter. Corrective programs which have usually not been in the best interests of native ungulates, have been to reduce game numbers through increased hunting pressure on low elevation winter ranges, and where winter game populations are high and considered valuable, then to initiate winter feeding programs. The big game resources suffers ultimately by both methods while summer range and watershed values also suffer from the latter plan. One critical problem is the fencing of ranges used by both antelope and domestic sheep, which prevent antelope from reaching water or sheltered areas in times of stress. A fence that will hold sheep but that will pass antelope has not been developed. Similar problems may occur if fences are so high as to be difficult for deer, elk and moose to jump (National Research Council, 1970). One study in Idaho showed there was only one acre of deer winter range for every 50 acres of summer range (Hungerford, 1969). Most studies in Canada and the Northern Rockies in the U.S. show that big game animals winter on 10 percent or less of their yearlong range (Cowan, 1950, Stelfox & Taber, 1969, Telfer, 1970).

The present and future welfare of wild ungulates has become acute throughout much of the Intermountain states and provinces where these critical winter ranges have, and are being, alienated for single use purposes such as livestock grazing, cultivation, urban and industrial development. A difficult aspect of the controversy to correct, is the concept that big game is the property of the Crown and managed by the government while much of the range occupied, especially during the winter, is privately owned. "Whereas stockmen often are unreasonable in their demands for exclusive use of federal lands, some sportsmen add to this problem by blind opposition to anything resembling control over the game numbers ... Under present laws, there is little provision made whereby landowners can be remunerated for furnishing forage to publicly owned game, and it is natural that they should resent excessive numbers. Conversely, on public land, there may be little justification for reducing game numbers below the carrying capacity of the game range ... Only when landowners, game managers, stockmen, and sportsmen can look upon land as a public heritage that must be conserved and usedto the greatest good of humanity, can game-livestock conflicts be settled" (Stoddart and Smith, 1955).

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3. EFFECTS OF ROADS AND RAILWAYS ON NATIVE UNGULATES

Within the Canadian Rocky Mountain National Parks the author has observed two beneficial effects and three deleterious effects of roads and railways on native ungulates. These are as follows:

Beneficial Effects

1. Roads are constructed primarily along the valley bottoms and lower mountain slopes within the Prairie Transition and coniferous Hudsonian zones. Under 50 years of fire suppression following extensive fires during the period 1880 to 1920, these zones grew up into dense stands of lodgepole pine or white spruce. As the productive early-successional seres disappeared, the carrying capacity for elk, deer, and to a lesser extent moose and bighorn sheep declined noticeably since ahout 1940. Currently, the natural carrying capacities of important wintering valleys such as the Athabasca Valley in Jasper and the Bow Valley in Banff National Parks are low. However, relatively large populations of elk, and lesser numbers of mule deer and bighorn sheep are being sustained throughout the winter on the grass-seeded highway back-slopes. The 35 miles of grassland (900 to 1,000 acres) adjacent to Highway No. 16 from Jasper to the East Park Gate provides most of the winter forage utilized by 800 elk, as well as providing considerable forage for some 300 bighorn sheep and 50 mule deer.

   Similarly, the grassed slopes adjacent to the Trans-Canada Highway for a distance of five miles west of Banff provides the majority of the winter forage for 75 to 100 bighorn sheep and some 25 mule deer and elk. Banfield (1958) pointed out that this bighorn sheep herd numbered 375 animals in the 1920's following extensive fires at the turn of the century. The herd declined to 50 to 75 animals in the late 1950's when the grasslands became replaced by a Douglas fir-white spruce forest. The construction of the Trans-Canada Highway in the 1960's and the grass-seeded back-slopes undoubtedly permitted the sheep herd to increase to an estimated 75 to 100 animals in 1968.

2. The roads and cleared back-slopes provide easy travel lanes for elk, deer and bighorn sheep during seasonal migrations and have undoubtedly resulted in less energy loss for herds migrating during deep snow periods. During the rutting period for bighorn sheep in Jasper National Park a mature ram was observed to walk a distance of 13 miles along the paved Highway No. 16 between two ewe bands. The highway traversed through 11 miles of lodgepole pine and white spruce forests which ordinarily would have created a barrier to this movement (Insp. George Mitchell, pers. comm.).

Deleterious

1. The wild ungulates are lured to the roadsides and railway right-of-ways in search of food or easy travel lanes or merely in order to traverse along a migration route. Large numbers are killed annually by vehicles and trains especially in foothill and mountainous areas. For example, the 50 miles of Highway No. 16 in Jasper National Park accounts for a minimum annual toll of 7 bighorn sheep, 16 elk, 19 mule deer, and 6 moose, or 48 ungulates (0.92 per mile of railway). Trains running on a nearby railway line account for another 9 bighorns, 12 elk, 4 deer, and 10 moose annually, or 35 ungulates (0.75 per mile of railway).

2. Bighorn sheep are also lured to highways that are "salted" during the winter to reduce icy conditions. Several bighorn sheep herds and one

mountain goat herd have become infected with a soremouth (contagious ecthyma) virus disease which causes debilitation and mortality, especially in lambs and kids. This disease in the Canadian National Parks is found only in herds which have access to artificial salt. The U.S. Bureau of Sport Fisheries and Wildlife reported that Wisconsin scattered 15.8 tons of rock salt per mile of highway during the winter of 1964-65. They report salt poisoning and fatalities among several game species in Wisconsin (Defending All Outdoors 5(3), March 1971).

In Scandinavia, highways and railways have transected reindeer ranges and migration routes without appreciable interference to the free movement of reindeer (Klein, 1971). In some cases, fences were constructed along stretches of railroad to funnel reindeer beneath bridges or to prevent them from crossing tracks except at designated locations. However, in Norway highways and railroads have obstructed the movement of reindeer. They milled close to the tracks for long periods before crossing and were repeatedly frightened away by passing trains. "Snow fences, deep cuts through rock, and drifted snow acted as physical barriers to the reindeer along many stretches of the railroad. Finally, several years after the construction of the railroad during the early 1920's, the reindeer stopped using the eastern region" (Klein, 1971). In the western region, the population which had been reduced by hunting, increased under protection despite the railroad and highway acting as a barrier to animal movement to the east. By the mid-1950's, serious range deterioration was evident and some animals began crossing the railroad and highway to use the eastern region. After increasing to a population of 15,000 animals in 1960, the population was reduced by hunting and dispersal to about 1,000 to

1,500 animals in the western region. The western range has not yet recovered from overgrazing while the eastern region has extensive stands of lightly used lichens. This case illustrates that railroads and highways may disrupt caribou and reindeer movements to the extent that serious range deterioration occurs (Klein, 1971).

Carcass counts along the high-speed Burlington-Northern Railroad in the Fisher River-Wolf Creek winter range in Montana from 1965 to 1970 showed deer kills per mile ranging from 0 to 37 over a 20 mile sample area. Trains travelling less than 30 m.p.h. in Alaska killed far fewer moose than trains travelling at greater speeds. Trails bulldozed through the snow parallel to the railroad right-of-way, in addition to the creation of feed yards by bulldozing down deciduous trees away from the railway tracks served to reduce moose mortalities from trains (Firebaugh, 1971).

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4. EFFECTS OF MINING ON NORTH AMERICAN UNGULATES

Stewart L. Udall adequately summarized the dilemma of past mineral resource exploitation and environmental ills as follows (Udall, 1970): "In the past, the myth of endless resources blinded us to the horrible results of reckless mining practices on our public lands. But times have changed and we realize now that we dare not destroy the few White Clouds which remain. The scars are far too deep. Our mountains have been stripped and gouged by copper miners in Arizona and Montana, by iron ore miners in Minnesota, by jade miners in Wyoming and coal stripping in Appalachia ... all in the name of 'progress'. Some of this mining was vital to national growth ... but far too much of it was carried out under a strip-and-run philosophy, needlessly reducing the quality of everyone's environment. The real culprit at White Clouds [Idaho] is not the mining companies nor the United States Forest Service, nor the people trying to save the beauty of those majestic peaks. What is really wrong is the antique mining law of 1872, a frontier law that protects the exploiter and ignores the values of scenery, wildlife, watershed and recreation. The law no longer serves the public interest. We need new laws that will." This philosophy still exists to a large extent throughout North America and has been responsible for the despoilation of extensive areas of wild ungulate range. Big game resources have been given little consideration in deciding whether or not mining should be permitted.

Coal bearing areas in Canada are often lands that support aspen and/or grassland vegetation. In western Alberta these are productive and critical ranges for abundant populations of mule deer, elk, bighorn sheep and for a lesser population of mountain goats, caribou, moose and white-tailed deer. The critical nature of the grassland and aspen communities for ungulate survival in the mountains can be appreciated when we realize that during the seven-month winter period (mid Oct - mid May) these animals are forced to winter on 10 percent or less of the mountainous area with many winter ranges supporting densities of 25 to 100 animals per square mile. Open grasslands and aspen pastures comprise over 75 percent of this confined winter range (Stelfox and Taber, 1969, Cowan, 1950).

Of the 47.2 billion short tons of coal in Alberta, 37.3 billion are bituminous (coking) coal located in the mountain and foothill region. Present contracts call for an annual export of 5.4 million tons to Japan by 1975. Coal production in Alberta is expected to increase to 11.6 million short tons by 1975, and to 32.4 million short tons by 1990 (a five-fold increase over 1970 production). The method of extraction of the bituminous coal will be almost exclusively a strip-mining operation along a 200 mile belt of mountain-foothill terrain adjacent to Waterton, Banff and Jasper National Parks. By 1990, Alberta strip mining will occur at a rate of 2,200 acres annually. At least 32,000 acres could be strip-mined over the next 20 years in the mountain-foothill belt (Canada Dept. of the Environment, 1971).

Mining sites in the Smoky River and Coalbranch areas of western Alberta lie in the heart of critical winter range for bighorn sheep, mountain goat, caribou, elk, mule deer and moose. These mountain and foothill ranges which lie adjacent to the National Parks of Jasper, Banff and Waterton Lakes also provide the necessary winter range for large populations of wild ungulates which migrate each fall from the parks to winter on the prime provincial ranges, where snow depths are more favorable.

There is concern over the effects of surface mining for chromite and other minerals in the Beartooth Mountains of south-central Montana, on ungulates. More than 100 square miles are in danger of total ecological disruption since major mining development began in 1967. Elk, mule deer, and moose occur in the mountain valleys while mountain goats and bighorn sheep are found on the peaks and plateaus.

Wildlife authorities are concerned that habitat destruction from both mining and road construction will be deleterious to big game animals, and that disturbances from mining and improved access may force the animals from the area. Under the antiquated mining law of 1872 there is no practical way to prevent a miner from prospecting, mining the mineral deposit and then moving on, leaving behind broken machinery, trash and mined holes (Wastcoat, 1971).

A major issue in the controversy of mining versus wildlife is the fact that reclamation of strip-mined areas is in general currently almost non-existent. Token efforts exist in some areas but there are few or no concrete reclamation programs being designed in conjunction with the actual mining plan. Reclamation in Alberta amounts to either extensive press coverage with very little actual restoration, or extremely minimal restoration to dispel adverse public opinion.

Another problem associated with mining which has a direct bearing on the welfare of native ungulates is the influx of humans. Plant sites, as well as town sites are generally situated in valleys near adequate water sources which almost invariably coincide with the locations of critical winter ranges for ungulates. The micro-climates and associated vegetative patterns along the valleys provide all the requirements for wintering ungulate populations. The harassment and displacement which results from the presence of modern man results in disastrous consequences for animals attempting to compete for the same space.

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5. THE EFFECTS OF DAMS AND DIVERSIONS IN NORTH AMERICA ON NATIVE UNGULATES

Two elements of controversy that have arisen are:

a) a tremendous increase in hydro-electric power demand for industrial, commercial and residential uses, e.g. demand currently doubling every 7.5 years in Alberta.

b) an acute water shortage already appearing in southern Alberta and Saskatchewan. Water shortages are even more acute in desert and semi-desert states such as Utah.

In Alberta this water shortage concern has resulted in the initiation of two major impoundment and diversion schemes. The P.R.I.M.E. scheme will divert portions of water flowing from the Foothills and Mountains of western Alberta northeast to the Athabasca and Peace Rivers to the Arctic Ocean, towards the southeast across the southern prairies towards the Hudson Bay. The project includes 23 dams, many of which have already been completed or started. The Saskatchewan-Nelson Basin Diversion Proposal is designed to evaluate potential diversions of north flowing waters from the Saskatchewan-Nelson Basin south into the Great Lakes and Souris basin area. It plans for 23 dams of which some structures have been completed.

Several controversies associated with the above two schemes are:

1. Are the costs of such losses as wildlife, agriculture and recreation being calculated into project costs? The U.S. Army Corps of Engineers are now compelled in some cases to include the cost of replacing wildlife habitat and recreation lands which they are about to inundate. Kenneth Boulding, an economist, states that "The only way you could explain the water policy in this country was the religious explanation that we worship the water goddess and hence had to build all these pyramids - all these dams and temples." There is no other conceivable rational explanation ... The domination of almost all resources policy by engineers and people of this kind is utterly disastrous (Marine, 1969).
2. What gross biospheric repercussions will evolve from major North American water diversions? What part does the Mackenzie River play in arctic thermal relations and in world climatic stability?
3. What effects will dams and diversions have on the availability of critical ungulate winter ranges and necessary seasonal migration, within Foothill and Mountainous regions?

Examples of the impact of several operational and proposed dams and diversion schemes on ungulates are as follows:

1. The Castle Reef Dam in Montana is expected to block the fall migration of elk to their winter range and to block their return spring migration. It would also flood bighorn sheep range. The Heligen Lake area on the Madison River in Yellowstone Park now supports 250-300 elk compared to at least 1,000 elk prior to the construction of the dam in 1915 which prevented the fall migration to the lower Madison winter area (Craighead, J.L. Pers. Comm.).
2. The Rampart Dam, if developed, would inundate an area along the Yukon River

larger than the State of New Jersey and would cause the destruction of vital moose range which currently supports 12,000 moose (Marine, 1969).

3. The Everglades scheme to construct a network of canals, levees, and dams caused the destruction of important deer habitat as well as thousands of deer. The most important single food item of the Everglades Park deer is the water lily which has been threatened by artificial control over water levels by the Corps of Engineers. In 1965 the Corps held up water from the drought-ridden Everglades until several wildlife species were endangered. As public indignation grew, the Corps agreed to release water (in one great rush) with the result that thousands of deer were drowned (Marine, 1969).

4. The Bennett Dam at the headwaters of the Peace River in B.C. built for hydroelectric power began storing water in 1969. By 1970, reduced water flows of the Peace River caused a drying-up of the Peace-Athabasca delta in northeastern Alberta. Stevens (1971, p. 351) pointed out that at least 7,000 bison inhabit the Wood Buffalo Park portion of the Peace-Athabasca delta. "Although most of the area is wet and marshy the bison thrive very well, wading into water and mud to their bellies, or even swimming long distances on occasion. The reason for their semi-aquatic existence in summer appears to be the presence of their preferred food, edible sedges of the genus Carex. One of these, Carex atherodes, grows near the water's edge and constitutes up to 80 percent of the diet yearlong ... The preferred sedges require a spring flooding in order to maintain the fertility and alkalinity of the habitat, and thereafter a slowly receding water level; otherwise less palatable sedges or the more xeric grasses replace them. It appears that a naturally fluctuating water regime is necessary for the maintenance of the staple food of the bison in the Wood Buffalo Park."

Dirschl (1971) pointed out that the exposed lake bottoms of the drying Peace-Athabasca delta are undergoing a rapid plant succession. This will lead to a great expansion in dense willow and phragmites thickets and reedgrass meadows and the loss of extensive awned-sedge (Carex atherodes) meadows which is expected to reduce the delta's carrying capacity for bison.

5. The Brazeau Dam in the foothills of western Alberta flooded 17.5 square miles of prime moose, elk and mule deer winter range in the late 1950's. The author calculated the flooding reduced the winter range carrying capacity of the Brazeau Valley by 229 ungulates (193 elk, 18 moose and 18 mule deer) or 13.0 ungulates per square mile (unpublished data).

6. The Libby Dam on the Kootenai River in Montana will be completed in 1972, and will create a 90-mile long reservoir extending 42 miles into British Columbia. It will inundate some 12,000 acres of big game winter range in Montana, and create problems for deer, elk and bighorn sheep (Firebaugh, 1971). An estimated 18,000 acres of critical winter range of white-tailed deer and elk in British Columbia will be destroyed resulting in the loss of 6,000 white-tailed deer and 500 elk. Additional numbers will be lost as a result of blocking animal movements by water, mud, and ice. A potential indirect loss to bighorn sheep and mule deer as well as to elk and white-tailed deer could occur if ranchers who will lose grazing lands when the reservoir fills are permitted to relocate higher up on the benches where critical winter range for wild ungulates occurs (Smith, 1970).

7. The Mica Dam being constructed on the Upper Columbia River in British Columbia is expected to result in the loss of approximately 400 moose, 50 elk, 25 caribou and 75 white-tailed and mule deer (Peterson and Withler, 1965a). The 310 miles of riparian habitat and 4,760 acres of

sloughs and wetland edge in the mainstem reservoir area supports about 400 moose. Elk, caribou, and deer are scattered throughout the area to to be flooded.

8. The proposed Duncan and Arrow Lakes Dams of the Duncan River and Arrow Lakes area of British Columbia will flood 11,000 acres and 40,000 acres of forested lands respectively. The Duncan Dam will displace about 400 white-tailed deer, plus about 200 mule deer, elk and caribou, while the Arrow Lakes Dam will displace not more than 1,000 deer and an unknown number of caribou (Peterson and Withler, 1965b and 1965c).

An insight into the effects of impoundments on ungulates in North America can be gained from past effects in Scandinavia. Klein (1971) remarks p.394, "Perhaps man's most detrimental influence on reindeer in recent years has been the extensive construction of hydroelectric projects". Klein pointed out that valley bottoms are often the best grazing areas for reindeer although these are also sites for hydroelectric impoundments. These areas also provide shelter during calving. "Because reindeer move between their summer and winter ranges during spring and autumn, the ice on large impoundments usually makes travel unsafe, thus disrupting migration routes. The draw-down of water from the reservoirs throughout the winter frequently creates shelves of shore ice that slant down to the floating ice, and this produces a dangerous obstruction ... Storing water in reservoirs in early winter results in greatly lowered water levels in streams and rivers below the dams. This often causes shelves of ice along the stream banks with an ice-covered moat between, which may be completely impassable or a veritable death trap for reindeer (Klein, 1971)."

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6. EFFECTS OF ARCTIC AND SUB-ARCTIC RESOURCES EXPLOITATION ON NATIVE UNGULATES

Ecologists and conservationists are increasingly concerned with the damage to fragile ecosystems caused by the current rush to explore and develop oil and other resources in the Arctic. They anticipate significant damage to the wild ungulate populations, in particular to the barren-ground caribou. Disturbance of surface vegetation destroys its insulating qualities and permits slumping of the local terrain -- a process known as "thermokarst" -- which alters drainage patterns, induces soil erosion, forms barriers to the movement of animals and results in serious change to the ecological balance. Research is needed to determine the level of disturbance which northern ecosystems can tolerate without suffering permanent damage.

Barren-ground caribou are extremely gregarious and migratory in behaviour. Herds of 5,000 to 150,000 caribou annually migrate over a range extending from 200 to 700 miles in length. These habits necessitate an extensive range and make the species vulnerable to overharvesting and habitat impairment on relatively small portions of their range. They range over both the Tundra barrens and the Taiga northern boreal forest biomes where their main food source, the lichens, are specifically adapted to the poor soil, permafrost conditions prevalent throughout the region.

As the caribou on the tundra have no escape habitat and depend on vast open spaces for security, the introduction of highly mobile transport aids (aircraft, snow machines etc.) and developments that restrict large areas of tundra use by caribou could have harmful effects (Brooks et al. 1971). The loss of lichen range would be fatal to most caribou populations because of the inability of vascular forage plants to develop within this inhospitable environment and possibly their inability to meet caribou nutrient requirements.

The fixed annual migration pattern covering several hundred miles makes the caribou especially vulnerable to:

1. hunting pressure at any point along the migration route. Excessive harvests and waste by humans from 1949 to 1958 in Canada were largely responsible for a 70 percent decline in caribou numbers from 670,000 to 200,000. The kill by humans averaged 20 percent while the increment of the population averaged only 15 percent. For the period 1949 to 1962, there was an 83 percent waste of carcasses, with only the tongues taken from 87 percent of the animals. Of those carcasses used, 40 percent were fed to dogs (Kelsall, 1968).
2. deleterious habitat change of any one essential habitat component within the year-round range. The barren-ground caribou is the only North American Ungulate specifically adapted to the winter environment found in mature northern boreal forests, in particular to the lichen-rich component of those forests. Development of the north following World War II was correlated with a remarkable increase in forest fires. The acreage of winter caribou range burned over in northern Saskatchewan from 1947 to 1961 increased 50 percent compared to the previous 60 years and 350 percent compared to the period 1840 to 1844 (Scotter, 1961). In Alaska, Lutz (1956) estimated 1.1 million acres of forest were destroyed by fires annually from 1940 to 1954, while Leopold and Darling (1953) stated that only 20 percent of the mature white spruce remained. Mature spruce forests produce 264 times as much lichen forage as newly burned range of 1 to 10 years of age, and 4.5 times the lichen forage present in a forest of 31 to 50 years of age. Mature black spruce forests on winter caribou range were found to produce 360 pounds of arboreal lichens per acre and were capable of supporting 50 to 60 caribou for one day (Scotter, 1962).
3. migration obstacles such as settlements, above-ground obstructions, impoundments etc. which tend to deflect migrations and cause abnormal

"bunching". Klein (1971) presented examples where highways and railways have obstructed the movement of reindeer and resulted in range deterioration. Similar effects could be expected with regards to caribou herds in the North American Arctic.

In addition to the above effects of modern development in the arctic region on caribou, another potential danger is causing concern to conservationists. This is the problem of air pollution effects on lichens and consequently on caribou, as well as to humans consuming caribou meat. Schofield and Hamilton (1970) and Klein (1971) view air pollution damage to lichens as a distinct possibility with petroleum exploration and development on the Arctic Slope. They show that lichens are inhibited by air-pollution when a large part of the pollution is sulphur dioxide. The first lichens to go are usually fruticose species, including the so-called reindeer lichens (Cladonia spp.), followed by foliose and then crustose lichens. Arctic Slope crude oil and natural gas contain significant amounts of sulphur. Some 390,000 caribou summer on the Slope and possibly 75,000 winter in the area, and are dependent for much of the year on a supply of lichens as forage (Schofield and Hamilton, 1970). Brooks et al. (1971) concluded that although oil development could cause damage to caribou and their range, that considering the enormous area available to caribou and their ability to adjust to even fairly conspicuous habitat changes, it seemed unlikely that their welfare would be significantly threatened by the scope of oil development now contemplated.

In so far as the effects which oil development will have on other ungulates, there is a danger of overexploitation of the small moose population by a large human population associated with Arctic Slope development. On the other hand, land disturbances associated with oil development are expected to have little, if any, effect on moose. The welfare of muskox and wild sheep herds is not expected to be adversely affected by developments on the Arctic Slope (Brooks et al., 1971).

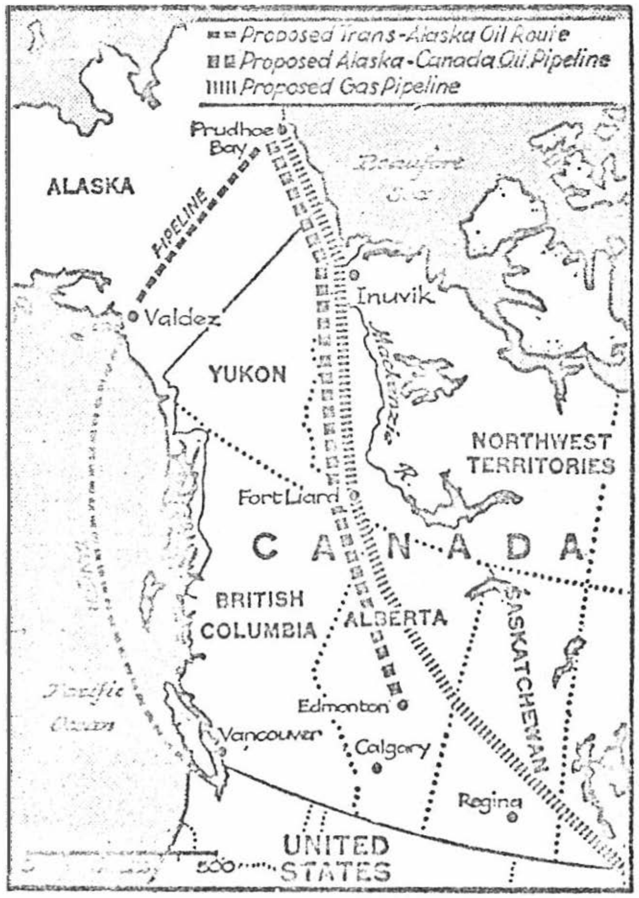
The major concerns regarding the effects of petroleum development in the arctic on ungulates are as follows:

1. transient camps will create most problems involving abuse of lands and wildlife and will be most difficult to influence and regulate. Experience with transient seismic camps in Alberta bears out this concern. In 1957, in company with a Conservation Officer, we found 2 moose and one great grey owl shot and left intact adjacent to a one mile stretch of seismic line which had no human use except for the seismic construction and exploration crews. The number of wild ungulates illegally killed by persons involved in oil-gas exploration must have amounted to hundreds, if not thousands, of animals annually in Alberta since 1955.
2. enormous quantities of seismic wire has, and will be, scattered over the tundra which will kill any ungulates which become entangled in it. Several instances of caribou becoming fatally entangled in this wire have been observed.
3. particular attention will have to be given to the management of moose whose number and productivity are low in relation to the potential harvest pressures.
4. as a 30-inch diameter pipe will be used for much of the transportation system, and as none of this pipe will be buried, it could create a serious movement barrier to caribou. Whether pipelines become a major barrier will depend on how the pipe is laid in relation to the road surface or shoulder. A network of barriers throughout the area could largely exclude caribou from the entire area (Brooks et al., 1971).
5. the threat of oil pollution from pipeline leaks or ruptures, improper waste disposal etc. could pose serious problems to ungulates by fouling drinking water, by soiling the hides of ungulates swimming in waters containing an oil slick, and by affecting both the production and

utilization of ground vegetation which come in contact with oil.

6. there are a number of unknowns such as the response of caribou to pipelines, the impact of harassment from vehicles, helicopters and airplanes on sheep and muskox which ecologists would like to have answers to before development becomes extensive.
7. the removal of vegetation along seismic lines, refilled pipeline ditches, etc. may become mires that will trap numbers of moose and caribou. Seismic lines constructed by scraping the vegetation from the wet tundra of the Tuktoyaktuk Peninsula in the Canadian Northwest Territories, developed into mud-filled moats, through degradation of the permafrost, and these effectively blocked movement of domestic reindeer in the area (Weeden and Klein, 1971).

Concerning the potential problems from pipeline spillage and barriers to ungulate movements from pipelines, a major controversy concerns the route(s) to be used to transport oil southward. The Environmental Protection Agency advised that the Canadian route which would pass up the Mackenzie Valley to Edmonton, Alberta, would not cross major earthquake areas as would the Alaska route. Furthermore, as the Alyeska Pipeline Co. plans to build one pipeline along this route to transport natural gas from the North Slope to Chicago, the EPA thought it preferable for purposes of minimizing environmental impact, to use a single route for more than one pipeline than having multiple pipeline routes (Conservation News, April 15, 1971). The alternative pipeline routes are shown in the figure below from Conservation News, April 15, 1971.



The total effects of North Slope exploration and initial development has not yet been assessed, but the most important biotic effects anticipated are summed up by Weeden and Klein (1971) as (1) the disturbance of vegetation and soil on uplands (2) the removal of gravel from streams, shorelines, and ridges (3) possible behavioral reactions of tundra animals to oilfield facilities and activities (4) hunting and harassment, and (5) oil pollution and waste disposal.

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7. THE EFFECTS OF MILITARY TRAINING RESERVES ON NATIVE UNGULATES

The northern wood bison was protected in 1896 by the establishment of Wood Buffalo National Park in N.E. Alberta. At that time it was thought there were fewer than 300 animals north of the Peace River and west of the Slave River (Stevens, 1971). By 1922 the population increased to 1,550. During World War II (1939-1945), Wainwright National Park, in central Alberta, was turned over to the Dept. of National Defence for military manoeuvers. The Canadian government transported 6,673 plains bison from Wainwright to Wood Buffalo Park. "Not only did that action mix up two races of bison but it also introduced two bovine diseases (tubercullosis and bovine brucellosis) into the region that represents a quandary and an embarrassment to this day." (Stevens, 1971).

Conversely, two other military reserves in the parklands and prairie regions of Alberta have developed high populations of white-tailed and mule deer, and antelope. A portion of these animals move outside the reserves to provide additional hunting recreation. A controlled short-season hunt is permitted annually within Wainwright Military Reserve to control deer populations. Populations of deer and antelope appear greater within the military reserves than on adjacent provincial ranges. This is likely due to the lack of other land-use practices such as agriculture, and from light hunting pressure.

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SUMMARY

The major controversy concerning the effects of resource exploitation on native North American ungulates appears to stem from the tremendous magnitude of resource development today compared to that of even one decade ago, plus the "snowballing" effects of several years of poor land management practices.

In almost all cases the conflict is one of degree. During early times, a small human population shooting big game for meat in the vicinity of homesteads or settlements had little effect on ungulate numbers; in fact, the small homestead clearings and trails opened up the forests and created a more desirable mosaic of food, shelter and cover thus increasing many wild ungulate herds. The conflict for forage from small livestock herds was relatively light prior to the time that extensive "bottom" grasslands were either harvested for winter forage or overgrazed so that insufficient forage remained to winter big game herds. Selective logging for saw-log timber was often beneficial as reduced forest canopies permitted an increase in grass, forb and browse forage, and as most of the "softwood" timber species harvested were not important ungulate forage species. The exception to this case was the woodland caribou whose necessary habitat was the mature coniferous boreal forests.

A major change occurred in the mid 1800's as cities grew, as roads and railways provided a network of access systems into the pristine "West". Then demands for meat, for timber to build cities, railways and telegraph lines, and for metals for the industrial revolution increased sharply and wild ungulate populations rapidly declined. The great herds of cattle and sheep, the plow, trophy and market hunting, massive mineral discoveries, and the extensive stripping of mature forests throughout the eastern, central and Lake states all combined to overexploit the renewable and non-renewable land resources to the general detriment of native ungulates.

Over-exploitation of the coniferous forests virtually eradicated caribou herds from the United States; while the bison met their demise from a variety of pressures principal of which were excessive overharvesting for sport and delicacy hunting, plus forage competition from livestock. Vast areas surrounding cities, mining and lumbering camps, etc. became depleted of wild ungulates due to an increasing demand for meat. Extensive forest fires accompanied the influx of humans west of the Mississippi River and there also occurred over-exploitation of Rocky Mountain and West Coast forests, especially during the period from 1880 to 1930. The result of extensive fires and logging was the creation of early forest succession seres rich in grasses, forbs and shrubs favorable for ungulate species such as mule and white-tailed deer, elk, antelope and moose. Coincidental with this period, were stringent laws enacted in the first decade of the 1900's to protect remnant ungulate herds. Grasslands were continually overgrazed by livestock which produced shrublands desirable for deer, antelope and moose. Another act favorable to the build-up of native ungulates was heavy predator control on wolves, cougar, bears and coyotes.

Thus we reach the World War II period from 1939 to 1945 when moose, elk, deer, and bighorn sheep populations generally approached or exceeded pristine populations throughout the parkland, foothill and mountain regions. Although the bison, elk, mule deer and antelope were virtually extinct on prairies which were now producing cereal crops and livestock forage, the white-tailed deer and, in some areas, the antelope thrived in conjunction with the agricultural industry.

A sudden change occurred during and immediately after World War II when the demand for both renewable and non-renewable resources accelerated. Affluence of an American society which was increasing at an asymptotic rate, and making tremendous mechanical, physical and chemical discoveries, enabled humans to rapidly alter extensive landscapes. The impact on native ungulate species became drastic in many areas and controversies developed over the beneficial and deleterious effects of resource exploitation on wild ungulates. Seven major land-use developments have had, and are having, far reaching effects on native ungulates during the past three decades. These are:

1. Forest Logging
2. Livestock Grazing
3. Roads and Railways
4. Mining
5. Dams & Diversions
6. Arctic and Sub-Arctic Development
7. Military Activities

Briefly, the impact of each of the above developments is one of degree. A small amount has little deleterious effect, in fact is often beneficial. However, the degree of development has become so great that many ungulate populations are either badly impaired or virtually threatened with extinction. The major elements of controversy concerning the impact of each of the seven resource developments on native ungulates are as follows:

1. Forest Logging -

Dense forests make poor native ungulate habitat except for caribou. Therefore, the logging industry contends it is doing big game species a favour by logging of the forests. The modern clearcut method is the least expensive technique and combined with modern methods of regeneration, forest rotation periods can supposedly be shortened to provide a higher proportion of the rotation in the early forest succession sere most productive for wild ungulates. If this is true then extensive clearcuts must be beneficial. Some biologists earlier agreed, and studies confirmed that forage production generally increased many-fold following logging. The most productive period for big game forage and populations were generally five to twenty-five years following logging. Recently, however, considerable evidence shows that often big game populations do not increase as expected, in fact elk, moose and mule deer populations often decline. The major reasons are firstly that extensive clearcuts eliminate necessary cover and shelter disrupting the desirable "edge-effect" or mosaic of open areas for feeding in close proximity to dense forest for escape and brooding cover and shelter from inclement weather. Secondly, the animals become too vulnerable to hunting in large clearcuts and the associated extensive access to hunters is causing the animals to vacate extensive clear-cut areas due to excessive harassment and sub-minimal cover requirements. This dilemma is compounded by the facts that a) foresters fail to understand or acknowledge that wild ungulates in the northern States and Canada must winter on ten percent or less of their year-long range because of inclement weather, forage, and shelter conditions over the remainder of the area. Biologists warn that the small crucial wintering grounds must be managed with the interests of the ungulates as the foremost land-use management consideration; b) many of the trees now being harvested are important forage species for native ungulates, e.g. the most producing eastern hardwoods and the poplar and birch species. This eliminates a major food source especially during winter months when the low-growing vegetation is unavailable due to deep snow; and that c) the present monoculture forestry practice is less productive to big game than one which manages for a variety of species and age classes, simply because tree species vary in their ability to provide suitable forage, cover, or shelter during the various seasons.

2. Livestock Grazing -

The major controversies today stem from four sources; namely:

a. That most of the critical winter range for native ungulates is either overgrazed during the summer by livestock on public lands, or has been sold to private livestock interests thus leaving a gross deficit of big game winter range.

b. Public land managers have not established equitable livestock grazing allottments to the satisfaction of big game managers. Wildlife interests maintain that grazing management plans are designed primarily for the benefit of livestock and that the managers lack an understanding of big game ecological needs.

However, several modern animal ecologists agree that proper livestock-big game grazing schemes are mutually beneficial and that stockmen and biologists must communicate and strive to optimize both resources harmoniously.

c. Extensive programs are in operation to convert shrub and forest land into grasslands for the express or prime purpose of livestock production to the detriment of wild ungulate populations.

d. A pronounced shortage of pyric-induced grass-shrubland range important to wild ungulates has developed in the foothill and mountain regions following several decades of fire suppression which permitted the re-invasion of forests. The livestock-big game competition for the remaining forage lands on public range has become acute.

3. Roads and Railways -

The major controversies here stem from the fact that firstly, it was roads and railways which permitted the destruction of the bison and also brought trophy hunters into the mountains in the early 1900's to annihilate herds of bighorn sheep and mountain goat. Secondly, roads have become so numerous that access to hunters, plus harassment from machines and workers have resulted in ungulate populations foresaking otherwise favorable habitat and big game populations becoming sub-optimal. Thirdly, roads and railways are accounting for large ungulate mortalities, eg. 0.75 to 1.00 ungulates per mile of highway or railway per annum in Jasper National Park. Similar death rates are occurring on some non-park lands thus reducing the allowable kill for hunters. On the other hand motorists are complaining of the traffic hazard from wild ungulates frequenting "high speed" highway right-of-ways. Fourthly, tons of rock-salt and/or calcium chloride are being spread each winter on each mile of highway throughout the northern States and Canada. This "salt" induces wild ungulates to frequent the road surface to lick the minerals. This results in a traffic hazard to motorists, increases the ungulate kill, disrupts the animals normal foraging behaviour, and is inducing a sore-mouth (contagious ecthyma) disease in bighorn sheep and mountain goats.

4. Mining -

The major controversies concerning the effects of mining on native ungulates are four, namely:

a. Often the areas which are valuable coal-mining regions have a vegetative coverage of grass, shrub or aspen vegetation which is productive and often critical winter range for native ungulates within the foothill and mountain regions.

b. Modern strip-mining methods plus huge coal and other mineral markets have permitted extensive strip-mining of extensive wild ungulate ranges. Until a decade ago only a few areas in North America, notably the Appalatia Region, were involved. Today, extensive areas throughout the Rockies and adjacent foothills are involved. For example in Alberta, strip-mining had occurred at a rate of less than 500 acres per year prior to 1969. It is accelerating presently at such a rate that 2,200 acres per year are forecast to be strip-mined by 1990. Much of this land is critical moose, deer, elk, and bighorn sheep range for both resident animals plus large numbers which migrate each fall from adjacent National Parks.

c. In the past, the reclamation of denuded strip-mine areas has been only a token gesture at best controlled by inadequate and antiquated laws. Thus the thousands of acres of strip-mined land are virtually worthless to wild ungulates. Conservationists are fighting for modern, effective reclamation laws which will restore denuded lands.

d. Wildlife biologists argue that where the wild ungulate resource is important or vital that mining be conducted in such a manner as to ensure the perpetuity of the animal resource. This may require sub-surface mining in some areas; it may also mean protecting critical pieces of ungulate habitat free from mining or other developments associated with mining.

5. Dams and Diversions -

The major controversies concerning the effects of dams and diversions on native ungulates are:

a. Of the less-than 10 percent land surface on which wild ungulates must winter, most of this exists along valley bottoms and lower slopes which presently are either inundated or threatened with flooding from massive water dam and diversion schemes throughout North America. The proposed Rampart Dam in Alaska-Yukon would inundate an area along the Yukon River larger than the state of New Jersey and would destruct moose range which currently supports 12,000 moose.

b. Adequate laws are lacking to prevent states or provinces with selfish interests from creating water impoundments which can have drastic effects on wild ungulate populations in other regions. For example the Bennett Dam at the headwaters of the Peace River in British Columbia began storing water in 1969 and by 1970 it was realized that curtailed water supplies downstream were causing the vegetal death of the Peace-Athabasca delta in north-eastern Alberta upon which at least 7,000 bison are dependent.

c. Water impoundments such as the Libby Dam along the Kootenai River in Montana and southern British Columbia will not only drastically reduce big game numbers presently existing on alluvial habitat along this valley, but will also greatly increase livestock-big game grazing competition for the remaining grasslands above the flood-line.

d. Water impoundments pose serious obstructions to necessary wild ungulate migrations. The winter draw-down of water from the reservoirs creates shelves of ice which slant down to the floating ice, thus producing either a migration obstruction or a veritable death trap.

6. Arctic and Sub-Arctic Resources Exploitation -

The heated controversies presently raging over the question of petroleum and mineral exploration in the Arctic Region on native ungulates, primarily barren-ground caribou, are these:

a. Due to seasonal weather vagarities herds of 5,000 to 150,000 caribou annually migrate over a range extending from 200 to 700 miles in length. The extensive range requirements and fixed migratory routes makes this ungulate species extremely vulnerable to deleterious effects from resource exploitation anywhere along the migratory routes, such as above ground pipelines, or impoundments.

b. Except for the vanished bison herds, the caribou is the most gregarious of all North American ungulates. Thousands can be lost at one time from deleterious effects of water impoundments or from mires produced when vegetation is removed along seismic lines, refilled pipeline ditches etc. Some 390,000 caribou summer on the Arctic Slope and possibly

75,000 winter in the area, making it possible for large numbers to be annihilated at any one time. Past experience showed that in Canada during the period 1949 to 1958 barren-ground caribou herds were reduced by 70 percent from 670,000 to 200,000 mainly by over-exploitation from hunting.

c. There is a serious danger that air pollution in the form of sulphur dioxide from petroleum activities will impair the growth and palatability of lichens which are the staple diet of caribou. The danger to the vast caribou herds from range impairment by air, ground and water pollution, plus migration deflection appears to be a greater threat than the anticipated exploitation from hunting or other harassment factors.

d. There is a danger that the small and spotty moose population will be over-exploited by hunting from the influx of human resource workers.

7. Military Reserves and Activities -

Public lands that have been taken over for military purposes have generally had little effect on wild ungulates. However, the conversion of a bison-elk preserve in Alberta to a military training reserve during World War II had two serious effects on native ungulates, namely:

a. 6,673 plains bison were transported some 500 miles north to Wood Buffalo Park where they hybridized with the only remaining population of wood bison, thus virtually destroying that sub-species.

b. The introduction of plains bison to Wood Buffalo Park introduced two serious bovine diseases namely tuberculosis and brucellosis to the wood bison population.

Military reserves have generally served as foci for unhunted wild ungulate populations from which some animals migrate to provide hunting and also re-stocking of adjacent lands. The present controversy is mainly focussed on what effects nerve-gas testing military areas will have on wild ungulates which either inhale, or ingest through the vegetation, the chemicals tested.

CONCLUSION

"To the average highway engineer, a landscape is something to be cut through, as directly and efficiently as possible; for him ultimate truth lies in traffic patterns, and the compound cloverleaf is the highest form of art. Similarly, a free-flowing river is to an army engineer what an unlicensed dog is to a dogcatcher - his first duty is to impound it, or otherwise prevent it from running wild. Each agency that threatens the environment has its own justification for what it is doing. The highway builders quote statistics on automobile production to justify more and wider throughways. The Corps of Engineers cite a "cost-benefit ratio" to prove that the public will profit from another dam. The Atomic Energy Commission must test bombs in a wildlife refuge to keep ahead of the Russians. The timber industry must be allowed a larger cut in the national forest to meet an alleged shortage of lumber. The stripminers must scalp the mountains because that is the cheapest way to get out the coal. The pesticide manufacturers must help our farmers to feed the world. and so it goes." (Brooks, 1970).

But wildlife authorities counter that all forms of land and water development must consider the entire ecological picture, as economic and political considerations are only part of the decision making processes. Social cost/benefit decisions for both humans and the rest of the animal kingdom may be more important from a long term standpoint with a symbiotic relationship among man-plants-animals being essential for the welfare and survival of all three components.

An important aspect of the controversy over resource exploitation versus wild ungulates is that North America is a young nation still operating under the pretext that unlimited resources exist, that forests, wildlife and rivers must be conquered, made subservent to man and to serve his immediate needs, and that the nation can only survive and prosper under an expanding, exploitation economy. Coupled with these false illusions are the problems of inadequate environmental protection from antiquated laws, and the lack of enforcement of existing laws.

Literature Cited

Brooks, Paul. 1970. The conservation revolution. Sierra Club Bull. Reprinted by permission in Wildlife Review 5(7): 16-17, Sept. 1970.