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NORTHERN ANIMAL HUSBANDRY: A LAND USE FOR NORTHERN MANITOBA

by

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ABSTRACT

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Charles Harvey Payne

Declining wildlife populations in northern Manitoba have spurred consideration of northern animal husbandry as an alternative land use. Species considered include reindeer, muskox and moose. Broad conclusions indicate that muskox and moose may show some potential for improving the well-being of northern people, but further investigations are required. Evaluation of reindeer husbandry from biological and socio-economic viewpoints yield negative results. Hunting and herding as ways-of-life or activities are compared, and it is assumed from both cultural and social viewpoints that hunting presents a more desirable lifestyle for northern people. It is concluded that the most provident form of wildlife management or husbandry north of the commercial treeline lies in the restoration of indigenous, wild caribou numbers.

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INTRODUCTION

Northern animal husbandry is not a new Canadian (or North American) topic. However, attempts to develop northern animal industries in North America have a rather inauspicious history. The failures have been largely due to the changes in life-style which animal husbandry imposes on people who have traditionally fed and clothed themselves through hunting and gathering activities.

Jeness (1967) outlined the traditional Chipewyan economy which reindeer husbandry would purport to replace:

They followed the movements of the caribou spearing them in the lakes and rivers of the barren grounds during the summer, and snaring them in ponds and shooting them down with bows and arrows during the winter when they took shelter in the timber. Buffalo, musk-oxen, moose, and smaller game tided them over periods when caribou were lacking.

Both the Eskimo and the Chipewyan depended heavily on caribou for subsistence. Hearne (1911), writing of the eighteenth century, considered the number of caribou skins required by native people to be quite high: "Each person, on average, expends in the course of a year, upwards of twenty deer (barren-ground caribou) skins in clothing and other domestic uses, exclusive of tent cloths, bags and many other things which it is impossible to remember."

Caribou population decline was coincident with the coming of Europeans, firearms and the fur trade. The search for furs to exchange for "whiteman

goods" led to an increase in sled dog numbers, due to lengthy trapping excursions. The extra dogs, plus the resident Europeans, placed a greatly increased demand on the food resources. Guns replaced harpoons and arrows, overkill became widespread and numbers of caribou, muskox and walrus declined sharply (McTaggart Cowan, 1969).

Many hypotheses have been advanced to explain the decline in caribou numbers (see Banfield, 1954, 1962; Loughrey 1956, 1957; Pruitt, 1959a, 1959b; Parker, 1972; Miller and Broughton, 1974). Management programs based on these hypotheses have failed to restore numbers.

As a result of dwindling caribou populations, the consequent effect on native people and the hypothesis that the range can sustain more intensive use, attention has turned to domestic reindeer as an alternative means of providing meat, hides and other products for use by residents of the tundra and northern taiga. It is understood that use of the range by reindeer will limit the number of wild caribou that the range will carry, should the solution to caribou restoration be found.

Throughout the global north only two other species are presently considered to have domestication possibilities: the muskox of the tundra, primarily as a producer of fine wool (although the meat is reported to be excellent) and the moose of the boreal forest for meat, dairy and transportation potential. Domestic exploitation of muskox was first advocated in a Royal Commission report in 1922 (Rutherford et al, 1922). Domestic herds presently exist in Alaska and Quebec. The muskox has potential as a domestic species for northern Manitoba.

The moose has already been domesticated in the U.S.S.R. The Soviet Union findings may have applicability to Manitoba but political and consequent

socio-economic differences between the U.S.S.R. and Canada make comparison difficult. However, the moose does have potential and is evaluated as a domestic possibility from biological, social and economic viewpoints.

This thesis is an investigation of northern animal domestication, specifically reindeer, moose and muskox. The subject is discussed from an historical perspective, both on a global scale and within North America, and from the standpoint of its potential use to Manitoba's native northerners in the latter half of the 20th century.

REINDEER HUSBANDRY

Taxonomy and Nomenclature of Reindeer and Caribou

The taxonomy of caribou in North America and reindeer in Eurasia was, for some time, a matter of confusion among zoologists. Prior to Banfield's (1962) revision of the genus *Rangifer*, it was considered that there were four caribou species in Canada, namely *arcticus*, *caboti*, *pearyi* and *caribou*. *Rangifer arcticus* was further subdivided into six subspecies (Kellsall, 1968). The native reindeer of Eurasia (*Rangifer tarandus tarandus*) was thus considered to be a different species.

Banfield's revision greatly simplified this taxonomy and seems to have received general acceptance. He reclassified all Canadian caribou as five subspecies of the single species *tarandus*. Thus, the barren-ground caribou of the Kaminuriak population whose range extends into northern Manitoba is scientifically known as *Rangifer tarandus groenlandicus* (Banfield, 1962, 1974). Only a subspecific difference exists between reindeer and caribou. Phylogenetically, both species are closely related and have similar biological requirements.

Common names used in reference to caribou can also be confusing. Early explorers first called them reindeer and later shortened the name to deer. *Tuktu*, an Eskimo word, has also been used by English-speaking peoples, and the French term *la foule* has received widespread use. The most commonly used term, "caribou", is usually reserved for the wild North

American species, whereas "reindeer" normally designates its domesticated or wild Eurasian cousin.

Range Requirements of Reindeer

Domesticated reindeer have virtually the same requirements as our native caribou. Basically, three ranges are required: winter range, summer range, and spring and fall range.

Winter Range Requirements

An abundance of lichens must be present. Most species are palatable. Arboreal lichens are a beneficial resource when snow conditions become adverse. Normally this resource is for emergency only, although it has been shown to be extremely important for woodland caribou (Stardom, 1972).

Winter grazing should not commence until after a good fall of snow has accumulated, otherwise severe damage will occur to the brittle lichen mat through trampling by reindeer. Snow cover protects the lichens from such damage (Skuncke, 1969).

A wet, freezing autumn can lead to such a heavy accumulation of ice on the lichen mat that reindeer are unable to free the lichens from it. Thus, consideration should be given to companion shrubs which will protect the lichens to some extent.

Snow cover must be below a particular thickness/density combination. For example,

Density of Snow Cover

Thickness of Snow Cover

0.2 g/cm ³	over 50 cm
0.3 g/cm ³	not over 50 cm
0.4 g/cm ³	not over 20 cm

If these combinations of density and thickness are exceeded, reindeer have difficulty feeding, which may lead to poor nutrition and/or starvation depending on the severity of conditions. Caribou have similar requirements but are free to locate suitable conditions (Nasimovich, 1955; Pruitt, 1959a, 1959b).

Spring and Fall Range Requirements

Reasonably close proximity to winter and summer ranges is essential. The spring range is used for fawning and must be well sheltered due to late blizzards and erratically falling temperatures. Good rangeland (ample green forage) must exist between the fawning area and the summer range. During migration between the fawning area and the summer range, the calves, being less sturdy than the adults, slow the movement of the herd and thus increase forage requirements along the migration route.

Summer Range Requirements

Grasses, sedges and other herbaceous perennials, along with young leaves and twigs of willows and dwarf shrubs, form the desired diet of reindeer in summer. Summer range should be rotated in order to allow for recovery of vegetation.

The height of the fly season (mosquitos and blackflies) is from the end of June to mid-August; the deer warble fly and the nostril fly (both parasites of reindeer) pupate and emerge at this time. These insects greatly torment the reindeer. Therefore, it is essential that some high or coastal location exposed to the wind be close-by, allowing the animals to obtain relief from this torment.

Generally, low relief is desirable for reindeer. However, it must

not be too wet, otherwise dermatitis and/or foot rot may develop.

Herding Requirements

"Close" herding (i.e., continuous guarding and supervision of the herd through all adverse weather conditions) is a basic requirement for reindeer husbandry, otherwise losses through predation and straying will be greatly increased. Another factor demanding close herding includes the fact that a natural indigenous caribou migration may "hijack" a herd of domestic reindeer if the caribou pass sufficiently close-by. Three herds were lost in such fashion in Alaska in 1947 and 1960, representing 2,000 reindeer worth \$80,000. Thus, extremely careful herding is required when reindeer and caribou come into close contact (Brady, 1968; Lantis, 1950).

All previous reindeer husbandry experiments in North America have indicated that success is in direct proportion to herding intensity.¹ This demonstrates the extreme importance of dedication and commitment on behalf of the herders.

The seasonal rhythm in the life of reindeer, reindeer husbandry, farming and forest management were summarized in an explicit table by Helle (1966). As farming and forestry aspects have little relevance to this study, the table is reproduced here only in part, (Table I).

Baskin (1970) produced a table similar to that of Helle but provided sufficient additional detail in specific areas to warrant its duplication

¹The Mackenzie Delta Reindeer Project is an exception due to the inclusion of the Tuktoyaktuk Peninsula as summer range, complete with natural boundaries which make close herding non-essential during summer.

TABLE I

Seasonal rhythm in the life of reindeer and reindeer husbandry in Finland

		August	September	October	November	December	January	February	March	April	May	June	July	
Temperature (broken curve) and amount of precipitation (solid curve and shaded area) in Ravaniemi	20°C 100 mm	[Graph showing temperature and precipitation curves]												
	10°C 80 mm 0°C 60 mm -10°C 40 mm -20°C 20 mm	[Graph showing temperature and precipitation curves]												
Depth of snow in 1949-1950 in Ravaniemi		[Graph showing snow depth curve]												
Principal forage plants of reindeer		[Table showing forage plants: Cladonia, Deschampsia, Eriophorum, Carex, Menyanthes, Vaccinium, Salix, Betula, Boletus, Mushrooms]												
Reindeer pastures	Mountain reindeer	Continued from July) . . bushes and twigs		In mountains grazing on lichens and withered grass		Grazing in the birchforest zone on lichens		In the pineforests grazing on lichens which lie under the snow			Because of hard snow, grazing in the birchforest		Grazing on lichen and hay in snowless spots near forest border	In mountains grazing on hay and leaves . . (Continued)
	Forest reindeer	(Continued from July) . . and twigs		Fungi and mushrooms, etc.		Grass and hay, etc.		Mostly lichens			Grass in the snowless spots		Hay and grass and leaves of bushes . . (Continued)	
Reindeer's life rhythm		(Continued from July) . . are as a plague		Rutting period, reindeer in flocks		Reindeer are scattered all over					Calving time		Shed their hair and insects . . (Continued)	
		(Continued from July) . . all over									In small flocks of few animals		Scattered . . (Continued)	
Reindeer management		Gathering of reindeer and identification of animals for owners, slaughtering for sale and shepherding the flocks						Identification of calves for owners						

After Helle (1966)

here (Table II).

Tables I-II provide considerable detail regarding reindeer *per se* and reindeer husbandry. In combination, they form a veritable manual for reindeer husbandry. Table I (after Helle, 1966) is based on the industry in Finland and Table II (Baskin, 1970) is based on Soviet experiences.

Current Status of Reindeer Husbandry in the Global Arctic

The U.S.S.R. is the world's largest producer of reindeer: the population of reindeer is estimated at 2.5 million. In the U.S.S.R. reindeer husbandry, through traditional herding practices and modern scientific management, is not only socially and economically viable, but is considered an extremely important element of the northern economy. However, it must be understood that there are problems. In 1968, an "expeditionary party" (task force or study group) recommended ". . . carrying out tests to determine the feasibility of several different methods of managing the industry to find an alternative to the nomadic way of life associated with reindeer husbandry" (Avdeev and Kondakov, 1968) which signifies that, even in the U.S.S.R., reindeer husbandry does not provide a desirable lifestyle to northern people, though these people are pursuing aspects of their traditional way-of-life. Their traditional way-of-life included many rights that have since been lost, and it is speculated that reinstatement of proprietary rights for herders may have potential to improve the desirability of the lifestyle. Klein (1974), with reference to the U.S.S.R. reindeer industry, states, "Interest in reindeer herding as an occupation understandably is declining . . . The major obstacle to achieving the official goal of expanding the reindeer industry to occupy

TABLE II

Pasturing seasons in reindeer husbandry in the U.S.S.R.

	Early spring	Late summer	Beginning of summer	Mid-summer	End of summer	Early autumn	Late autumn	Early winter	Mid-winter	End of winter
Phenological phenomena	Appearance of frozen snowcrust Appearance of thawed patches	Appearance of thawed patches Appearance of first verdure. Cotton grass begins to bloom	Appearance of leaves on willows and dwarf arctic birch Beginning of hot days and massive onsets of midges ("mosquito time")	Beginning of "mosquito time". Coarsening of verdure. First summer frosts	End of polar day Beginning of second vegetation End of second vegetation. Appearance of mushrooms	Appearance of mushrooms Beginning of yellowing of leaves	Beginning of yellowing of leaves Disappearance of green vegetation	First lasting snow, freeze-up Small shrubs wholly covered with snow	Dwarf trees wholly covered with snow Appearance of frozen snowcrust	Appearance of snow blowoffs Appearance of frozen snowcrust
Biological phenomena	Bucks and barren does shed antlers	Calving. Discharge of botfly larvae	Beginning of movement of the herd in northern direction. Shedding of hair; beginning of growth of antlers (fawns and does)	End of shedding of hair. Struggle of reindeer with midges by crowding together	Adult bucks clean their antlers. Beginning of fattening of does	Two-year old bucks have begun their rut. Fattening of does	Rut of adult bucks; fattening of does. Does cleaning their antlers	Adult bucks shed their antlers	Wintering	Wintering
Main foods	Lichen, tree mosses	Lichen, plant remnants	Willow leaves, motley grass	Aftercrop of willows, second verdure of motley grass	Alder leaves, mushrooms, second verdure of motley grass	Alder leaves, mushrooms	Lichen, verdure along edges of marshes	Lichen, verdure, green winter plants	Lichen, green winter plants	Lichen
Grazing phase	Passing to calving pastures	Calving takes place	On the way to summer pastures; fattening	Summering, fattening	Turning from summer to autumn pastures	Mushroom season	Rut takes place. Fattening of reindeer	Migration to winter pastures	Wintering	Migration to mountain tops
Zootechnical measures	Straying away of pregnant does. Castration	Calving takes place. Castration	Summer grazing	Summer grazing	Summer grazing. Dehorning	Rut takes place	Rut takes place	Head count. Organization of grazing herds	Delivery of production to State. Wintering	Wintering

Source: Baskin (1970)

all available rangelands is the shortage of herders".

On the economic side, Diachenko (1970) states that, "In terms of existing state purchase prices this number of reindeer (2.5 million) may yield about 100 million rubles". This is approximately \$125 million.

Reindeer husbandry is economically profitable in the U.S.S.R. primarily due to low production costs. Herders, pilots, veterinarians and biologists are all paid low salaries relative to those which would be paid in Canada. Furthermore, as the meat yield is only approximately 120 million pounds, the meat is valued at approximately \$1.00/pound. Thus, with high meat value and low-cost labour input in a labour-intensive industry, the reindeer industry in the U.S.S.R. is both beneficial and economically viable. In addition, the industry receives further priority because the U.S.S.R. is sparing little effort to achieve agricultural self-sufficiency.

In Scandinavia, there are approximately 700,000 domestic reindeer (Klein, 1974). Helle (1966) estimated that the meat production in Finland in 1964 was 2,140,000 kg, representing a return of approximately 20 percent on the capital investment in the deer but excluding consideration of the owner's own labour input, which may be considerable. Reindeer husbandry in Scandinavia is considered beneficial to the national economies from the point-of-view of producing jobs and a reserve supply of meat. Helle (1966) also pointed out that through reindeer husbandry it is possible to utilize a natural resource (*i.e.*, rangelands) which would otherwise largely remain unused.

Domestic reindeer in Alaska currently number 30,000 (Klein, 1974;

Brady, 1968). In 1967 the gross income from reindeer herding was estimated at \$300,000. Brady (1968) states: "Reindeer butchered for home use and herd operations have a substantial impact on the subsistence economy of western Alaska, even though operators receive little or no net profit".

A 1963 report on the reindeer industry by the U.S. Bureau of Indian Affairs (cited in Brady, 1968) states:

Reindeer are the major, if not the only significant resource of Northwest and Western Alaska -- an area as large as the State of Texas. They are the only large animal subject to domestication¹ which can live year-round on the tundra. Few, if any other resources exist in the area which can provide cash income, employment, and a growing local source of food, clothing and craft materials.

This statement tends to pall when we consider the socio-economic conditions prevalent in Alaska at that time. In 1963, the same agency estimated that the real income (discounting welfare, hunting and fishing) of native people was about \$500 per annum (Brady, 1968).

It appears, therefore, that the reindeer industry in Alaska will continue to exist in order to provide for the subsistence needs of the native people. However, the probability of reindeer husbandry providing a reasonable living standard for these people, under current economic conditions, seems remote.

In Canada the reindeer husbandry industry comprises only one herd located in the Mackenzie Delta. The population is estimated at 8,000 animals by its current owner, Silas Kangeana, who bought the herd from the Government of Canada in 1974. Obviously, this man is confident that he can run the enterprise economically as he has made a substantial fi-

¹The author of this report failed to consider muskox.

nancial commitment in making the purchase.

Table III provides an indication of the variable economic returns which can be obtained relative to production and wholesale meat prices in Canada.

The History of Reindeer Husbandry in North America

Reindeer husbandry in North America is a relatively new means of livelihood. It was never practiced by native people prior to the coming of the white man. Its origin in arctic and subarctic regions of Eurasia is shrouded in the mists of prehistoric times; dating estimates suggest that it began around 2000 B.C. (Scotter, 1970).

The history which follows brings together various accounts of North American attempts to introduce reindeer husbandry in arctic and subarctic regions of this continent. It is evaluated by area rather than in chronological order.

History of Reindeer Herding in Alaska

In the late 1800's the Eskimos of coastal western Alaska reportedly faced starvation due to depleted wildlife populations. This situation (a recurring syndrome in this history) prompted Captain M. A. Healy, commander of the revenue steamer "Bear", to suggest to Dr. Sheldon Jackson the first superintendent of education in Alaska that reindeer be introduced to Alaska from Siberia (Brady, 1968).

Jackson was impressed, and between 1891 and 1902 he imported 1,280 reindeer for a cost of \$2,146. In addition, Norwegians, Lapps, Finns and Siberians were brought to Alaska to instruct the Eskimos in herding practices (Brady, 1968).

TABLE III

Financial significance of variances in production rate and in wholesale meat price

Percent of animals slaughtered	Actual number of animals slaughtered ¹	Pounds of meat @ 125 pounds per animal	Total wholesale meat prices				
			\$0.50/pound	\$0.75/pound	\$1.00/pound	\$1.25/pound	\$1.50/pound
13 ²	650	81,250	\$40,625	\$60,983	\$81,250	\$101,563	\$121,875
20 ³	1,000	125,000	62,500	93,750	125,000	156,250	187,500
30 ⁴	1,500	187,500	93,750	140,625	187,500	244,375	281,250
50 ⁵	2,500	312,500	156,250	234,375	312,500	390,625	468,750

¹Number of animals slaughtered is based on a herd of 5,000 reindeer.

²Meat yield based on 13% slaughter, the anticipated yield of a low-overhead operation in the Mac-kenzie Delta.

³Meat yield based on 20% slaughter, the anticipated yield of a high-overhead operation in the Mac-kenzie Delta.

⁴Meat yield based on 30% slaughter, the average yield in the U.S.S.R.

⁵Meat yield based on 50% slaughter, the highest yield obtained in the best herds in the U.S.S.R.

Herds developed rapidly and by 1911 there were 33,629 reindeer in 46 herds in Alaska. The first shipment of reindeer meat left Alaska in that year, when 125 carcasses were shipped to Seattle (Brady, 1968).

Palmer (1926) wrote that, "The reindeer industry in Alaska, though still in its infancy, promises with guidance to become an important factor in the future development of the Territory". Indications at that time were certainly full of promise. The reindeer population had increased to 350,000 head in 110 herds, and during the period 1918-1925 in excess of 1,875,000 pounds of reindeer meat were shipped from Alaska (Palmer, 1926).

However, this was not as profitable to the Eskimo as it might appear. A new era for the industry had begun in 1914 when Carl J. Lomen purchased 1,200 reindeer. Lomen and his brothers proceeded to establish a massive reindeer industry in Alaska (Brady, 1968).

The Lomen Brothers (or Lomen's Northwestern Livestock Corporation) prospered. In 1930, the peak year of Alaska's reindeer industry, 2.5 million pounds of meat and 20,000 hides were exported. The 1930's also marked the decline of the industry. Several complex factors and interactions were involved. Some, regarding the Eskimo herds, were outlined as follows by Lantis (1950):

1. Eskimos were not enthusiastic about the herding way of life. The monotony and privations of herding were¹ not a satisfactory alternative to hunting and fishing.
2. Wolves, lynx and other predators were constantly attacking the deer.
3. As herds increased in size, the number of encounters with native caribou populations became more common, and reindeer were 'hi-jacked' by migrating caribou herds.

¹Whereas it may be speculated that the herding practices of the Lapps may relate back to their cultural origin in a more southerly climate, there is no evidence that this the case, as the cultural origin remains unknown.

4. It became increasingly difficult to keep account of the animals as herd size increased and different herds mingled.
5. Some ranges had been overgrazed. Lichens (reindeer mosses) take a long time to recover from this treatment.
6. Bot-flies and warble-flies, the parasites of all reindeer, weaken and madden the herds. Relief from these tormenting insects is found in water or on wind-swept ridges, which were not always available.
7. Lomen's influence on Eskimo herding was adverse. Hired herders were pirating the Eskimo herds and several thousand company reindeer were feeding on Eskimo ranges. Obviously, the Eskimos resented this.

The decline of the Lomen Company was no less complex. Some reasons for it are given by Lantis (1950):

In 1931, the Reindeer Service issued complicated new range rules . . . One can imagine sorting and marking fawns, tallying accurately, figuring percentages, in the terrific hurly-burly and noise of corralling several thousand deer, often in bad weather . . . With large numbers of reindeer of so many owners running together, with fawns separated from their mothers, and with so many adult strays, some such scheme for crediting animals to owners had to be used.

These measures resulted in failure. The Lomen Company had difficulty making a profit, not only for the above reasons but for a variety of others, largely associated with the remoteness of the operation from its market. The depression of the 1930's was also an influencing factor. Most Americans preferred beef to reindeer, and some states prohibited the sale of reindeer, classifying it as game. Vilhjalmur Stefansson has claimed that the tremendous livestock interests of the Western States were responsible for this and other restrictive measures.

In 1939 the Lomen Brothers sold their company, lock, stock and bar-

rel, to the government. Herds declined, and by 1950 the population was reduced to 25,000 (Brady, 1968). In 1969 there were approximately 30,000 reindeer in Alaska and the government was attempting to re-establish the industry. To my knowledge, attempts to date have not met with great success (Pruitt, pers. comm., 1974), and the population still remains at 30,000 (Klein, 1974).

History of Reindeer Herding in Newfoundland and Labrador

Dr. W. T. Grenfell of the Grenfell Mission at St. Anthony was impressed by the success of the reindeer industry in Alaska, and in 1908 he introduced 300 reindeer from Norway. Three Lapp families were brought to Newfoundland to herd the animals but again early success preceded failure. By 1912 the herd had increased to about 1,300 animals, but the Lapp herders liked neither the wet climate of Newfoundland nor the low pay and decided to go home. Poaching, indifference and ignorance among the local people, together with a lack of animal supervision, quickly reduced the herd to 230 head. One hundred and fifty were successfully rounded up and moved to Rocky Bay, Labrador. They were subsequently removed to Anticosti Island where they are believed to have become extirpated (Cameron, 1958).

When Grenfell imported his reindeer, 50 of them were to be delivered to the Anglo-Newfoundland Development Company Limited (AND) at Lewisporte. The main interest of the AND Company in reindeer was as beasts of burden to haul pulpwood and supplies in the winter. Because of a late departure from Norway and ice conditions in Notre Dame Bay, all reindeer were disembarked at Cremaillere Bay. Conditions were not good there

either and the reindeer had to swim ashore. In order to deliver the animals to Lewisporte, a decision was made to drive them overland and this led to Hugh Cole's reindeer trek down the northern peninsula of Newfoundland March 4th to April 30, 1908 .

The story of events was narrated by Arthur Johnson (1962). The party was beset by poor weather conditions as indicated by excerpts from Hugh Cole's diary: "three feet of snow", "made only four miles", "raining incessantly making travel impossible", "after seventeen days on the trail we put up camp for the first time", "encountered terrific storm". Hugh Cole finally arrived at his destination, only to find that the AND Company had grossly erred. There was no reindeer food; no survey had been made, on the assumption that, if reindeer have suitable pasture at St. Anthony, they have suitable pasture all over Newfoundland. So Hugh Cole drove the reindeer back to South Brook where they were loaded on the coastal boat and returned to Grenfell in St. Anthony. The original 50 animals now numbered 73 and were given to Grenfell as a gift.

History of the Baffin Island Reindeer Operation

In May 1919 the Government of Canada set up a Royal Commission to investigate the feasibility of raising domestic reindeer and muskox in northern Canada.

Stefansson, a member of the commission, applied for and was granted grazing privileges in excess of 100,000 square miles of Baffin Island. This was prior to completion of the report of the Royal Commission. Stefansson proceeded to hire a botanist to evaluate the range. He also persuaded the Hudson's Bay Company to establish a subsidiary company,

namely The Hudson's Bay Reindeer Company, of which Stefansson was to be a director and technical advisor (Scotter, 1970).

Vegetative conditions were judged suitable on Baffin Island, and in 1921, 550 reindeer were imported to Baffin Island from Norway. Upon landing, the reindeer scattered and only 230 were recovered by the six Lapp herders who had accompanied the reindeer from Norway. This operation was doomed from the start and there was not even temporary success. The reindeer were lost, the Lapps went home, forage was poor and the grazing permit was cancelled in 1927. The experiment ended in total failure at a cost of \$200,000 (Scotter, 1970).

The Hudson's Bay Company attributed the failure to a lack of feeding grounds and probably justifiably so; Stefansson blamed the herders. Scotter (1970) explained the probable nature of events. Caribou and reindeer have basically identical range requirements. However, the animals have behavioural differences. Whereas caribou are free to graze freely over vast areas, reindeer are confined through herding. Thus, if lichens (winter feed) exist only in scattered pockets, pasture that can support caribou will become useless for domesticated reindeer due to herding difficulties, as the reindeer will exhibit stronger roaming tendencies than normal in order that they can find suitable food.

History of the Mackenzie Delta Experiment

In 1911 the Government of Canada acquired 50 reindeer from Grenfell at St. Anthony. They were shipped across the Straits of Belle Isle, freighted by rail to Edmonton, transported by wagon and horses and finally trucked and canoed to Fort Smith, N.W.T. Throughout the trip, the herd

dwindled and was finally reduced to one animal. At this point, the Canadian Government decided to end the experiment and instructed the herder to kill the sole-surviving reindeer. He did as instructed and there was a steak barbecue in Fort Smith that night; those steaks are reputed to have cost the government \$286/pound. The drive lasted five years at a total cost of approximately \$62,000. Billy McNeill was the herder, and the journey is well documented (see Hedlin, 1961; Inglis, 1969).

The report of the aforementioned Royal Commission was published in 1922, containing recommendations concerning muskox and reindeer. Some of the more pertinent recommendations are as follows:

4. That small experimental reindeer herds be established in a number of such localities as may, after searching Departmental investigation, be found most desirable in points of vegetation and otherwise.
5. That in the selection of the localities for these stations, the needs of the natives, in the matter of food supply, be given the most careful consideration.
6. That where suitable arrangements can be made, the various missionary bodies be requested to co-operate in an earnest effort to ensure the success of the undertaking, not only by influencing the natives to protect the animals, but also by encouraging them to learn how to handle and care for them, so that, as in Alaska, they may become herders and eventually owners of herds.
7. That at least one experienced Lapp deer-man should be detailed to each herd, this being necessary, not only to avoid mistakes in handling the deer, but to ensure that the instruction given to the natives is of a sound and practical character.

. . . Altogether apart from the proposed introduction of domestic reindeer the vast herds of wild CARIBOU which undoubtedly still exist in the interior mainland areas,

repeatedly referred to in this report, constitute a valuable national asset, the importance of which, if properly dealt with, can be enormously enhanced, and your commissioners therefore respectfully recommend:

11. That an earnest effort be made to ascertain as soon and as closely as possible the numbers and movements of the Barren Land Caribou, especially those on the mainland and on the islands adjacent thereto; as also the numbers and movements of the caribou of other varieties, particularly those in the Yukon Territory and in northern British Columbia.
12. That a comprehensive survey be made of the vegetation and other conditions having a bearing on the support of herbivorous animals in the interior area, with the object of securing information as to the comparative value of the various districts for grazing purposes; the extent of which these natural pasture lands are now being used by the caribou; the approximate numbers of additional caribou or reindeer which might reasonably be expected to find sustenance in the different districts.

It will be obvious that in securing accurate and reliable data on these points, the migratory habits of the caribou and the length of time required to reproduce the reindeer moss after it has been eaten down, will have to be closely studied . . .

13. That special attention be given to the enforcement of such regulations as will effectively prevent the wasteful or useless slaughter of the wild caribou, either by natives or others.
14. That an intelligent and systematic campaign be inaugurated, having for its object the extermination of wolves, wolverines and such other animals as prey upon the caribou.
15. That at each of the Reindeer Experimental Stations, the establishment of which is recommended herein, provisions be made for the domestication, on intelligent lines, of such numbers of your wild caribou as may be conveniently handled with the reindeer herd.

The foregoing recommendations led to the establishment of the Macken-

zie Delta Reindeer Operation. The underlying justification was similar to the Alaskan situation: introduction of firearms had led to increased killing of caribou and depletion of caribou numbers, upon which the Eskimos depended for food.

Porsild (1929) reported the initial action of the government: "In May, 1926, I received instructions from the Director of the North West Territories and Yukon Branch of the Department of the Interior for my brother, Robert T. Porsild, and myself to investigate the reindeer grazing situation in certain defined areas in the Northwest Territories."

Porsild's approach to this assignment was to investigate the situation in Alaska. He then made surveys of the area north and east of Aklavik (including the Tuktoyaktuk peninsula) and an area north of Great Bear Lake (Porsild, 1929).

Porsild's 1929 report was quickly acted upon by the government and in the same year an agreement was made with Carl Lomen, "The Reindeer King of Alaska", to drive 3,000 reindeer 1,600 miles from western Alaska to the east shore of the Mackenzie River Delta (Scotter, 1966).

Scotter (1966) referred to this reindeer journey as "a saga of human endurance". Andy Bahr, a 60 year-old reindeer herder, was the leader of the expedition which took five years to complete. Problems encountered were similar in nature to those encountered by Hugh Cole on his trek down the northern peninsula of Newfoundland.

Two thousand, three hundred and eighty-two deer arrived at their destination and gave birth to 800 additional fawns a few weeks later. Only 10 percent of the herd made the whole journey, the remainder being born on the trail (Scotter, 1966). The cost of the herd to the government was

\$195,000 on delivery (Dickie, 1968).

Porsild (1929) had concluded that the arctic coast and Eskimo Lake regions of the Mackenzie District had a carrying capacity of 250,000 reindeer. This estimate was later found to be extremely high and was reduced to a carrying capacity of 30,000 head (Scotter, 1970) on a range one-third the size proposed by Porsild.

Initial success quickly followed the introduction of reindeer. The herd increased in size, native people began to learn herding methods and native-owned herds were established. By 1942 there were approximately 9,500 reindeer on the reserve (Scotter, 1970).

The 1950's, like the 1930's in Alaska, brought about a recession for the reindeer industry in the Mackenzie Delta. Many of the reasons were similar to the Alaskan story: loss of interest on behalf of native people, alternative means of livelihood, predation, poaching, disease. The operation was further complicated by having the decision-making body located in Ottawa. Scotter (1970) suggested that the application of Lappish close herding methods as opposed to semi-open range grazing also contributed to failure.

All herds were returned to the government by 1964. The government was in a position of not really knowing what to do. Indications were that the experiment had been a failure. However, something had to be done with the 7,000 remaining animals, and, as a stop-gap measure, the government contracted management of the herd to various private individuals for the period 1961 to 1968. Expenditure exceeded revenue in the ratio of 3:1, and the herd size dwindled to 2,756 animals (Scotter, 1970).

In 1968 management of the operation was placed under the direct con-

trol of the Canadian Wildlife Service (C.W.S.). From 1968 to 1973, scientific study of the herd was undertaken by C.W.S., and the size of the herd grew to 4,000 animals.

During my investigation of this operation, I got the impression that the Canadian Wildlife Service wanted "out", and this is understandable as domesticated reindeer are not wildlife in the true sense of the term.

In any event, the herd was scheduled to be sold in its entirety to Silas Kangeana, an Eskimo resident of Tuktoyaktuk. He has worked with the "reindeers" (as he calls them) for over 20 years, and indications are that he may manage a successful operation.

Kangeana (pers. comm., 1974) estimates that there are approximately 8,000 reindeer in the herd now. He bases this figure on the government figure of 4,000 animals plus 1,000 strays which he has rounded up plus 3,000 calves which he estimates were born in the spring.

Discussion

Reindeer husbandry in North America has had a rather inauspicious history. In all cases but one, initial success has been followed by failure. The question in the minds of many people is why reindeer husbandry is so successful in the U.S.S.R. but a dismal failure in North America.

This is a question which cannot be easily answered. The foregoing histories provide the accepted reasons for failure of each of the individual experiments. It is readily evident that there is a common theme running through all of them which I interpret as a socio-economic influence. Socio-economic policies in North America are very different from those of

the U.S.S.R., the Kolkhozes (collective farms) and Sovkhozes (state farms) of the U.S.S.R. having no true counterpart in North America. In fact, our closest equivalent to a Soviet Kolkhoz is a Hutterite farm colony. Whereas it is contended that the absence of property rights in the U.S.S.R. is a negative factor in evaluating the productivity of reindeer, the Sovkhozes and Kolkhozes with attendant non-voluntary labour attributes are a significant positive factor.

Another point worthy of consideration is the Soviet desire to become self-sufficient in food production by exploiting all its regions for the production of food. The boreal forest or taiga was the only region in the U.S.S.R. without a domestic animal until the recent domestication of the moose (Knorre, 1956).

North America is the world's largest food producer and consequently does not feel pressured into maximizing food production to the same extent as the U.S.S.R. The economic viability of any operation is of greatest concern to North Americans. Should reindeer meat become worth \$5.00/pound as opposed to \$0.60/pound, we could feel confident that our vast northern tundra would be utilized to maximize the production of reindeer.

Biologically, reindeer husbandry is feasible in North America, as the experiments have shown. Most operations have failed for socio-economic reasons.

Reindeer Husbandry as a Land Use for Northern Manitoba

Availability of Suitable Rangeland

Lichen woodlands are quite abundant and suitable for winter range. Sedge meadows required for summer range appear to be rather sparsely distributed, although sufficient to support small herds. The most suitable

and largest summer ranges exist in the Northwest Territories, north of 60°. Most of the summer range in Manitoba is already occupied by caribou, albeit at a reduced density. Spring range/fawning areas would have to be determined locally. Suitable areas exist, but the presence of lynx may create a serious predator problem (see Bergerud, 1971).

Feasibility

During the summer of 1974, two Soviet reindeer scientists, from Noril'sk, Drs. Zabrodin and Yakushkin, were the guests of the Government of Manitoba in order that they could assist the government in a biological evaluation of northern Manitoba with respect to the feasibility of raising reindeer there.

The tentative conclusion is that it is biologically feasible to raise reindeer in northern Manitoba, within certain limitations (Bossemmaier, 1974). These limitations are as follows:

1. Five or six herds could be raised.
2. The total number of animals would not be less than 800 to 1,000 head per herd.
3. The reindeer would be raised in the coastal zone (see Figure 1).
4. Six herders would be required for each herd.

Furthermore, it is considered that these numbers of reindeer would have no adverse effects on existing populations of caribou.

The obvious implication of herd size (eg., 800 to 1,000 animals) is that the productivity of a unit will be insufficient to produce a reasonable financial return for the individual herders (a relatively large number). Equally important are the social implications. Herds would be

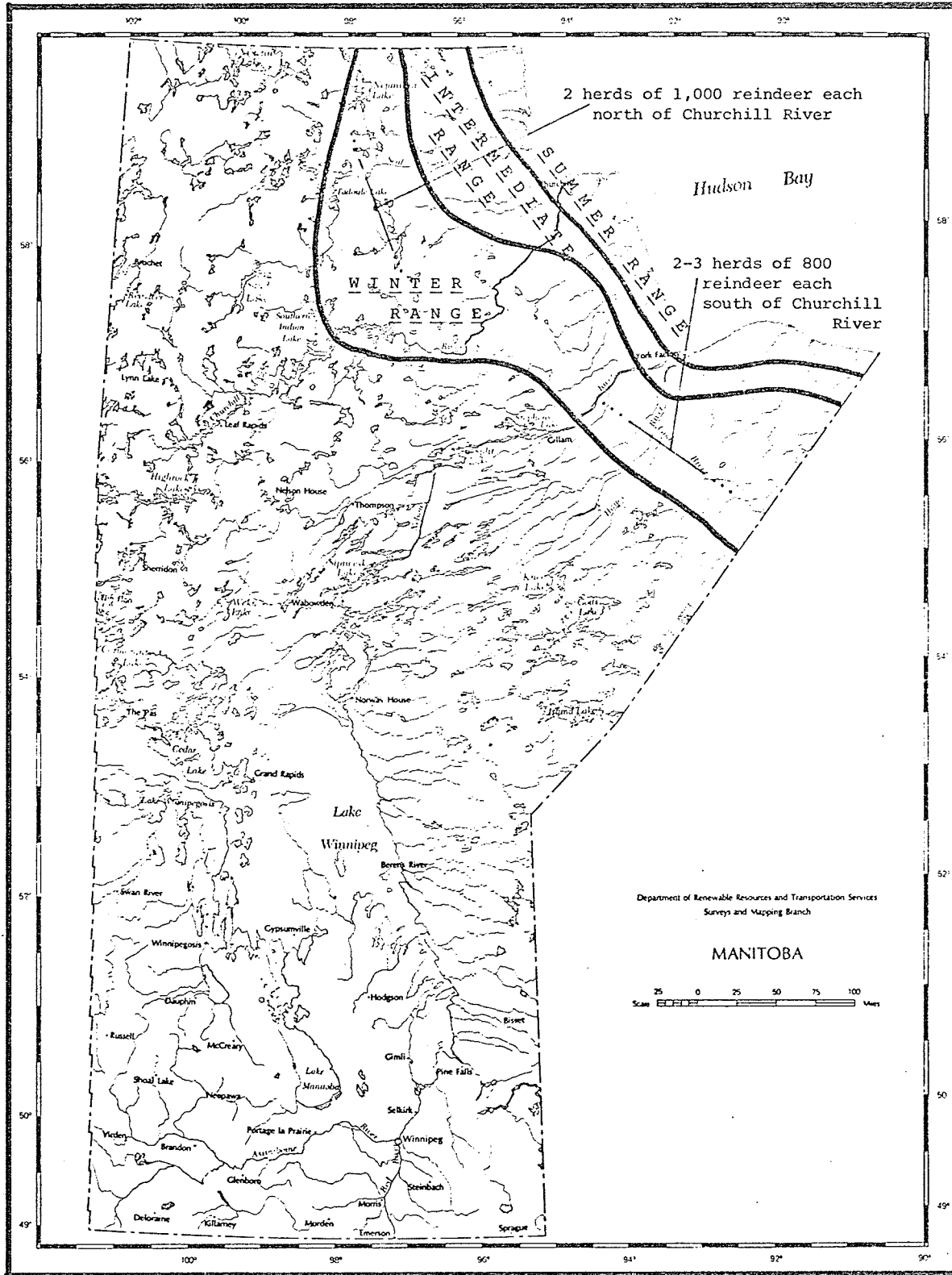


Figure 1. Preliminary range assessment for reindeer in Manitoba by Soviet biologists.

grazed at considerable distances from communities, creating disjunction of family units. Such privation, coupled with the monotony of reindeer herding, is not likely to be tolerated by native people for any prolonged period.

Large herds, requiring the cooperation of the Government of the Northwest Territories in the provision of summer range, are not considered. Such operations would involve N.W.T. rangelands to a greater extent than Manitoba rangelands. Furthermore, the following discussion could be equally related to such considerations assuming the cooperation of the N.W.T. Government.

In Manitoba we are faced with the predicament of a major reduction in the wild caribou resource on which northern native people were and still are largely dependent. This factor, coupled with the desire to increase the productivity and utilization of far northern resources for the benefit of northern people, suggests that a reindeer industry could prove a beneficial enterprise for northern Manitoba.

There are four approaches to considerations of establishing a reindeer operation in Manitoba:

1. The economic approach;
2. The social values approach;
3. The biological approach;
4. An approach combining all three of the above.

1. The Economic Approach:¹

This is the only approach that can be accurately evaluated at this

¹The details of the economic analysis are included in Appendix A.

time. Cost/benefit analysis, on the basis of a Crown corporation reindeer operation containing 1,000 head, conservatively indicates annual financial losses in the region of \$38,000 with a cost/benefit ratio of 0.69. Even these figures are optimistic in the sense that (1) they are based on a production of 300 animals/1,000 head of reindeer, (2) the value of the meat (in whole carcasses, not cut, wrapped or frozen) is estimated at \$1.00/pound and (3) considering the conditions under which the herders are required to work, \$6,000/annum/man is not considered to be overly remunerative.

Modification on the input side (*i.e.*, the herding) could favourably influence the economics of reindeer husbandry. Consider that two families choose to herd a group of 1,000 reindeer, rotating family duties on a monthly basis. With capital expenses being in proportion to the foregoing, a net family income of \$14,000 could result, provided the foregoing production figure (300/1,000) was not reduced.

However, it must be stressed that these figures are based on average Soviet production figures, a state of achievement unlikely to be equalled in Manitoba for a considerable time.

2. The Social Values Approach:

This approach hinges very largely around the question "Would it be better for those people to be out on the tundra herding reindeer rather than subsisting on welfare in the settlement?" The immediate answer which comes to mind is "Yes, of course it would!" But, deeper consideration reveals a lot of questions which must be answered:

1. Effects of family disruption when the male is away from home for two weeks or more at a time.

2. The realization that the job of reindeer herder is another form of government subsidy, differing from welfare only in degree.
3. The effects of boredom and dullness normally associated with reindeer herding.

Obviously, these questions have no cut-and-dried, yes-or-no answers. Nor can they be accurately assessed numerically to enable a cost/benefit analysis to be carried out. Consequently, any recommendation in this regard would have to be strictly subjective and therefore is not offered.

Modification of the herding input to a family basis rather than employment of six individuals could relieve some of the foregoing problems. Family disruption would be eliminated or at least substantially reduced, income would be related directly to production and these factors should reduce the problems of boredom and dullness to some degree. However, herding on this basis presents its own unique problems:

1. Schooling for children would need some modification, eg., boarding school or a more-flexible free-school schedule.
2. Families may not wish to spend extended periods of time on the tundra living under adverse conditions.

Reindeer husbandry requires a sustained commitment from the herder. He must feel dedication to and responsibility for the herd, otherwise large losses of animals will result.

My observations of native communities indicate that the people most-suited to making such commitments to herding are already productively employed at other activities such as fishing and trapping. In this regard, average production figures can be quite misleading as certain individuals are making a good income from these resources, whereas others included in the statistics are producing very little. Obviously, it is the individual

who is already productive who would, in all probability, be most-suited to making a sustained commitment to reindeer herding. Unfortunately, reindeer herding offers this individual less remuneration than his current activity, coupled with what appears to be a less desirable way-of-life. Many of the "unemployed" individuals are unlikely to make sufficient commitment to reindeer husbandry to make such activity productive.

3. The Biological Approach:

If reindeer are introduced to Manitoba, they will utilize caribou rangelands which, in their current understocked state, can accommodate reindeer. It is assumed that the reindeer herds will not come in contact with the wild caribou populations. Theoretically this is possible, but even with the best herding, there will be some straying albeit perhaps only one percent of the herd.

For the most part biologists do not approve of introducing reindeer. Their negative opinions do not centre on any particular aspect of the introduction, but rather on the basic ecological principle that the native caribou which have evolved in North America are most-suited to that rangeland. Based on this premise, most discussion ranges around the ethics or morality of introducing exotic species. Some examples of this attitude follow.

Hall (1963, cited in Scotter, 1970) stated quite categorically: "Introducing an exotic species is a destructive action resulting from the ignorance of wellmeaning persons . . . Introducing exotic species of vertebrates is unscientific, economically wasteful, politically short-sighted and biologically wrong."

Harper (1955) with reference to reindeer asks, "Would it not be the

part of wisdom to exclude the inferior domesticated alien, with its difficult and generally unsuccessful culture in North America, and thereby to give the wonderful wild caribou of the Barrens its best chance for survival?"

Murie (1939, cited in Harper, 1955) says,

The greatest hazard to the caribou is the possible occupation of the range by man's agricultural activities. The most serious danger is introduction of domesticated reindeer on wild caribou range, for the wild herds must be removed in order to make possible the safe herding of the domestic animal. There is not room for both of these animals on the same or closely adjacent ranges.

Harper (1955) forecasts the extinction of wild caribou:

Perhaps the worst threat of all to the caribou has been the introduction of reindeer culture along the arctic coast. This has resulted in interbreeding between the wild caribou and their inferior domesticated relatives. When and if this mixture extends to all the herds of the Barren Grounds, the caribou may be written off the record as a pure species; the animal will have become extinct through dilution, as the biologists express it.

Harper (1955), referring to earlier reindeer introductions across Canada, says, "The persons responsible were doubtless inspired by high humanitarian motives; but it is doubtful if they could have thoroughly considered or foreseen the serious biological consequences of their efforts."

Others are less dramatic and attempt to stall or avoid introductions through postulating the potential of caribou. Rutherford *et al.* (1922), in a report of a Royal Commission on reindeer and muskox, state:

Altogether apart from the proposed introduction of domestic reindeer the vast herds of wild CARIBOU which undoubtedly still exist in the interior mainland area, . . . constitute a valuable national asset, the im-

portance of which, if properly dealt with, can be enormously enhanced . . .

Scotter (1970) suggests that ". . . game ranching with caribou may be ecologically and economically more feasible."

There is virtual unanimity among biologists that such introductions are unwise, due to past experience with exotics in other parts of the world.

Historically man has made some disastrous mistakes through introductions of exotic species, e.g., deer to New Zealand and rabbits to Australia. Others argue that reindeer to North America also fall in this category. However, in spite of the introduction of reindeer to the Mackenzie Delta, the caribou population there has increased significantly albeit "genetically diluted" by reindeer. During the winter of 1973-74 the hunters of the town of Aklavik (total population 742) killed approximately 1,000 caribou. Carl Lomen (the Reindeer King of Alaska) considered a cross between caribou and reindeer to produce an animal superior to both (Rutherford *et al.*, 1922).

However, I believe that if all biologists voted on the subject of the introduction of domestic reindeer, the majority would vote against it. It can therefore, probably be concluded that, from the biologist's viewpoint, the introduction of reindeer should not take place.

4. The Combined Approach:

Throughout the global circumpolar zone, reindeer husbandry offers the herder monotony, privations, exposure to adverse conditions and poor remuneration for his services. Unfortunately the herding intensity recom-

mended cannot be reduced without significant herd losses being incurred, as previous experiments have indicated. At this point in time, a reindeer husbandry operation in northern Manitoba could be expected to provide the following without incurring "serious" financial losses:

1. Purposeful employment albeit for less than the minimum wage ;
2. Locally produced, high-quality meat¹ (30,000 pounds/1,000 reindeer herded) ;
3. Utilization of northern rangelands which currently are unused and show little potential for other uses, barring the restoration of caribou numbers ;
4. A lifestyle which few would care to endure solely for the remuneration which would be received ;
5. A reduction in welfare payments to certain communities .

The foregoing points do not indicate that any great overall benefits would accrue to the people of northern Manitoba through the introduction of reindeer.

On an international basis, the reindeer industry is experiencing difficulties, both social and/or economic. It would be presumptuous to assume that a Manitoba-based industry could avoid these problems.

In summary, it appears that reindeer husbandry cannot compete with the relatively cheaply priced beef of more southern climes. The reindeer industry is highly labour-intensive and increased labour costs appear to be squeezing the industry out of competitive capability in the 20th century economy.

¹The value of the meat is the wage basis for the herders, so the meat is not an additional financial benefit.

However, should the people of northern Manitoba desire to establish a subsistence low-key economy based on the renewable resources of the area, reindeer husbandry offers a potential which could scarcely be equalled by the restoration of caribou to their former high populations.

Throughout the circumpolar world, reindeer husbandry is the most economically and ecologically viable utilization of tundra rangelands; it is the most renewable (and therefore the most productive) utilization of the resource that man has developed. But, due to the low tundra productivity, reindeer cannot be expected to produce comparably with cattle. This fact is borne out by the subsidy paid to reindeer owners in Scandinavia (Helle, 1966) and by the suggestion of Scotter (1970) that "development of a luxury market for reindeer meat should be encouraged." A "luxury market" represents an artificially inflated price for a small volume of production, in effect a subsidy.

Therefore, although it is biologically feasible to raise reindeer in northern Manitoba, the economics, social deprivations and biologist's viewpoint on reindeer husbandry make it undesirable to encourage establishment of such an enterprise at this time.

Problems Which Must be Borne in Mind When Considering Domesticated Reindeer Husbandry in Northern Manitoba

Reindeer will utilize present and/or potential caribou (native barren-ground and woodland) rangeland. Straying reindeer eventually would interbreed with native caribou, as has happened in the Mackenzie Delta. Parasites present in reindeer may not be present in caribou. These parasites (which presumably cause no problems in reindeer) could conceivably be deleterious to caribou. Research would be required to clarify this

aspect. The reverse is also true.

Lichens in the global boreal regions, due to their longevity and methods of collecting airborne food particles, accumulate a rather high content of radioactivity. This radioactivity is, in turn, deposited and accumulates in caribou/reindeer flesh or bones, depending on the type of radiation (Pruitt, 1962). The degree of such contamination in northern Manitoba should be investigated before the caribou/reindeer intake of the northern people is greatly increased.

In the case of several past failures to successfully herd reindeer in North America, the major reason for lack of success is considered to be that the native people were not interested in reindeer herding due to the monotony of the lifestyle.

MOOSE HUSBANDRY

The Domestication of Moose

An experimental moose domestication farm was established in the Pechora-Ilych Forest Reserve of the U.S.S.R. in 1949 (Knorre, 1956, 1973; Kozhukhov, 1973; Yazan and Knorre, 1964). To date, this has been the most serious effort made to domesticate moose; several other attempts and experiments have been conducted and have met with partial success (Knorre, 1956, 1973). Moose were kept and bred in captivity in Michigan during the late-1930's and early-1940's (Kellum, 1941), and extremely tame moose have been raised in Alberta (Smeeton, 1974).

The Pechora-Ilych moose farm was established to solve the following problems (Knorre, 1973):

1. To study the biological peculiarities of moose and to develop adequate diets and rations, as well as a system of maintenance and of economic exploitation of the domesticated moose;
2. To produce a herd of domesticated moose comprising 20-30 head;
3. To study the vitality and reproduction of moose in captivity; and
4. To study the various possibilities of economic exploitation of moose.

Knorre (1973) reported that, by 1969, the experimental farm had successfully solved all of these problems, and a herd of domestic moose had been created. Currently, these animals reproduce normally and are exploited as

a source of meat, milk and as draught animals. The herd consists of animals of four domestic generations, some of which are 18 years old (Knorre, 1973). Since its establishment in 1949, the farm has obtained and reared 174 moose. The "fate" of these animals was listed by Kozhukhov (1973) as follows:

	Number of Moose	Percent of Total Number
Died of traumas	5	2.9
Died from different diseases	14	8.0
Died of food poisoning	5	2.9
Sacrificed in the cause of experimentation	2	1.1
Killed by predators	17	9.5
Killed by poachers	16	9.2
Disappeared on free pastures	30	17.1
Forced to be slaughtered	5	2.9
Slaughtered as animals not fit for breeding	30	17.1
Frozen to death in winter	5	2.9
Handed over to other organizations	27	15.5
Present in early May 1969	19	10.9
Total	174¹	100.0

Recent publications (Knorre, 1973; Mikhailov, 1973; Kozhukov, 1973) indicate that the Soviets consider this new domestic animal to have high potential for maximizing production of meat and milk and as a means of transportation in the taiga zone. However, to my knowledge, commercial moose farms have yet to be started.

The logistics of moose farming are rather different from those of other domestic animals in many ways, largely due to the fact that it is

¹There appears to be a typographical error in the original Soviet publication as these figures total 175.

a newly domesticated animal, and it is a boreal browser, requiring a relatively large area for sustenance and thus creating difficulties as far as application of traditional herding methods are concerned.

The moose, in its natural state, is a solitary rather than gregarious animal. However, the Soviets have found that this behavioural characteristic can be modified and that, through training, moose will browse in groups (Knorre, 1956). The obvious effects of such group browsing are beneficial in the sense that the herder can care for them more easily, but problems are created with the quick depletion of the browse resources. In simplistic terms, only so many moose can be raised per square mile and, if they are raised in groups, they must be moved regularly from one pasture to another. Obviously, as group size increases, the time spent on any given pasture will have to be decreased accordingly. The Soviet literature to date does not appear to have quantified the maximum carrying capacity which can be expected. This capacity will, of course, vary, depending on the quality of the habitat relative to the requirements of moose.

The procedure for domestication of moose in the Soviet Union appears to have been as follows. Initially, wild calves were captured and hand-reared on cow's milk. These calves reached maturity and subsequently bred, the resultant calves being taken from the mothering cow moose which, in turn, were milked manually. This milk was then fed to the calves by the herders. This method of calf rearing increases contact between moose and man, thus enhancing the domestication process. At a certain stage of maturity, some moose were free-pastured in the open forest for varying times.¹

¹The particular stage of maturity seems to vary from male to female moose, and the precise ages are not stated in the literature.

At these times, they were not herded and were subject to predation, poaching and straying. Instances are quoted of moose leaving the farm in the spring and returning prior to the fall rut for many successive years. The fall return enables selective mating to be carried out. In spring, the cows calve on the farm, and another annual cycle begins.

Moose were trained as draught and pack animals, and encouraging results were obtained. The boreal forest and winter snow form no serious barrier to moose movement, and suitable browse for food is naturally available in most areas enroute. Some of these draught animals have been used successfully in the hunting of wild moose. The domestic moose facilitates approaching the wild moose, and, when in range, the domestic moose is not spooked by the ensuing gunfire. The domestic moose is then used as a beast of burden to carry the wild moose carcasses out of the woods.

The domestication process obviously alters the natural behavioural patterns of moose. Knorre (1974) exemplifies some aspects of behavioural change:

The birth of a calf to a milkmoose occurred in the barn or in the yard of the moose farm. The newborn calf was taken from its mother immediately after birth and was bottle fed using its mother's milk. As a result of this change in the mother-calf relationship, after ten days the mother lost her innate instinct and did not allow the calf near her, eventually refusing to nurse it. Evidently, the maternal instinct of the milkmoose is transferred to the person who milks her: she becomes very attached to the latter so that at the established milking hours, she will, of her own accord, come in from free-pasture to the farm in order to be milked as if she were giving milk to her own calf. The following incident illustrates this situation: When the third calf of the domesticated milkmoose 'Maika' was born, it was decided to leave the calf with its mother for the filming of several scenes for an art film entitled 'Story of the forest giant'. However, after calving, Maika did not behave normally toward her calf: she did not begin to lick it, did not try to feed it, did not pay any attention

to it and pushed it away and walked off from it to stand in the opposite corner of the pen which had been specially constructed for the film production. When the somewhat dried and strengthened calf managed with effort to approach its mother and moved as if to nurse, Maika suddenly began to strike at it with her front feet. The moose farm workers who were present rushed into the pen and carried the calf out, but Maika had struck the calf seriously and after several hours it died. After this, the woman who had been assigned to milk Maika the previous year, approached the pen and the moose immediately ran to her with soft cries and tried to lick her face and arms through the fence. Then the woman entered the pen and began to milk Maika, who was continuing to express her maternal tenderness and attachment to her. It is still surprising, however, how quickly and completely the established reflex of innate maternal instinct was elicited with the aid of a human being.

Such behavioural changes constitute the difference between wild and domesticated moose.

The Soviets consider that a domestic moose resource is more beneficial than a resource of wild moose for the following reasons:

1. For use as draught animals;
2. Enhanced meat production relative to hunting wild moose due to:
 - a. Castration of selected males leading to increased weight;
 - b. Absence of wounding loss as is the case in hunting wild moose;
3. Production of milk; moose milk is similar to the cream of the milk of domestic cattle.

The major question arising concerning the domestication of moose is whether the increased meat production and other benefits warrant the increased input and influence of man required for this benefit. This is an aspect which is difficult to quantify due to a lack of data regarding the cost (monetary, social, and so on) of successfully hunting a wild moose

versus raising a domesticated moose.

The Feasibility of Moose Husbandry in Manitoba

Because of the ecological adaptations of moose as browsing animals, their range requirements are large. It is suggested that 10 moose/square mile would be the maximum carrying capacity of good moose range. Thus, for an operation of any economic proportion to be established, the range required would be vast, demanding a minimum of 20 square miles for a herd of 200 moose; one section of that range would support the entire herd (200) for two weeks on the same basis. This high density (relative to densities in natural ecosystems) can be expected for the following reasons:

1. Supplemental feed would be supplied.
2. Efforts would be made to maintain the range in prime moose habitat condition through one or more of the following means: controlled burning, scarification, fertilization and/or seeding.
3. Perhaps unfavourable snow conditions can also be manipulated to some extent by a process similar to scarification.

The economics of moose husbandry are purely conjectural, but, working from ten basic assumptions which require experimental confirmation, hypothetical estimates can be made. The ten assumptions are:

1. North American moose can be domesticated.
2. Two herders can handle an operation containing approximately 200 breeding moose, covering a 20 square mile area, without the use of aircraft.
3. Meat from moose calves is valued at \$1.00/pound; older animals are valued at less.
4. Hides from calves and adults are valued at \$40.00 each.



5. The habitat, with intensive management, can support 10 moose/square mile.
6. Calves at the age of nine months will yield 200 pounds of meat on the average.
7. The age/sex distributions outlined can be achieved.
8. Ninety percent of the females over three years of age will produce one calf/annum on the average.
9. A male:female ratio of 1:10 will be adequate to achieve points 7 and 8 above.
10. Predation and other losses will be minimal and in no case exceed 10 percent of the population.

A model of the domestic population is postulated in Figure 2, and the age/sex distribution of an hypothetical population of 200 domestic moose is illustrated in Figure 3. The areas of the rectangles in Figure 2 are approximately proportional.

Indications (hypothetical as they may be) are that a population of domestic moose, numbering in excess of 200 animals, could constitute an economically viable operation (see Appendices B and C).

Assuming that it is both biologically and economically feasible to raise domestic moose, the only major considerations left are social. The social implications of looking after domestic moose do not present the same monotony and privations as reindeer herding, as they would be free-pastured in close proximity to a settlement. The greatest social conflict foreseen with regard to moose domestication is that the community (or a few individuals within the community) will not accept curtailment of their hunting privilege on the moose pasture and could cause the operation to close down before it has even started. Domestic moose would provide an easy target (similar to domestic cattle), especially during winter when visibility on the pasture would be greatly increased due to the loss

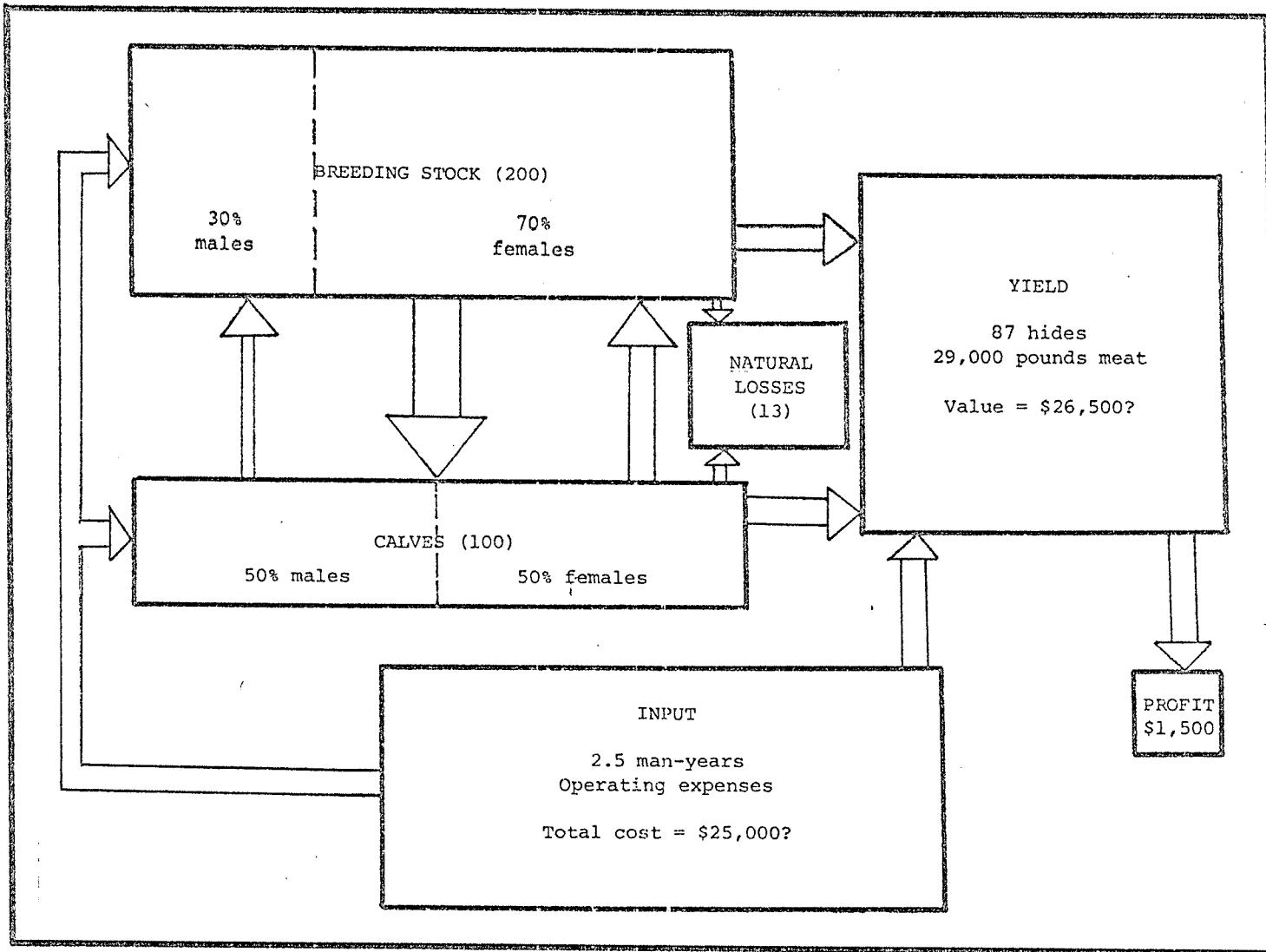


Figure 2. Hypothetical moose herd model.

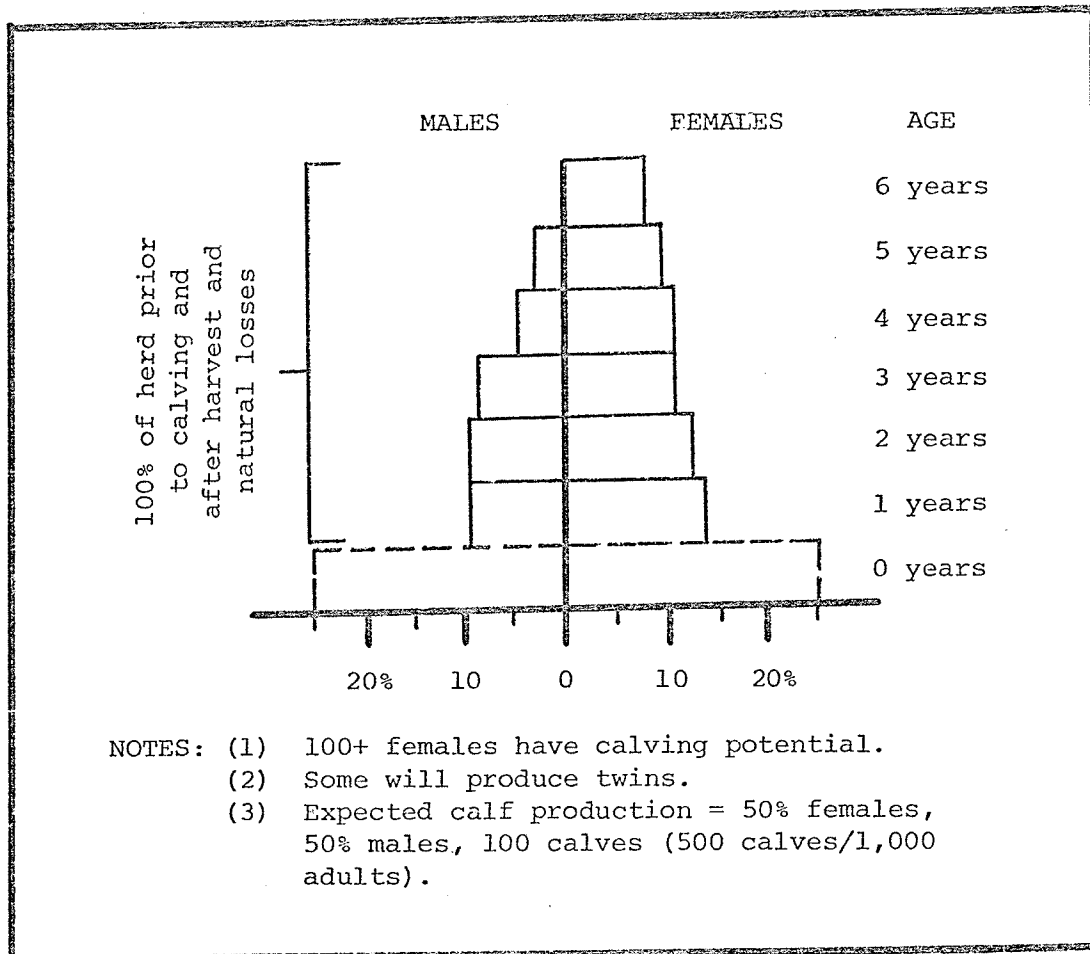


Figure 3. Hypothetical age/sex distribution of a herd of 200 domesticated moose.

of leaves by deciduous trees. Any hunting activity directed toward the semi-tame or tame moose would have a serious detrimental effect on the future domestication of moose by promoting the fear of man in the animals.

In spite of this problem, it is considered that moose may offer sufficient positive potential to warrant establishment of an experimental moose farm. The goals of such a farm should include clarification of the former assumptions to as great an extent as possible and resolution of the question asking whether domestication is a viable alternative to hunting as a meat-producing activity. How the recreational aspects of hunting rate among native people is also a factor which should be considered. Factors such as prestige, comradeship and so on may be of high importance.

The labour input required for moose domestication is not highly intensive and consists primarily of occasional round-ups and supplemental feedings in order to maintain human-moose contact and thus domestication (analogous to feeding sugar lumps to a horse). Any hunting or harassment of the domestic herd will produce an adverse and possibly irreversible effect. Other "herding" (this term is used loosely) duties include some protection of the herd from predators. Through domestication and consequent contact with domestic dogs, domesticated moose lose their fear of canine predators, allowing them to approach and thus domestic moose are more susceptible to being killed (Knorre, 1974). Of major concern here is the protection of calves from wolf predation. Wolf control (through trapping) within the area might also provide a financial bonus to the individual controller, provided such activity did not conflict excessively with other essential time-consuming tasks.

As stated earlier, comparison of labour input required to produce a given number of moose through hunting as opposed to domestication of the animals is impossible to make at this time due to lack of data. However, it can be surmised that the input required to successfully hunt moose must be quite high, otherwise the number of moose killed in and around northern communities would be much higher than it is. Incidental expenses (eg., motor toboggans, gas and so on) are not expected to vary greatly with regard to hunting versus raising domesticated moose.

It could be argued that domesticating moose represents an advance from a hunting and gathering activity to an agricultural one and is therefore potentially beneficial. Conversely, it could be interpreted as promoting work for work's sake, with little accrued benefit. The distinct lack of data with regard to moose domestication makes an accurate estimate of its potential impossible to predict. However, the foregoing ten assumptions provide a relatively solid framework when compared to the data regarding the activity of moose hunting. The ten assumptions can be quantified through experimentation. Hunting activity (including comradeship, prestige, recreational benefits, cultural identity) cannot be so readily quantified.

With a lack of data regarding the economics of hunting versus domestication, no conclusion can be reached on economic grounds, yet obviously this aspect is important in the promotion of moose domestication.

It could be argued that the superficial evidence of potential benefits presented from available information does not indicate that moose domestication offers sufficient potential for the improvement of socio-economic conditions of northern communities to warrant an experiment on

moose domestication or an evaluation of moose hunting economics.

Conversely, it could be argued that, in order to establish whether moose farming would be beneficial to northern communities, an experiment on moose domestication must be conducted and the economics of moose hunting must be ascertained for comparison purposes.

MUSKOX HUSBANDRY

The Domestication of Muskox

The establishment of domesticated herds of muskox in North America has become a relatively common occurrence over the last 20 years. However, the idea of domesticating muskox is by no means new, being officially recommended by Rutherford *et al.* (1922) in a Royal Commission report on reindeer and muskox industries in arctic and subarctic regions. The Commission saw the domestication potential quite clearly, stating:

There is ample proof that the young muskox can be readily domesticated, the evidence showing that when cows having young calves are killed, the calves show no fear of man and are easily led away, or will often follow without being led. In many cases they have been taken on board ship and have become pets, . . . In the matter of domestication, your commissioners would recommend that a station be established at some carefully chosen, suitable point in the northern islands, and that a small staff of intelligent and competent men be charged with the task of capturing a number of the younger animals, these to be kept under reasonable and proper restraint until they become familiar with and friendly to human beings.

However, in 1922 muskox were seen primarily as meat rather than wool producers: "The flesh of muskox is very nutritious and palatable, comparing most favourably with beef, though more tender and luscious" (Rutherford *et al.*, 1922). From the fur standpoint, the skins of muskox were considered to be of little value. At that time, the wool was considered to be problematical, due to its mixing with the coarser hair of the outer

coat during shedding. Feelings at that time were that manual removal of the wool would have an adverse effect on the animals, as a muskox from which the wool had been combed (in New York Zoological Gardens) died some three weeks later from pneumonia. Thus, manual removal was not recommended.

In any event, regardless of the prime purpose of the proposed domestication, the Canada Department of the Interior declined to act on the recommendations of Rutherford and colleagues with respect to muskox, and the question appears to have received no further attention until 1953, when the current wave of muskox domestication commenced.

Incongruously, the first attempt to domesticate muskox was made in 1954 in Vermont by John Teal, a university professor. Although he experienced a reasonably high degree of success, the warm climate presented problems. Porcupines, avoided by horses and cattle, greatly attracted the muskox due to their insatiable curiosity. Unfortunately, many of these encounters resulted in infections leading to death of the muskox. Other problems included various types of internal parasites, none of which occur in the Arctic, and the effect of summer heat on the calves, in whom sweat glands do not develop until later in life (Bruemmer, 1970).

However, Teal had no intention of raising muskox on a permanent basis in southern latitudes, and he decided to move his operation to Alaska. It appears that consideration had been given at one time to establishing the herd at Churchill, Manitoba, but, because of university facilities at Fairbanks, Teal decided to move to Alaska (Craig, 1973).

Funded by the W. K. Kellogg Foundation in cooperation with the University of Alaska, 10 male and 24 female calves were captured on Nunivak

Island in 1964 and 1965. Breeding began in 1966, and by 1970 the herd numbered 78 animals (Wilkinson, 1971).

In 1967 a similar operation was started at Old Fort Chimo in Quebec through the capture of 3 male and 12 female calves on Ellesmere Island. In the following five years, 17 calves were born, and scientists reported that the herd had adapted well to captivity (Bloomfield, 1973). Reports, however, indicate that the experiment is not as successful as previously indicated (King, pers. comm., 1974).¹ It is suggested that the climate of Ungava may be too damp for muskox as they require a cold, dry climate (pers. comm., Pruitt, 1974).

Norway also has a domesticated muskox farm based on 25 calves (10 male and 15 female) captured in eastern Greenland in 1969.

During the summer of 1974, muskox calves were supplied to the U.S.S.R. by the Canadian Government (Anonymous, 1974a).

Wilkinson (1971) considers that the future of muskox farming seems good, depending on the success of integrating new skills (farming and garment production) with the socio-economic framework of native people.

The logistics of muskox domestication vary little. Calves are captured before they attain five months of age. These calves are readily tamed and soon become accustomed to the attentions of man. When the calves reach maturity, they breed. Normally (in their wild state) muskox only calve every second year. However, Teal found that, through weaning the calves before the fall rut, the adult females will produce annually. Obviously, this procedure greatly speeds up the building of a commercial

¹A recent discussion indicates that the operation is again (or still) showing a high success rate (Folinsbee, pers. comm., 1975).

herd. Wilkinson (1971) reported that few females fail to conceive.

Calving may occur at any time; most frequently, it occurs during early-morning or late-evening. Herdsmen are kept on duty in case of accidents or complications. Calves can stand within 20 to 30 minutes of birth, suckle 10 to 15 minutes later and, within two hours, most calves can walk and even run steadily for short distances. The sex ratio of calves born in Alaska strongly favours females: 45 females:29 males. Calf mortality is low (Wilkinson, 1971).

Thus, with annual calf production, a high ratio of female to male calves and a low calf mortality, herds can quickly be built up. Twinning, however, has not been observed.

All calves are dehorned surgically in order to protect herdsmen and animals alike. Horns do not grow again, once removed (Wilkinson, 1971). It is conceivable that, in the future, naturally polled animals can be bred.

The Feasibility of Muskox Husbandry in Manitoba

The muskox is a sedentary tundra animal. The sedentary aspect of its behaviour is highly significant as it means that the herding requirements are minimal, amounting to scarcely more than occasional (weekly or less) inspection, spring round-up to collect the underfur (*qiviut*) and fall round-up to control breeding.

However, there is little tundra within the confines of Manitoba boundaries, and our only community located on the tundra is Churchill. Churchill has been suggested by many as a suitable location for domesticated muskox as they used to roam there in earlier times (Hearne, 1911).

However, Pruitt (pers. comm., 1974) states that muskox require a cold, dry climate. The Churchill region is, therefore, unsuitable because of its relatively damp climate. This factor may be crucial and severely limiting. It is possible that the natural occurrence of muskox in the Churchill region, as reported by Hearne in the eighteenth century (Hearne, 1911), was because of the animals being forced into marginal habitat through high population densities in their prime habitat.

Nonetheless, the concept of raising domesticated muskox in the Churchill region is worth examining in view of the many advantages of the area and the consequent benefits that would accrue to it. The population of Churchill is approximately 3,000 people. Most are of either Chipewyan, Cree or Eskimo descent. The economy of these people is, to say the least, depressed and greatly in need of improvement. Herding muskox would provide some employment without requiring adaptation to a nomadic lifestyle as in the case of reindeer herding. Wool collection would also provide seasonal employment for men and women. Muskox are reported to become so tame that even young children can pluck the wool from them. A major economic benefit would be derived from the knitting of the *qiviut* into garments. This part of the industry could be carried out within the homes of the people. In Alaska the knitter is paid \$25.00/square foot (King, pers. comm., 1974).

One advantage of the Churchill region is the presence of a rail link to the agricultural zone of the province. Supplemental feed in the form of hay could be readily transported to Churchill, if deemed necessary.

The *qiviut* industry would depend largely on a southern market. Tourists buy *qiviut* products because of their northern flavour. The ex-

port of these products to high-fashion centres such as Paris, New York, London and Montreal is dependent on a similar appeal.

The establishment of a *qiviut* industry in Churchill would have two-fold benefits, if successful. It would enhance the attraction of the region as a nature tourist resort, and the tourists would add to the existing market for *qiviut* products.

It must be realized that domestication of muskox in the Churchill area would not create an economic boom. The *qiviut* industry, being "cottage-based", will provide some supplemental income to many native people. This income may range up to \$2,000/annum or more, depending on how the retailing of products is carried out. Obviously, if incorporated with a large tourist trade, the income could be substantially increased, relative to the income which could be derived through export of large quantities of raw materials or finished products.

The great appeal of *qiviut* products is that they weigh only about one-fifth the weight of the same product made from sheep wool. Small scarves retail for about \$60.00 each.

With most ventures, there are drawbacks and doubts, and the muskox industry is no exception. The industry caters to a small, elitist market; muskox products are a novelty, and the whims of the market may change. Today northern products are very popular; tomorrow the situation may be different. The market may be too small to accomodate products from Alaska, Quebec, Northwest Territories and Manitoba.

However, on the basis of current information, the potential seems to exist for benefitting native people through muskox domestication. Certain parameters, e.g., the dampness of the region and more detailed economic

analysis, should be investigated before attempts are made to establish the industry. Details on the build-up of a muskox herd and the production of *qiviut* appear in Appendix D.

DISCUSSION

In the case of earlier efforts to establish reindeer husbandry in North America, the prompting factors were based on improving socio-economic conditions of northern native people. In simplistic terms, domesticated reindeer were offered as a substitute for dwindling caribou herds. Today, low caribou populations are stimulating similar considerations in Manitoba (Mowat, 1976).

In spite of southern subsidies of one type or another, the native people of northern Manitoba are still largely dependent on wild game for food. When game is scarce, protein intake is greatly reduced, resulting in dietary deficiencies. Implications of such deficiencies have suggested correlations with alcoholism and other pathologies associated with the culture of poverty. Evidence of this correlation is provided by McLeod and Clarke (1974) in a paper on alcoholism and native people. They state:

Abram Hoffer,¹ a Saskatoon psychiatrist with a background in biochemistry, has helped pioneer a hypothesis that malnutrition and vitamin deficiency can contribute to emotional disturbances. In addition to the standard list of disorders such as ulcers, heart and blood pressure problems, rashes, and so on, he focuses on hypoglycemia and sub-clinical pellagra. Hypoglycemia may be considered as an explanation of alcohol abuse among native people.

¹Hoffer, Abram and Osmond Humphrey. 1960. The Chemical Basis of Clinical Psychiatry. Springfield, Illinois, Charles C. Thomas.

Hypoglycemia is a condition of low blood sugar and is estimated to exist in millions of people in North America. The most common cause of this condition is stress from physical, emotional, nutritional and/or chemical sources. Its treatment includes a high protein diet and elimination of sugar and starch intake as well as the removal of the stressor from the individual's physical or social environment. Hypoglycemia is suggested to be the major physical basis of alcoholism. The craving for alcohol is, in large part, the reaction of the body to its low sugar condition. It is also stated (McLeod and Clarke, 1974) that most native people have hypoglycemia. Therefore, although obviously not the entire solution, dietary deficiencies contribute largely to northern native problems.

Although these correlations have been scientifically identified only in recent years, dietary deficiencies and consequent malnutrition have been recognized as causes of disease of one type or another for a very long time. Wilfred Grenfell, doctor and medical missionary, discovered that one out of every three deaths on the north coast of Newfoundland and Labrador was caused by tuberculosis (ca 1900). Furthermore, one out of three babies died before reaching the age of one year (Hewitt, 1921). These events prompted Grenfell to turn his attention to the introduction of reindeer to improve the diet of the people; for all practical purposes, the keeping of traditional domestic animals (goats, sheep, pigs) was out of the question. Unfortunately, the benefits which could have been obtained from reindeer were not realized by the Newfoundlanders, and the introduction failed.

The reliability of hunting as a food-producing activity has always

been precarious. Times of feast, coupled with times of famine, are common features of societies based on a hunting economy. Even during periods of large caribou populations, the migratory routes often varied from year to year, and consequently, as far as a particular band of natives was concerned, the caribou did not come at all (see Mowat, 1952). Banfield (1954) qualified this phenomenon through scientific study and concluded ". . . The herds do not return each winter to the same areas. Usually a herd returns for several successive winters to the same locality, then abandons this area and spends several winters in an area fifty to several hundred miles away."

Declining numbers made caribou movements even less predictable, resulting in local starvation which reached dramatic proportion between 1945 and 1955 when caribou populations plummeted (McTaggart Cowan, 1969).

Hewitt (1921) summarized the role of native people in the ecology of North America prior to European settlement as follows: "In his primitive state he was merely a unit in that balance of nature that is so marvelously adjusted that while the abundance of species of animals rises and falls, extermination does not follow the preying of one species of animal upon another."

The wasteful disrespect for the caribou resource in the early 1950's was exemplified by Harper (1955):

Almost everywhere the animal slaughter is both excessive and wasteful. Few inhabitants of the North, whether native or white, stay their hands while caribou are present and ammunition is available. There is undue reliance on a continuation of past abundance and an indifference to the welfare or rights of posterity . . . The average trapper of the barren grounds apparently aims at killing annually at least 100 caribou. Only a small portion is required to feed himself and his family. The rest is

designed for use as fox bait and dog food . . . If the season turns out to be a particularly poor one for Arctic Foxes, the trapper may abandon his trap-line for that winter, and dozens or scores of caribou will have been sacrificed in vain.

The wildlife of northern Manitoba was probably never in sufficient abundance to guarantee support of the native population; the likelihood of famine always existed, and it sometimes prevailed. In fact, the wildlife resources on which the native people survived were only sufficient to preserve the race, the survival of individual populations or bands being for the most part insecure. It is likely that both human and wildlife populations fluctuated in synchrony. A large population of caribou could cause the build up of a large human population, which in turn could lead to the demise of the caribou population and consequent starvation for much of the human population and so on in a cyclic pattern. Parker (1972) tends to support this hypothesis, stating: "Barren ground caribou populations appear to fluctuate continually in total numbers." In actuality, conservation of resources was, in effect, due to the lack of man's ability to overharvest continually.

Today, however, times of famine are no longer acceptable, and subsidy of native communities in order to preserve the "hunting economy" have become widespread. The "hunting economy", therefore, no longer exists in reality. Through subsidy, we are attempting to preserve a culture, but we are, in effect, creating a non-viable entity in a bastardized version of an earlier culture. The absolute necessity of hunting success has been removed, thus placing the northern native hunter in a similar category to the southern sport hunter where hunting success, though desirable, is not essential for survival.

There is much concern regarding the loss of the culture of northern people. Perhaps this concern is largely unjustified and unrealistic as culture is not static but continually evolving. The culture of the northern native people has changed greatly since the coming of the European. Regrettable as this may or may not be, the change is irreversible. The native people still cling to the most desirable characteristics of their culture, and hunting is a prominent feature of these. There are still many hunters, but there is no longer a "hunting economy", nor is there a culture based on hunting. Furthermore, due to the degree of interrelationship between caribou and northern native cultures (the caribou-eating Chipewyan in particular), decimation of caribou has meant a fundamental modification of culture so profound as to make the culture of pre-European contact virtually extinct.

Nonetheless, there is a culture centred largely on hunting and trapping, be these activities for sustenance, income, recreation or "fun". Domestication of indigenous species or introduction of domesticated exotics, if accepted by native people, offers further cultural modification, leading to an even greater removal from the pre-European contact culture of native people. The desirability of so directing cultural change from outside the culture undergoing modification is highly questionable. Ideally, such impetus should come from within the culture. However, due to the technological superiority of the European culture and consequent superiority complex, the European culture has accepted the responsibility of directing cultural evolution towards increased exploitation of resources, increased consumerism and towards increased modification and consequent degradation of the global environment. Obviously, due to various restraints, this

topic will not be discussed at length in this study. Suffice to say that man's "state of well-being" is a direct function of his environment. Environmental modification changes the state, which reflects well-being. The ultimate in well-being, therefore, is a fantasy, and this is the "state of well-being" sought by Euro-North American society and presumed to be sought by the native population.

It is a commonly believed theory of cultural evolution that modern man evolved from a hunting and gathering society through some form of herding and consequent animal domestication to an agricultural society. European culture went on to an industrial society, and today our society is commonly known as a post-industrial society. Whether or not all of these steps have to be or should be taken by the native people is conjecture. To date, we have largely attempted to by-pass these steps and to bring the native people into our post-industrial, wage-earning society in one theoretically smooth step. In reality, efforts in this direction have been only piecemeal gestures, *i.e.*, "We'll put \$10.00 in your pocket for furs", with the underlying knowledge that those same furs will produce \$20.00 on the open market. Since the early days of the fur trade, things have changed to some extent, but largely only in degree. Furs, fish and lumber all provide greater economic return to southern businessmen than they do to the northern native producer. He is penalized for freighting costs when shipping his produce to the southern market and penalized again when southern products are shipped north for native consumption.

To maintain (or achieve) economic viability (in southern terms), northern Manitoba would need to be extremely highly productive, which it

is not. Northern regions, due to their relatively meagre budget of solar energy, are lands of low biological productivity. In effect, there exists a slim resource base capable of sustaining a very low-key economy, such as the hunting economy which existed there before the European came. Thus, a southern type (high-key) economy based on renewable resources cannot exist in the north without extensive subsidy. Boom-and-bust economies can result from exploitation of non-renewable resources, but even this option does not exist for much of northern Manitoba.

It would greatly assist the economy of northern communities if efforts were directed towards increasing the self-sufficiency of those communities. Any amount of food production would enhance the economy. Much effort can be made in this direction through hunting, fishing, herding, greenhousing and gardening. Hunting is currently the major red meat producing activity. In the 1972-73 caribou hunting season at Fond du Lac in northern Saskatchewan, approximately \$16,000 was invested in equipment, fuel and air charters for a return of 1,081 caribou (Muller-Wille, 1974). Figures are rough, but Muller-Wille estimates that the cost of caribou meat was approximately \$0.40/kg. If we consider that 30 percent of the meat was fed to sled dogs (used for hunting), the cost of meat for human consumption approximates \$0.50/kg. Even if we consider the labour input (34 men put in 79 hunting trips out of Fond du Lac, amounting to 445 workdays in this bush), and valuing labour input at \$40/man-day, the production cost of one kg of meat approximates only \$1.20, or roughly \$60/caribou. MacPherson (1968) wrote ". . . the value of a single carcass in the remote settlements of the region (Kudson Bay), based on its replacement value in food and clothing, might be as much as two hundred

dollars." Incidentally, a hind quarter of caribou will sell for \$5.00 in Fond du Lac (Muller-Wille, 1974). Muller-Wille concludes that the need for caribou for subsistence and the need for money for the new economic situation are, at the moment, incompatible. Actually, it is difficult to see how they can ever be compatible. Furthermore, perhaps we should seriously question any contrivances with such aims.

Fundamentally basic to the entire issue is the loss of conservation practice by native people. Prior to European contact, the native people were forced, through limited technology, to practice conservation. In 1946-47 the Split Lake band of Indians (on the Nelson River in Manitoba) reportedly killed 4,000 caribou, the greater part of which were utilized as dog feed (Harper, 1955). No bands kill such large numbers of caribou today, but they do kill all that they have access to. Harper (1955) reports that Nueltin Lake was said to have been covered with the bodies of unutilized caribou, shot for "fun" by the Chipewyans during the winter of 1944-45. There are innumerable tales of such wanton slaughter. Even today, virtually every caribou that native people have access to is shot and killed or wounded and not tracked down. Pruitt (1959a) expressed amazement at the poor marksmanship of Chipewyans: "With two shots, one hunter failed to hit unalarmed caribou, 150 yards distant." On another occasion, he observed hunters ". . . sitting in their toboggans chasing a band of caribou down the lake, shooting as they bounced along behind the racing dog team".

It is evident from the foregoing that restoration of caribou numbers will, in itself, not solve many problems unless accompanied by an understanding of conservation principles and the development of conservation

ethics and ecological awareness among native people. In fact, without such education, the restoration of caribou numbers will be extremely difficult. If basic conservation ethics cannot be fostered in native people, the harvest of wildlife will have to be controlled through legislation and strict enforcement. Although achievement of the latter could present even more difficulty than the former, itself a formidable task, it is imperative that conservation be practiced (either voluntarily or mandatorily) for the mutual benefit of people and resources. Otherwise, it is strongly anticipated that wildlife populations will never be maintained in high usable populations, thus so greatly depleting the value of the resource that it will become no more than a potential resource. The extirpation of moose or caribou from northern Manitoba is not foreseen at the moment, due to the sparseness of human populations in that region, but wild game populations are now greatly reduced due to past abuse and current misuse of these animals. It is depressingly evident that wildlife populations cannot be successfully managed in areas of high native hunting activity without forced or volunteered native adherence to the moral code of conservation.

Data regarding meat production through hunting in northern Manitoba are scarce and unreliable, but it is obvious that actual production is much lower than it was in earlier times. The town of Pukatawagan (900 to 1,000 people) only killed approximately 15 moose in the fall of 1974 (Cross, pers. comm., 1974). The people of Tadoule Lake (population 80) only killed 15 caribou during the winter of 1973-74. The people of Brochet have been complaining for many years that they no longer kill sufficient caribou. Indications are that the people of Moose Lake (10-

cated in the heart of prime moose habitat) are no longer able to kill moose in sufficient numbers for their personal needs (Larocque, pers. comm., 1974). Distances travelled in hunting have increased, and the harvest is very low. The people of Brochet, Pukatawagan, Moose Lake and Norway House have all expressed interest in some form of agriculture to replace hunting activity (at least in part). Generally, interest has been expressed in cattle raising. Traditional cattle ranching is ecologically impossible due to the nature of the environment, but the possibility of raising domestic indigenous or introduced animals for meat production seems good. Traditionally, domestication of animals has led to a higher productivity of species desirable to man at the expense of more undesirable species. Therefore, domestication of ecologically suitable species in northern Manitoba will lead to higher productivity of meat and consequently an improved diet for northern people. The economics of the domestication of most of the suitable species (reindeer excepted) are not accurately quantifiable at this stage due to lack of experimental data.

Needless to say, the problems which have to be overcome are many. Primary among these is the danger of free-ranging animals being poached, coupled with the waiting period required for the herds to increase to sufficient size to yield a reasonable harvest.

It should be stated that domesticated animals are not seen as creating an economic bonanza for the north. An industry or industries of similar magnitude to its southern counterpart the cattle industry would be impossible to attain. The major limiting factor is the large range requirement of northern species. Nonetheless, herds sufficiently large to pro-

duce sufficient meat for small northern communities are within the realms of reality.

Other problems which would be encountered include achieving a sustained commitment to herding from the native people. A recent study by the Canada Department of Indian Affairs (Smith, 1974) indicated that reindeer herding was considered (by native high school students) to be one of the least prestigious occupations; all but one of ten groups questioned placed reindeer herding among the five lowest ranking occupations. Coupled with the monotony and privations of herding as a way-of-life is the poor remuneration which this occupation can be expected to provide.

It appears, therefore, that northern animal husbandry shows minimal social or economic potential at this point in time. However, the time aspect is very important in this regard. World food shortages, coupled with increasing food prices, could drastically change the economics of reindeer or moose husbandry in a very short time. This change could occur in a shorter time period than that which is required to establish domesticated herds. Food shortages may demand that lands devoted to beef production but suitable for human vegetative food production be used for the latter, due to the 90 percent loss of energy resulting from feeding plant food to animals.

Then attention will be turned to the production of meat in currently unused areas such as the boreal forest and the tundra. The price of meat will obviously increase, in all probability to such an extent as to make reindeer and moose husbandry economically viable. The degree of profitability may also be sufficient to counteract the aforementioned social

discomforts. We will modify the environment and alter the behaviour of wild animals for the benefit of man. Whether such modification and consequent degradation will ultimately improve the state of well-being of man is questionable.

It is impossible to discuss northern animal husbandry without directly relating it to the hunting activity which it purports to replace. As already stated, all attempts to introduce reindeer to North America were instigated as a result of decreasing wildlife resources. Today, the basic problem we are facing is a depleted wildlife resource. The practice of animal husbandry would alleviate hunting pressure on wildlife resources. It would not, however, eliminate the dependence of native people on native game populations. Wildlife populations, and specifically caribou in the far north of the province, form the most important resource of northern native people. These caribou ". . . constitute a valuable national asset, the importance of which, if properly dealt with, can be enormously enhanced . . ." (Rutherford *et al.*, 1922).

Hewitt (1921), foreseeing depletion of numbers and advocating conservation, attempted to identify the economic value of this resource:

. . . First, the necessity of preserving so essential a source of food and clothing for the Indians, Eskimos, and other present and future inhabitants of the north; and second, the desirability of developing so important a natural resource for the benefit of the Dominion as a whole, inasmuch as it would provide a source of meat of incalculable value, and skins that could be utilized in the manufacture of many articles of clothing and commerce.

The progress in properly dealing with, conserving or managing this resource since Rutherford's recommendation to the Government of Canada in 1922 has been disheartening, to say the least. To advocate the introduction

of exotic species as a substitute for a low wildlife population reflects a defeatist attitude to a problem that can be solved through increasing our understanding of the population decline and, more importantly, by applying our understanding through positive management action. The current situation of the Kaminuriak population of barren-ground caribou exemplifies our apathy towards this situation. The problem of declining numbers of barren-ground caribou (in Canada generally) was identified over 50 years ago. Since then, innumerable studies by innumerable biologists have reached innumerable conclusions, leading to recommendations. Few recommendations have been acted upon other than those calling for more study. In fact, all too often the actions of well-meaning people were contrary to the recommendations (e.g., hunting privilege for all residents of the Northwest Territories for 5 caribou/year and legalization of the sale of caribou meat). I have found it difficult to ascertain why so little positive action has been instigated in an effort to restore numbers. The most intensive management action has been the control of the wolf (through poisoning and a bounty system), the major predator on caribou other than man. The success of wolf control programmes seems to be supported by most authorities, provided a thorough programme (bordering on extirpation) is carried out. Today, however, with increasing ecological awareness on the part of the public and among biologists, the morals of such programmes are being seriously questioned. Pruitt (1959a) attested that winter range deterioration and destruction (largely by fire) was the underlying reason for declining caribou numbers. He stated: "Northern Saskatchewan is the most abused portion of the earth's surface I have ever seen" and, earlier in his treatise, "There is no caribou prob-

lem, but there is a very grave and pressing land use problem." Pruitt (1959a) also refuted wolf control (at that time and place), stating ". . . in the light of my observations on the state of the winter range and the size of the caribou populations, I can see no biological justification for it." He quoted Leopold and Darling (1953) to support his thesis as follows:

We wish to make it clear that we are not filing a blanket objection to predator control as a legitimate tool of game management. There are indeed situations where wolf removal may be highly beneficial in restoring depleted breeding herds of moose or caribou *on range that can carry more animals*. But in each case where an increase in breeding stock is deemed an immediate objective of management, it should be established in advance that the range will support more animals. . . It has been the history of big-game management throughout North America that range limitations are usually recognized and defined after excess breeding stocks are created by over-zealous protective measures. We cannot afford to repeat that error on Alaskan caribou ranges which are so highly sensitive to overgrazing as shown by the reindeer experiment.¹

Attempts were made to restrict hunting, but these largely failed.

Kelsall (1968) summarized the reasons as follows:

1. Most caribou hunters, Indian, Eskimo, and white, traditionally, and in disregard of the law, habitually engaged in excessive and wasteful killing of caribou.
2. A few Eskimos and Indians are still absolutely dependent on caribou to provide sustenance for themselves, their families, and their dogs; to provide clothing and bedding skins; and to provide other necessities. It was morally impossible to curtail drastically the hunting activities of such people without first providing alternative economic means.

¹Bergerud (1974) disputes this hypothesis.

3. Enforcement of the game regulations, except locally, was inadequate. A number of areas, including some where the greatest annual caribou kills were expected, received only sporadic and ineffective attention from enforcement officers.
4. Treaty Indians, under the British North America Act and the individual treaties, cannot be forced to obey hunting regulations. Unfortunately, under the low caribou population levels recently recorded, they are a large enough group that their hunting activities alone might maintain the decline.

Enforcement of game regulations was, therefore, either physically impossible in remote areas where people chose to disregard the law, morally impossible where native people depended on caribou for sustenance or legally impossible in the case of treaty Indians. Thus, efforts to restrict hunting through regulation and enforcement failed.

Reduction in wastage of caribou through public information and co-operation programmes received some success. Caribou were used as dog food to a reduced extent. Government-organized hunting of caribou in the Northwest Territories supervised by Game Management Officers increased the efficiency of hunting and reduced waste; more caribou reached the settlement as the expeditions were normally airborne.

In summary, management efforts largely failed to reduce hunting pressure, although the human kill factor became greatly reduced largely due to the decline in population numbers and an increased dependence of native people on other forms of subsistence, mainly social benefits such as welfare.

SUMMARY

This study has attempted to evaluate and weigh sociological, economical and biological benefits and drawbacks of northern animal husbandry with particular reference to the potential of increasing the production of the northern rangelands of Manitoba for the benefit of northern native people. The relative merits and demerits of reindeer, moose and muskox domestication were discussed. For most of far northern Manitoba and its native residents, such operations offer the most viable commercial exploitation (both ecologically and economically) of the natural resources of the region. However, it is evident that some of these operations are not likely to meet with any great success without significant changes in the socio-economic value system of the majority of native people. Southern economic values and northern productivity, for the most part, do not readily mesh. Furthermore, to suggest establishment of a low-key northern economy based on regional productivity is tantamount to treating the native people as second-class citizens; at least that is how any such suggestions will, in all probability, be considered, not only by the native people but by many concerned people of Euro-North American culture.

Euro-North American society is becoming aware that an ever-expanding economy cannot be maintained. Our consumption of non-renewable resources, coupled with technology, has enabled us to reach our current high living standards, an artificial phenomenon which cannot be maintained indefinitely.

A low-key northern economy could last indefinitely, and soon we may all have to lower our sights toward this level. Nonetheless, the reality of the current situation is that northern native people want a fair share of the North American economic pie, while there is still some pie.

Moose and muskox husbandry may show some potential in this regard, but certainly no economic bonanza will result. However, some socio-economic improvement could be achieved in some communities if the native people are desirous of pursuing such activity.

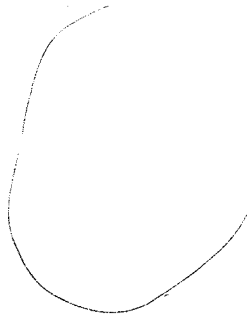
The following conclusions have been drawn from the study:

1. Wildlife is the most important natural resource of far northern Manitoba.
2. Rangelands of northern Manitoba are understocked.
3. Management of wildlife should be directed to restoring wildlife populations (with special reference to caribou) to former numbers.
4. Conservation ethics should be fostered in northern people.
5. The rangelands of northern Manitoba can support reindeer.
6. It is not desirable to establish a reindeer industry in Manitoba at this time.
7. An experimental herd of reindeer could be introduced.
8. Moose domestication may have a potential to improve the lives of northern people, but experimentation is required to clarify this.
9. Muskox could provide the basis for a cottage industry based on *qiviut* textiles, but further investigation is required.

The rangelands of northern Manitoba form a considerable resource. Currently they are understocked, and consequently the benefits which we

can realize from these resources are greatly reduced. This under-utilization of rangelands is wasteful of resources and can be likened to the wanton slaughter of caribou in the early-1950's.

Whereas the restoration of indigenous wild caribou is considered most provident, should management fail to restore numbers, other land use alternatives should be explored with vigour as it is imperative that these rangelands be restocked.



APPENDIX A

Economics of Reindeer Husbandry

Computer analyses of the economics of reindeer husbandry were carried out by L. Gravelines, Resources Economist, Manitoba Department of Mines, Resources and Environmental Management. The following figures, derived from these analyses, exemplify the range of economic return which could be derived relative to production and the price which could be obtained for the venison. Considering five herds of 1,000 reindeer each, returns would vary from a loss of \$194,125 (10% production @ \$0.50/pound with 6 paid herders/1,000 animals) to a profit of \$423,375 (50% production @ \$1.50/pound with 2 unpaid family units managing 1,000 animals). Both of these figures are unrealistic, but the figures are of value in that they demonstrate the significance of production and wholesale prices. The figures also show how increasing meat prices could make reindeer husbandry a viable northern industry at some future time, especially if anticipated maximum production (currently estimated at 30%) could be increased.

With 10% Yield (This approximates that which could be expected from a wild population through hunting):

With costs (a) for 6 herders/1,000 animals = \$225,375
 (b) for 2 family partnerships (no wages) = \$45,375

<u>Revenue</u>	<u>Net Cash Balance</u>	<u>Income</u>
@ \$0.50/pound = \$31,250	(a) -\$194,125 (b) -\$14,125	(a) \$6,000/annum ¹ (b) -\$1,413/annum ²
@ \$0.75/pound = \$46,875	(a) -\$178,500 (b) \$1,500	(a) \$6,000/annum (b) \$150/annum
@ \$1.00/pound = \$62,500	(a) -\$162,875 (b) \$17,125	(a) \$6,000/annum (b) \$1,713/annum
@ \$1.25/pound = \$78,125	(a) -\$147,250 (b) \$32,740	(a) \$6,000/annum (b) \$3,274/annum
@ \$1.50/pound = \$93,750	(a) -\$131,625 (b) \$48,375	(a) \$6,000/annum (b) \$4,838/annum

¹Income (a) is for individual herder.

²Income (b) is for family herding unit.

With 20% Yield (This approximates the anticipated production of the Mac-kenzie Delta reindeer herd):

With costs (a) for 6 herders/1,000 animals = \$225,375
 (b) for 2 family partnerships (no wages) = \$45,375

<u>Revenue</u>	<u>Net Cash Balance</u>	<u>Income</u>
@ \$0.50/pound = \$62,500	(a) -\$162,825 (b) \$17,125	(a) \$6,000/annum ¹ (b) \$1,713/annum ²
@ \$0.75/pound = \$93,750	(a) -\$131,625 (b) \$48,375	(a) \$6,000/annum (b) \$4,838/annum
@ \$1.00/pound = \$125,000	(a) -\$100,375 (b) \$79,625	(a) \$6,000/annum (b) \$7,963/annum
@ \$1.25/pound = \$156,250	(a) -\$69,125 (b) \$110,875	(a) \$6,000/annum (b) \$11,088/annum
@ \$1.50/pound = \$187,500	(a) -\$37,875 (b) \$142,125	(a) \$6,000/annum (b) \$14,213/annum

With 30% Yield (This approximates the average yield obtained in the U.S.S.R.):

With costs (a) for 6 herders/1,000 animals = \$225,375
 (b) for 2 family partnerships (no wages) = \$45,375

<u>Revenue</u>	<u>Net Cash Balance</u>	<u>Income</u>
@ \$0.50/pound = \$93,750	(a) -\$131,625 (b) \$48,375	(a) \$6,000/annum ¹ (b) \$4,838/annum ²
@ \$0.75/pound = \$140,625	(a) -\$84,750 (b) \$95,250	(a) \$6,000/annum (b) \$9,525/annum
@ \$1.00/pound = \$187,500	(a) -\$37,875 (b) \$142,125	(a) \$6,000/annum (b) \$14,213/annum
@ \$1.25/pound = \$234,375	(a) \$9,000 (b) \$189,000	(a) \$6,300/annum (b) \$18,900/annum
@ \$1.50/pound = \$281,250	(a) \$55,875 (b) \$235,875	(a) \$7,863/annum (b) \$23,588/annum

¹Income (a) is for individual herder.

²Income (b) is for family herding unit.

With 40% Yield (This approximates a good yield in the U.S.S.R.):

With costs (a) for 6 herders/1,000 animals = \$225,375
 (b) for 2 family partnerships (no wages) = \$45,375

<u>Revenue</u>	<u>Net Cash Balance</u>	<u>Income</u>
@ \$0.50/pound = \$125,000	(a) -\$100,375 (b) \$79,625	(a) \$6,000/annum ¹ (b) \$7,936/annum ²
@ \$0.75/pound = \$187,500	(a) -\$37,875 (b) \$142,125	(a) \$6,000/annum (b) \$14,213/annum
@ \$1.00/pound = \$250,000	(a) \$24,625 (b) \$204,625	(a) \$6,821/annum (b) \$20,463/annum
@ \$1.25/pound = \$312,500	(a) \$87,125 (b) \$267,125	(a) \$8,904/annum (b) \$26,713/annum
@ \$1.50/pound = \$375,000	(a) \$150,625 (b) \$329,625	(a) \$11,021/annum (b) \$32,963/annum

With 50% Yield (This approximates the best yields obtained in the U.S.S.R.):

With costs (a) for 6 herders/1,000 animals = \$225,375
 (b) for 2 family partnerships (no wages) = \$45,375

<u>Revenue</u>	<u>Net Cash Balance</u>	<u>Income</u>
@ \$0.50/pound = \$156,250	(a) -\$69,125 (b) \$110,875	(a) \$6,000/annum ¹ (b) \$11,088/annum ²
@ \$0.75/pound = \$234,375	(a) -\$9,000 (b) \$189,000	(a) \$6,000/annum (b) \$18,900/annum
@ \$1.00/pound = \$312,500	(a) \$87,125 (b) \$267,125	(a) \$8,904/annum (b) \$26,713/annum
@ \$1.25/pound = \$390,625	(a) \$165,250 (b) \$345,250	(a) \$11,508/annum (b) \$34,525/annum
@ \$1.50/pound = \$468,750	(a) \$243,375 (b) \$423,375	(a) \$14,145/annum (b) \$42,338/annum

¹Income (a) is for individual herder.

²Income (b) is for family herding unit.

APPENDIX B

An experimental moose husbandry ranch

The experimental ranch, in addition to answering the questions posed in the text of this study, is also envisaged as a demonstration model which would serve as an exhibit for people interested in establishing commercial units. If successful, the station would also make breeding stock available to interested parties.

The experimental station would include buildings and corrals and be equipped for research.

During the early years, calves would be captured on wild moose range in successive springs. Knowing as little as we do at this time, it would be difficult to say how quickly the herd could be built up, but, making a few basic assumptions, the following could be expected:

1. Capture 25 calves (5 male and 20 female) annually.

Assume the females will give birth after three years in captivity.

Assume that each female from that time on will produce 1.5 offspring/annum.

2. These conditions (barring some disastrous incident) could lead to a herd of over 200 moose after five years, rising to about 600 animals after seven years.

After the first year (*i.e.*, the second spring of capture), it may be feasible to make a very large capture of 100 calves. This would greatly speed up the building of a herd.

The experimental station is envisaged as a continuing institution, operating on a similar basis to agricultural research stations. It should also provide some education facilities primarily for the benefit of native people, in whose interest the entire project is conceived.

The following parameters can be taken as guidelines for selecting a site for moose domestication:

1. Good moose habitat: cut or burned-over range with deciduous secondary growth of aspen, birch, willow, etc. The areas should also have low-lying areas with aquatic plant life.
2. Ideally, the community close-by should have an interest in the project, and consideration should be given to this as-

pect.

3. A certain remoteness is desirable for the ranch. Access by four-wheel-drive vehicles only would probably supply this need.
4. Accessibility must not be too difficult as this is also to be a demonstration area. Furthermore, there will be the supply of necessary goods from the south. This point does not necessarily have to conflict with the above (3).
5. A stand of timber suitable for log construction (e.g., straight spruce, with a minimum amount of taper) would be a valuable resource in the construction of buildings, fences and the like.
6. Approximately one township of land would be required initially.

A moose farm or ranch would require a certain amount of buildings and fencing. These requirements are tabulated below:

<u>Buildings</u>	<u>Function</u>
2 semi-open sheds	Winter shelter for calves ¹
1 storage shed	Supplemental food storage
1 shed	Laboratory and equipment storage
1 house	Staff quarters

<u>Fencing</u>	<u>Function</u>
4 miles of two-strand electric fence	To enclose a section of range
6000 feet of 6-foot fencing	To enclose 3 paddocks

Once construction is completed, the operation could be handled by a director and four assistants.

Calves are most easily captured in the water, otherwise, for the safety of the captor, it may be necessary to kill or at least stun the cow in order to separate the calf. Boats with outboard motors are therefore suggested as the best method of capture.

¹During the first years of operation, some winter shelter will be required for the calves as there will be no cow moose to break trail for them in the snow.

Calves should be transported as quickly as possible to the ranch. Helicopters are recommended for this purpose.

Soviet experience has been that moose calves become attached to the herder quite quickly. The calves should be fed fresh milk with a bottle, and domestic dairy cattle will have to be kept at the ranch for this purpose until moose begin to reproduce. Once calves are established, continued human contact should quickly domesticate them, and, after about three years, calves should be produced on the ranch.

With annual calf capture during the early years, economically viable herds conceivably could be established by the end of a five-year period.

APPENDIX C

Economics of Moose Husbandry

Due to a lack of basic data concerning the domestication of moose, economic potential is extremely difficult to predict. Nonetheless, the following hypothetical estimates based on the 10 assumptions contained in the text are given and summarized:

For Breeding Population of 100 Head:

0-1 years of age	17 males	17 females
1-2 years of age	16 males	16 females
2-3 years of age	15 males	15 females
3-4 years of age	3 males	14 females
4-5 years of age	3 males	12 females
5-6 years of age	2 males	10 females
6-7 years of age	0	0
7-8 years of age	0	0
8-9 years of age	0	0
Meat yield: 13,500 pounds		\$8,000
Yield of hides: 27		1,500
Total		<u>\$9,500</u>
Costs: 1.5 herders		\$12,000
Expenses		3,000
Total		<u>\$15,000</u>
NET LOSS		-\$5,500

For Breeding Population of 200 Head:

0-1 years of age	50 males	50 females
1-2 years of age	18 males	25 females
2-3 years of age	18 males	24 females
3-4 years of age	16 males	21 females
4-5 years of age	5 males	21 females
5-6 years of age	3 males	18 females
6-7 years of age	0	16 females
7-8 years of age	0	16 females
8-9 years of age	0	15 females
Meat yield: 29,000 pounds		\$23,000
Yield of hides: 87		3,500
Total		<u>\$26,500</u>

Costs: 2.5 herders	\$20,000
Expenses	5,000
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Total	\$25,000
NET PROFIT	\$1,500

For Breeding Population of 350 Head:

0-1 years of age	101 males	101 females
1-2 years of age	18 males	45 females
2-3 years of age	18 males	43 females
3-4 years of age	16 males	35 females
4-5 years of age	5 males	35 females
5-6 years of age	5 males	34 females
6-7 years of age	0	34 females
7-8 years of age	0	32 females
8-9 years of age	0	32 females

Meat yield: 47,500 pounds	\$37,000
Yield of hides: 173	7,000
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Total	\$44,000
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Costs: 3.5 herders	\$28,000
Expenses	7,000
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Total	\$35,000

NET PROFIT	\$9,000
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For Breeding Population of 700 Head:

0-1 years of age	220 males	220 females
1-2 years of age	18 males	95 females
2-3 years of age	18 males	90 females
3-4 years of age	12 males	85 females
4-5 years of age	10 males	80 females
5-6 years of age	10 males	80 females
6-7 years of age	0	75 females
7-8 years of age	0	75 females
8-9 years of age	0	75 females

Meat yield: 106,000 pounds	\$85,000
Yield of hides: 405	15,000
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Total	\$100,000
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Costs: 6 herders	\$48,000
Expenses (including aircraft use)	24,000
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Total	\$72,000
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NET PROFIT \$28,000

For Breeding Population of 1,000 Head:

0-1 years of age	350 males	350 females
1-2 years of age	50 males	150 females
2-3 years of age	45 males	140 females
3-4 years of age	40 males	130 females
4-5 years of age	35 males	130 females
5-6 years of age	15 males	125 females
6-7 years of age	10 males	125 females
7-8 years of age	5 males	120 females
8-9 years of age	0	100 females

Meat yield: 175,000 pounds	\$137,000
Yield of hides: 620	26,000

Total	\$163,000
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Costs: 8 herders	\$64,000
Expenses (including aircraft use)	41,000

Total	\$105,000
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NET PROFIT	\$58,000
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SUMMARY SHEET

Size of breeding population	Land or range requirements (miles ²)	Number of calves produced	Meat yield (pounds)	Age of harvested animals	Value of meat and hide yield	Estimated cost of herd maintenance	Number of herders-staff	Estimated profit or loss	Cost:benefit ratio
100	10	35	13,500	2.5-5.5 years	\$9,500	\$15,000	1.5	-\$5,500	1:0.63
200	20	100	29,000	Mostly calves	\$26,500	\$25,000	2.5	\$1,500	1:1.06
350	35	200	47,500	Mostly calves	\$44,000	\$35,000	3.5	\$9,000	1:1.26
700	70	450	106,000	Mostly calves	\$100,000	\$72,000	6	\$28,000	1:1.40
1,000	100	700	166,900	Mostly calves	\$163,000	\$120,000	8	\$43,000	1:1.59

APPENDIX D

The muskox herd

Basic Herd

Initially the herd would consist of 5 male and 25 female calves.

Growth

Growth of the basic herd would be slow initially, accelerating as the breeding stock increased. The following chart illustrates the projected growth through 8 years:

Year	Calves	Yearlings	2-year-olds	3-year-old cows	Mature cows	Bulls	Steers	Total
0	30	0	0	0	0	0	0	30
1	0	30	0	0	0	0	0	30
2	0	0	30	0	0	0	0	30
3	16	0	0	25	0	2	3	46
4	25	16	0	0	25	2	3	71
5	25	25	16	0	25	2	3	96
6	30	25	25	8	25	4	9	126
7	41	30	25	12	33	4	22	167
8	53	41	30	12	45	5	34	220

These figures are based on optimum success. The actual results could be substantially less.

Wool Production

Production of wool is variable, depending on the age and sex of the animal. For example:

Yearlings produce	3 pounds/annum
Two-year-olds produce	3 pounds/annum
Cows produce	4 pounds/annum
Bulls and steers produce	7 pounds/annum

The total wool production will increase from approximately 90 pounds the

first year to 750 pounds in the eighth year. Similarly, the cost/pound will decrease from approximately \$500/pound to \$80/pound over the same period. This cost factor compares unfavourably with the current price of raw *qiviut* at \$35/pound (Birt, 1971). Profitability is only brought into the operation through the secondary industry of processing the *qiviut* into garments. However, the primary industry cannot be ignored, as raw *qiviut* is not readily available on the commercial market.

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