THE IMPACT OF FORESTRY PRACTICES ON MOOSE (ALCES ALCES) IN NORTH - CENTRAL MANITOBA

by

BARBARA E. SCAIFE

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ABSTRACT

The impact of forestry operations on moose (*Alces alces*) in north - central Manitoba was determined through an examination of: (1) browse utilization by moose on forest cutovers, (2) spatial distribution of moose on forest cutovers, and (3) hunter-kill of moose in areas of pulpwood and timber extraction.

An examination of the literature and the results of the browse and moose distribution surveys showed that forest harvesting can be used to create moose habitat in Grass River Provincial Park. From these results, a series of guidelines regarding pulpwood and timber extraction in the study area were developed. The Provincial Park Lands Act provides Parks Branch with the legislation to regulate harvesting of trees in Grass River Provincial Park according to these guidelines.

An examination of the impact of forestry practices on moose in north - central Manitoba has led to a number of conclusions. A positive impact of forestry cutting practices is the creation of moose habitat which will in turn cause the moose population to increase in the harvested area. A negative impact of forestry practices is the increased access for hunters to the moose population. Residual cover on a cut enables moose to utilize the entire cut, even if the cut is relatively young (less than 4 years old). Depending on the amount of cover available, moose utilization of browse on cutovers increases on cuts of 6 years or older. Irregularly - shaped cuts enable moose to utilize

clearcuts larger in area than cuts which are uniformly - shaped. Forestry roads have a direct effect on moose populations in that hunting pressure increases with the additional access. Designated hunting routes can be used to alleviate the problem. Forest management may be used to create moose habitat in Grass River Provincial Park on the condition that harvesting operations follow the suggested guidelines.

Hunting success on cutovers and forestry access roads in Grass River Provincial Park should be carefully monitored. Stricter hunting regulations should be applied in the Park if increased hunter access proves detrimental to the moose population.

Suitable cutting operations can lead to the acheivement of multiple objectives in Grass River Provincial Park, including: (1) the continuation of pulpwood and timber harvesting, (2) the enhancement of non-consumptive recreation (moose viewing), and (3) the enhancement of consumptive recreation (moose hunting).

Further research is needed on the maximum allowable size of cut. As the maximum size that is non-restrictive to moose utilization is significantly affected by available cover on the cut, research should be carried out to determine the characteristics of moose cover, especially on cutover areas.

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TABLE OF CONTENTS

TABLE OF CONTENTS CONT'D.

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Statement of the Problem

Parks and Wildlife Branches of the Manitoba Department of Natural Resources are concerned as to the impact of forestry practices on moose in north - central Manitoba. Studies conducted in other regions of Canada have shown that forestry operations influence moose utilization of habitat. Research is lacking on the impact of pulpwood and timber harvesting on moose in north - central Manitoba.

Forestry is a major industry in north - central Manitoba. In 1966, an agreement was signed between the Province of Manitoba and Churchill Forest Industries (now Manitoba Forest Industries Limited, or Manfor). This agreement grants Manfor timber rights to approximately 103, 600 square kilometers of land in northern Manitoba. (Manitoba Department of Mines, Resources and Environmental Management, 1973). Forestry practices involve the creation of cutovers, which directly alter moose habitat, and the construction of forestry roads, which enable the general public, hunters in particular, to have greater access to moose populations.

Parks Branch is particularly interested in the effects of forestry practices on moose in Grass River Provincial Park. Moose are a significant part of the Park's faunal community. Other ungulates in the Park include woodland caribou (*Rangifer tarandus caribou*) and white-tailed deer (*Odocoileus virginianus*).

In the Provincial Park Lands Act (S. M., 1972, c. 67), there is no specific policy regarding resource extraction from Manitoba provincial parks. In Grass River Provincial Park, Manfor and five private operators, are presently cutting timber. Information is required concerning the impact of such operations on moose in order to determine the feasibility of using forest management to maintain or improve moose habitat within the Park and surrounding region. For this reason, the Parks Branch of the Manitoba Department of Natural Resources identified the need to investigate this impact.

1.2 Background

1.2.1 *Moose Population*

Moose populations are of great value, both to the hunter and to the vacationer who desires to view a moose simply for aesthetic pleasure. Although moose are abundant in Grass River Provincial Park, they are rarely seen. Visitors to the Park hope and even expect to see a moose. The Provincial Park Lands Act states that provincial park lands are to be used by Manitobans and visitors to Manitoba for healthful enjoyment, and for the cultural, educational and social benefits that are derived from the visit. If cut-over areas provide good moose habitat, Parks Branch may consider using forest harvesting to increase the probability of a visitor viewing a moose.

1.2.2 *Cutting Policy*

The cutting plan for Grass River Provincial Park consists of a zoning concept developed by Parks Branch in 1972 (Witty 1972). At that time, Grass River Provincial Park was zoned into three categories: (1) open, (2) restricted, and (3) closed cutting. Forestry operations within the Park are still carried out on the basis of this zoning. In the open zone (28,282 hectares), timber and pulpwood extraction may occur, provided Parks Branch receives notification from Forestry Branch. The restricted zone of 33,684 hectares, applies to areas around all navigable or scenic waterways and existing or potential intensive recreation development areas. To remove timber from a restricted zone, Forestry Branch must obtain consent from Parks Branch. The closed zone, in which no cutting is allowed, covers 41,634 hectares and includes woodland caribou calving grounds, scenic shield terrain and fragile string bog areas.

All timber harvesting in Grass River Provincial Park is supervised by Conservation Officers of the Cranberry Portage Detachment, Manitoba Department of Natural Resources. Supervision is governed by the timber sale contract, the Forest Act (S. M., 1964, 1st Sess., c. 19, s. 1) and regional policy applicable to the Park (Manitoba Department of Mines, Resources and Environmental Management 1973).

1.2.3 *Present Forestry Operations*

The allowable annual cut for Grass River Provincial Park is 26,000 cords. There are presently 5 established quota holders operating in the Park. Of the allowable cut, 16,000 cords must be allocated to the quota holders, and the remainder of the quota may be taken by Manfor. The portion of the quota allotted to each operator is based on the size of operation (Lamb 1980).

The quota holders generally do not clear cut but tend to cut small stands, gradually cutting away at the area included in their timber sale. These operators can extract trees selectively. However, for cutting of a stand to be economical, at least 100 trees are required for removal. The amount of harvesting is dependent upon the market for timber and pulpwood. Timber presently is selling for $270 per 1000 board feet, thus making it profitable to extract only a few trees. However, there is no market for pulpwood and Manfor has all the pulpwood it requires at this time.

1.3 Objectives

The primary objective of this study is to determine the impact of forestry practices on moose (Alces alces) in north - central Manitoba.

Specifically, the study will:

1. examine the influence of certain characteristics of cutovers on moose utilization of these areas,

2. assess the impact of forestry road construction on moose populations in north - central Manitoba, in terms of hunter kill, and

3. determine the feasibility of maintaining or improving moose habitat in Grass River Provincial Park through selected forestry management practices.

1.4 The Hypotheses

1. Moose utilization of logged over areas in north - central Manitoba is influenced by

the following characteristics:

(a) area of cutover - as cutovers increase beyond approximately 100 hectares in area, browsing by moose will decrease towards the centre of these cuts

(b) age of cutover - cutovers 10 years and older are used by moose to a greater extent than are 0 to 5 - year old cuts

(c) type of cutover - selectively - cut areas provide more cover for moose than do clear - cut areas and therefore selective cuts are used by moose to a greater extent than are clear cuts

(d) scarification of cutover - scarification enhances regeneration of desirable browse species for moose and therefore increases moose utilization of a cutover

(e) shape of cutover - moose utilize irregularly - shaped cutovers to a greater extent than uniform (e.g. square or round) cutovers of the same area

(f) type and abundance of vegetation on the cutover - moose utilization will be highest on cutovers offering the greatest abundance and variety of browse and cover vegetation

2. Hunter - kill of moose in north - central Manitoba is concentrated in areas of forest harvesting.

3. Forest harvesting can be used to create moose habitat in Grass River Provincial Park.

1.5 Definition of Terms

For the purposes of this study, terms are defined as follows:

1. A 'cutover' is a forested area from which pulpwood or timber has been removed.

2. A 'clear cut' is a cutover on which all trees have been removed.

3. A 'selective cut' is a cutover on which either small stands or individual trees have been left behind, usually because they are not economically desirable species.

4. 'Forestry practices' or 'forestry operations' include: (1) the cutting of pulpwood or timber, resulting in cutovers, and (2) the construction of forestry access roads to enable transport of machinery to the harvesting area.

5. A 'forestry - disturbed area' is one in which cutting of pulpwood and timber and/or construction of forestry access roads have taken place.

6. 'Scarification' involves using skidders to drag large anchor chains over cutovers in order to break up slash, expose mineral soil and prepare the seed bed.

1.6 Limitations

1. The study allowed only one season of field research.

2. The Timber Rights Agreement signed between the Province of Manitoba and Manfor is due for revision in 1983. However, for the purpose of this study, recommendations regarding cutting within Grass River Provincial Park will be made on the basis of the present agreement.

3. Hunter - kill information was obtained from hunter - checks conducted by Conservation Officers in the field and from voluntary reports of successful hunters to the Manitoba Department of Natural Resources. As it is unlikely that all successful moose hunters in the study area were questioned, the reliability of the hunter - kill data is reduced.

1.7 Study Area

The study area lies within north - central Manitoba

(Figure 1) and extends from The Pas north to Lake Athapapuskow, northeast to include Grass River Provincial Park, and south of the Park to The Pas to include the Mitchell Lake area (Figure 2).

1.7.1 *Physiography*

The study area is divided into two physiographic units; the Canadian Shield on the northern half and the Manitoba Lowland on the southern half (Tarnocai 1975). The Canadian Shield is characterized by Pre-Cambrian volcanic and gneissic bedrock which forms a broken topography with steep slopes rising up to 30 meters from the valleys. Lower, rounded hills are formed from granitic bedrock. The Manitoba Lowland portion is undulating and slopes gently towards the South. The Lowland in underlain by Ordovician dolomite or dolomitic limestone.

1.7.2 *Drainage and Hydrology*

Waters in the northern part of the study area drain into the Grass River, while those in the southern part drain into the Saskatchewan River (Tarnocai 1975). The Grass River connects a chain of lakes including the Cranberry, Simonhouse, File, Elbow, Iskwasum and Reed Lakes. The Grass River is relatively shallow and clear, and has rapids in some areas. It provides a popular canoe route for visitors to Grass River Provincial Park.

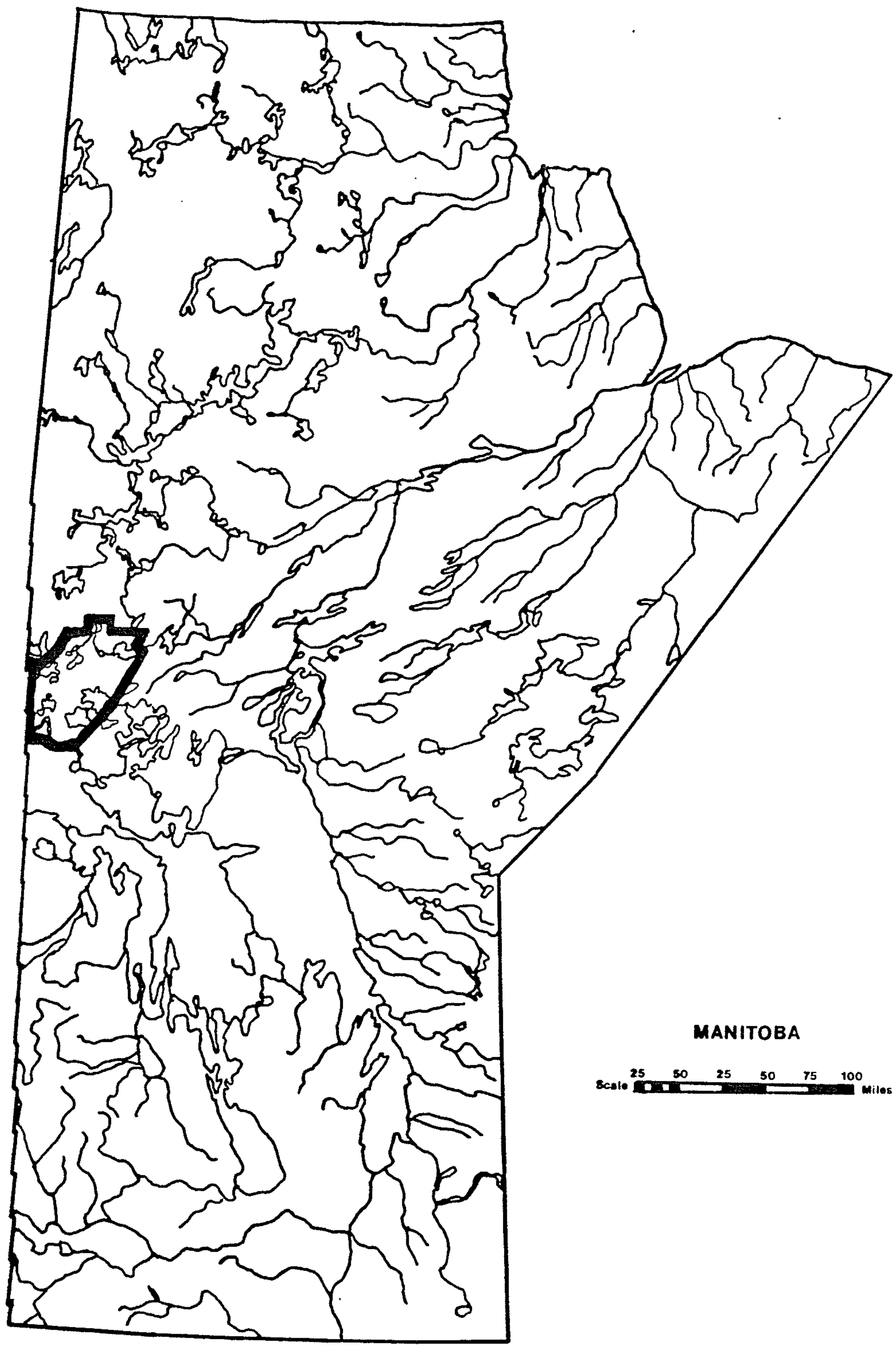

Figure 1. Location of study area in north - central Manitoba.

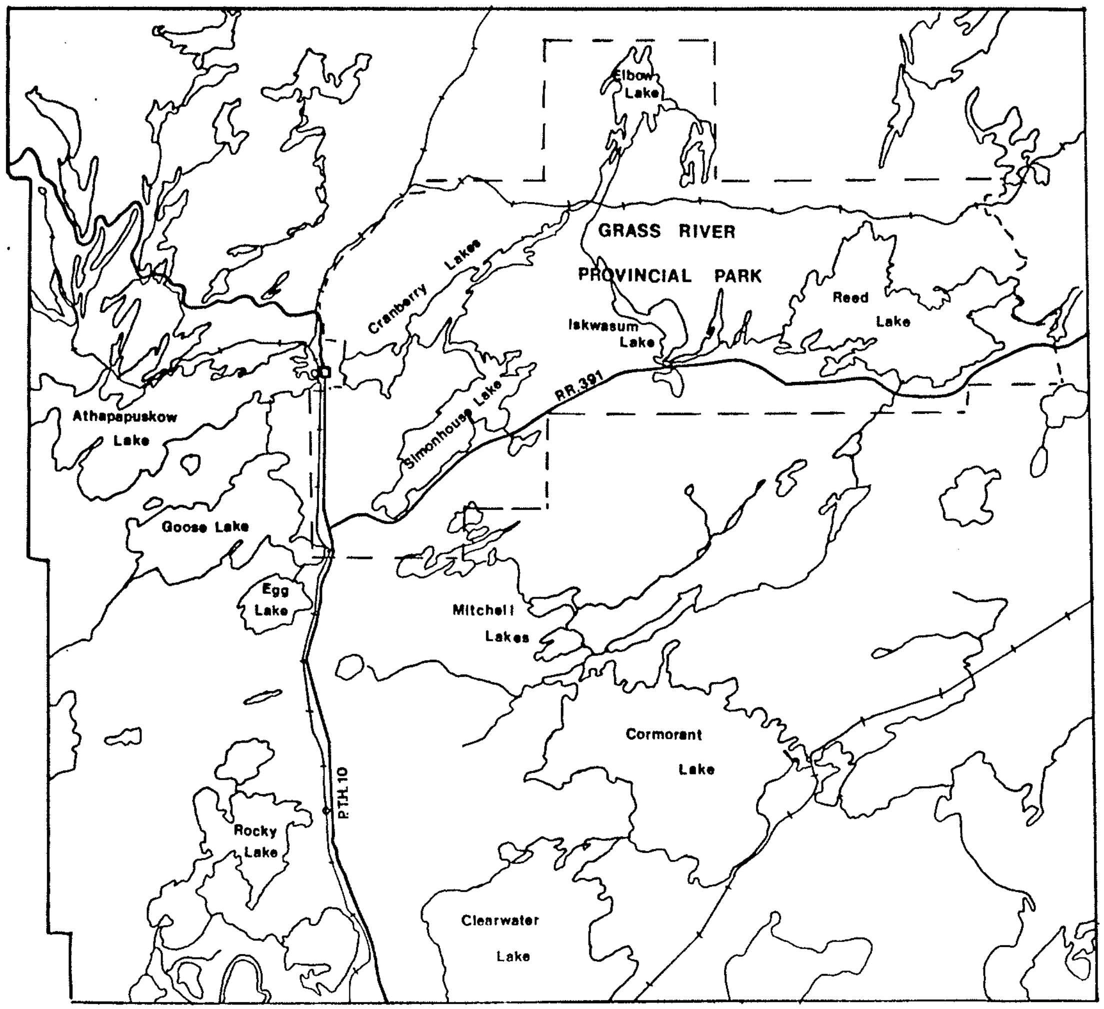

Figure 2. The study area. (Scale: 1:750,000)

1.7.3 *Climate*

The climate is characterized by short, warm summers and cold winters, with a mean annual temperature of approximately 0°C (Tarnocai 1975). The vegetative season (i.e. the time period in which the average temperature is above 5°C) is 140 days. The mean frost - free period is approximately 100 days. The mean annual precipitation is approximately 445 mm, about half of which falls between May and September.

1.7.4 *Vegetation*

The study area is located primarily in the Northern Coniferous Forest Zone (Tarocai 1975). Major softwood species include black spruce (Picea mariana), white spruce (Picea glauca), jack pine (Pinus banksiana), and balsam fir (Abies balsamea). Hardwoods include trembling aspen (Populus tremuloides), balsam poplar (Populus balsamifera), and white birch (Betula papyrifera).

Black spruce occurs in moist to saturated sites. Better drained areas support mixed wood forests of white spruce, aspen, poplar and balsam fir. Jack pine occurs on well - drained sites following a forest fire but it is eventually replaced by white spruce. Poorly drained fen peatlands are sparsely treed with tamarack (Larix laricina), or are occupied by sedges, willows or birches.

1.7.5 *Grass River Provincial Park*

Grass River Provincial Park comprises a major part of the study area, covering approximately 2287 square kilometers. Established in 1963, the Park includes the chain of lakes from Cranberry Portage to Reed Lake. Provincial Route 391 extends east from P. T. H. 10 on the south of the lake chain, and is the main access road through the Park. Development in the Park is minimal. There is a summer tourist camp at Reed Lake. Public campgrounds are located at Simonhouse, Reed and Iskwasum Lakes. The theme of the Park is a semi-wilderness or wilderness area.

2.0 LITERATURE REVIEW

Moose are solitary animals, generally inhabiting highly productive ranges which offer a mosaic of cover - and food - producing units (Eastman 1974). Although not specific to either the boreal forest or the effect of forest harvesting on moose, earlier research relating to timber stand improvement should be reviewed; results from these studies provided the basis and direction for further research examining the potential of forestry operations to produce food for moose. Morton and Sedam (1938) discussed the effects of slashing and thinning on forested land in Pennsylvania. Slashing, or clear cutting, was tested in areas where cover and food conditions were unsatisfactory and where the timber was not large enough to market. Slashing in zigzag strips 50 to 90 feet (15 to 27 meters) wide was recommended as the most practical method of increasing browse growth. Thinning of trees was also considered to benefit moose habitat in that the canopy was opened to admit sunlight, which stimulated the growth of browse species. Cook (1939) found that thinning of a hardwood forest near Stephentown, New York resulted in an increased growth of herbs and ferns for approximately three years, before the effect began to disappear. Conversely, Murphy and Ehrenheich (1965) noted that selective cutting or timber stand improvement in the Missouri Ozarks did not greatly increase production of understory vegetation.

It was believed that the openings were too small to appreciably reduce the overall crown cover, and thus forage production on the whole was not greatly increased. Peterson (1955) stated that clearcutting of smaller spots or strips normally increases the available food supply and improves the habitat for moose, but selective cutting frequently fails to reduce the forest canopy sufficiently to allow successional growth.

The apparent discrepancies in the literature concerning the effect of selective cutting or thinning on browse production are likely due to the loose definition of terms. 'Selective cutting' and 'thinning' appear to be used interchangeably in earlier literature. Thinning may involve the removal of very few trees, in which case, little opening of the forest canopy may result. In recent literature, partial or selective cutting involves removal of a greater number of trees, either individually or in patches. Eastman (1974) defines partial cutting to include cutting and leaving strips, single tree selection, and diameter limit, where only trees exceeding specified diameters are taken. In the sub-boreal spruce zone of British Columbia, Eastman (1974) found that the amount of timber removed and the amount of canopy opened varied according to a stand's species composition and the distribution of stem diameters.

Cowan et al. (1950) investigated the nutritional properties of vegetation in various successional stages following deforestation of an area adjacent to the airport at Quesnel, British Columbia. The study showed that younger stages not only provide a greater abundance of browse, but also provide the most nutritious food. However, for certain nutrients, access to older coniferous stands is desirable.

Researchers have tried to quantify the increase in food available to ungulates after a cutting operation. In a study conducted on the response of deer browse to cutting in the Jefferson National Forest in Virginia, Patton and McGinnes (1964) found that even a 30% removal of trees (in terms of basal area) increased browse production from an average of 10 pounds per acre (1.8 kg/ha) for uncut areas to 31 pounds per acre (5.7 kg/ha), one year after the cut. An investigation of forage yield on logged areas in New Brunswick showed that the weight of available winter browse for moose and deer increased from 450 pounds per acre (82.6 kg/ha) two years after the cut, to 19,800 pounds per acre (3632 kg/ha) 10 to 12 years after the initial cut (Telfer 1972). In the foothills of western Alberta, Stelfox, et al. (1976) observed that production of browse for moose, deer and elk was higher in the mature forest than on the cutovers one year after logging. Five years after logging, browse production was lower in the mature forest than on the cutovers. Usher (1977) examined cleared areas of forest in the Sand River area of Alberta. One year after clearing, samples showed a browse yield of the 10 species studied in the cleared areas ranging from 0.07 kg/ha to 242.09 kg/ha. In the mature forest, the yield only ranged from 0.38 kg/ha to 10.66 kg/ha.

Eventually, it became apparent that the amount of browse produced was not the only important factor in determining moose utilization of a cutover. Researchers began to consider the different types of forestry activities and their particular effects on moose habitat.

MacLennan (1975) looked at a large cut in the Porcupine Forest in Saskatchewan. He compared the average distance of a moose observed in a cutover from cover to an average distance generated randomly to determine if the animals were selecting only a certain part of the cut or were using the whole cut. He found that moose stayed closer to cover than a random distribution throughout the cut would indicate. Hunt (1976) used the same method, again in the Porcupine Forest, and discovered that moose may use all of a small cut but tend to remain closer to the edge of the forest in a large cut, avoiding the central portion. However, if the cutover had a fair amount of residual cover throughout, the moose were able to utilize the whole area. In a large clear cut in the Thunder Bay District of Ontario, Hamilton and Drysdale (1975) also noted decreasing utilization of browse by moose with increasing distance from cover. It was increasingly apparent that cover has a significant effect on the availability of cutovers for moose.

Although cover is an important factor in determining the amount of use that moose may make of a large cutover, a precise definition of what constitutes 'cover' presents a problem. Hunt (1976) defined cover as any treed area or patch of tall shrubs that was large enough to be delineated on a forest inventory map. However, Telfer (1974) stated that forest inventory maps have a specified minimum stand area so that extremely patchy vegetation must be lumped and given a type designation based on the predominant condition among the patches; therefore, caution must be exercised in rating effective cover from forest inventory maps. MacLennan (1975) stated that any uncut area was considered as adequate shelter. However, this definition includes swamps, willow swales, small clumps of spruce and uncut stands as cover. MacLennan (1975) admits that some of these areas may actually be too small or short to provide protection.

The age of a cut also has an effect on moose utilization. Stelfox (1962) looked at an area that had been clear cut in strips with undisturbed strips left between. During the first five years, moose ignored the logged-over areas. Twelve years later, even though browse production had greatly increased in the logged strips, which were now 17 years old, most of the winter moose use was observed in the mature forest

(Stelfox 1974). It was thought that this was due to the lack of shelter in the 17-year old cuts. Telfer (1974) suggested that clear cut areas larger than 1.3 km^2 are not heavily utilized until the new stand has grown sufficiently to provide shelter (15 years or more after logging). Opinions differ as to the optimum age of a cutover for moose utilization. The general consensus is that older cuts provide preferable winter habitat. In the Porcupine Forest in Saskatchewan, moose tended to prefer 9 to 10-year old cuts (Hunt 1976). Vallee, et al. (1976) found the optimal age of regeneration of browse species in soft and mixed wood stands that have been cut to between 5 and 10 years of age, and between 10 and 15 years for hardwood stands.

Stelfox (1962) noted that scarification following logging generally retarded forage production and utilization one to two years as compared to unscarified areas. Although browse production in the cutovers still exceeded that in the unlogged forest 17 years after logging, browse production in scarified areas remained consistently lower than in the unscarified cuts. However, in examining browse production of different species, poplars were 24% more abundant in scarified than in unscarified areas (Stelfox, et al., 1976). Usher (1978) suggests that areas be cleared and heavily scarified in order to produce maximum sucker response.

Usher (1978) examined the changes in browse production and browse utilization by moose with time, stating that cuts producing the greatest amount of woody forage will be used the most. The density of browse stems initially increases rapidly and then begins to decrease after year 4 or 5, becoming significantly less than that of one-year old cuts by 15 to 20 years after cutting (Figure 3). Browse production and utilization declines as trees grow beyond the reach of moose and shrubs produce fewer stems due to competition for light and nutrients. Usher (1978) stated that moose populations can be expected to peak 12 to 15 years after clearing when browse yields are high and cutovers provide adequate cover. Moose utilization of browse will peak at the same time (Figure 4). After 30 years, range will become marginal due to decreasing browse diversity, yield and quality (Usher 1978).

The variance in opinions as to preferred age of cutovers needs clarification. Measuring browse production on a cutover may determine the age of optimum forage availability but not the age of maximum utilization of the cut by moose. The maximum production of browse may either be delayed due to scarification or may occur at an age when cover is still lacking, and cover significantly affects the availability of a cutover for moose. The age at which a cutover provides the best moose habitat is also geographically influenced. Regional location determines the soil type, moisture regime and other factors influencing the speed of regeneration in a cutover area.

Clear cuts do not have the same effect as selective cuts. Partial cutting creates a habitat that most closely resembles

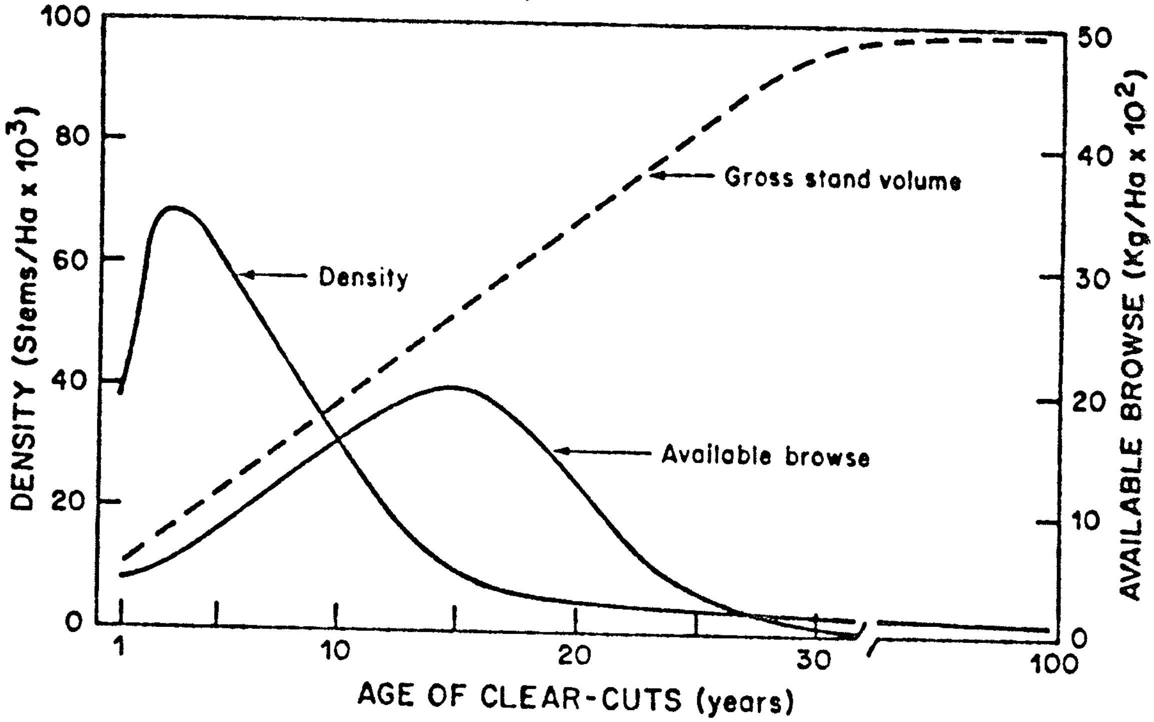

Figure 3. *Browse production in clear-cuts ranging from 1 to 30 years.*

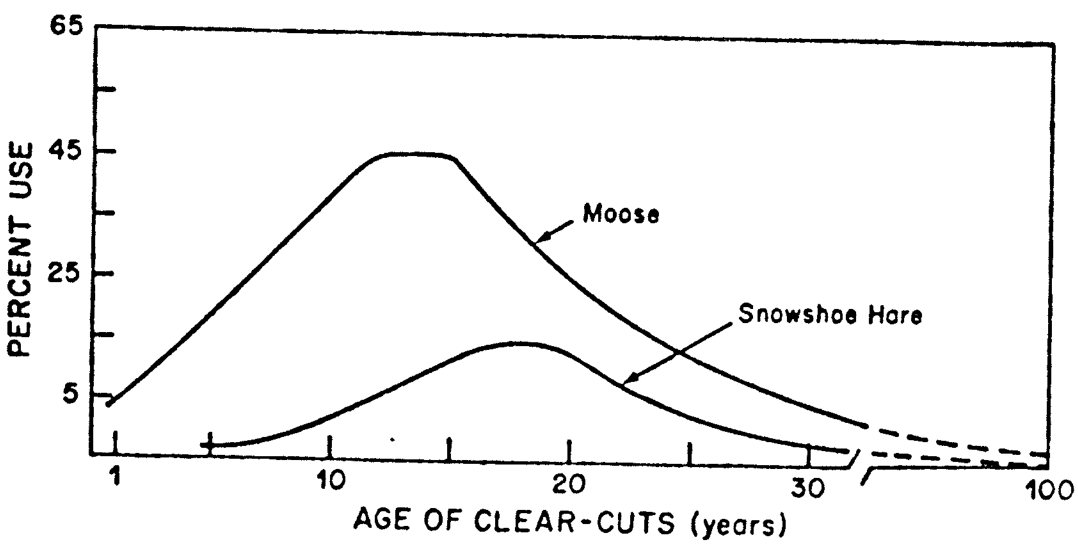

Figure 4. *Browse use by moose and snowshoe hare in clear-cuts, ranging from 1 to 30 years.*

Source: Usher (1978).

highly productive, naturally heterogeneous ranges (Eastman 1974). Cover is retained but browse production is also stimulated, because opening of the canopy allows sunlight to penetrate to the forest floor. In north central British Columbia, Eastman (1974) found that browsing rates were generally highest in partial cutovers. A range with a variety of stand types and age classes offers escape cover, refuge from winter conditions and alternate food sources (Usher 1978). In southwestern Quebec, Crete (1976) found that selectively cut hardwood stands were used more intensively by moose than uncut stands. Clearcut hardwood stands also were utilized more frequently in Pontiac County while the opposite trend occurred in Mont - Tremblant Park. The lower utilization in Mont - Tremblant Park was believed due to the slower and less abundant regeneration of browse in the area (Crete 1976).

The type of cutover can also affect snow depth. Without shelter of trees, snow is deeper on cutovers than in the surrounding forest. In earlier research, it was believed that as snow depth increased on the cutover, moose retreated into conifer forests. Eastman (1974) suggests that more central areas of cuts are used primarily for feeding in early winter but are less favoured in late winter as snow depth increases. Telfer (1974) mentions the importance of conifer cover to wintering moose. Usher (1978) states that keeping close to cover edges in winter is probably motivated additionally by the need to avoid wind chill. However, Hunt (1976) found that moose ventured further from dense cover during particularly severe periods in winter, while MacLennan (1975) found this to become the case as winter progressed. Neither researcher explains this apparent contradiction to earlier findings.

Edges of cutovers are important as they provide simultaneous access to different habitats required for different needs, i.e. food and cover (Usher 1978). For this reason, the shape of a cutover can influence the degree to which the area is browsed by moose. Telfer (1974) stated that extensive edge results from narrow strips of various cover types or age classes. Usher (1978) recommended blocks of irregular shape which provide greater amounts of forest edge.

Moose tend to use forestry roads in much the same way as forest cutovers. Road edges are similar to cutover edges in creating increased browse near dense cover. Roads may also be used as travel lanes. Van Ballenberghe and Peek (1971) observed a cow moose that spent six days in February on or adjacent to a newly ploughed logging road, when snow depth was greatest.

A negative effect on moose of forestry roads, is to create access to the moose population for hunters. Hildebrand and Imrie (1975) recommended designated vehicle route systems which have been instigated in northern Manitoba. These systems are used to control vehicular access during the moose hunting season.

The ability of moose to move into an area of available habitat has been the object of some discussion. Peterson (1955) states that ecological conditions as well as population pressure appear to govern to a large degree the movement of moose from one specific area to another. Irwin (1975) suggested that moose have evolved mechanisms for rapidly colonizing large recent burns, and capitalizing on large quanities of available browse. Therefore, habitat manipulation involving logging should favour moose populations. Preliminary results of studies in Alberta suggest that moose distributions can be changed locally by creating stands in early successional stages, and that treatments scattered through a sufficiently large area, at least 100 km^2, should cause regional moose populations to increase (Telfer 1978). On the Little Sioux Burn in northeastern Minnesota, Peek (1974) determined that substantial immigration of yearlings to a burn occurred within 6 months after a fire. However, it was anticipated that any subsequent population increases would be due to increased production and twinning rather than immigration. Peek states that the capability of widely dispersed, low density moose populations to rapidly colonize favourable habitats is an adaptation to survival in the boreal forest.

In summary, moose utilization of a forest cutover appears to depend on the size, shape, age, type and residual cover of the cut. Moose are able to utilize all of a smaller cut while they tend to restrict their activity to the outer edges of a large cut. Cuts of irregular or narrow shape provide preferred habitat due to the extensive edge they offer. Cover is an important factor in allowing moose to venture further from the nearest edge, utilizing the entire cut. Cuts 10 years or older offer more cover and therefore are used to a greater extent by moose than are more recent cuts. Selective cuts provide cover as well as browse for moose and therefore are used to a greater extent than clear cuts. Forestry practices also include construction of roads which may either be utilized by moose or may be detrimental to the population, under varying situations.

The factors which have been shown to influence moose utilization of a forestry-disturbed area have led to a number of recommendations by researchers:

(1) Square cutovers should not exceed 0.67 miles (1.08 km) on edge, nor exceed 285 acres (115 hectares). Partial cuts, 11 to 20 years old, are preferable winter habitat since they most resemble naturally heterogeneous ranges (Eastman 1974).

(2) Cutovers less than 200 meters in maximum width are of small enough size that distance from cover does not significantly alter use patterns by moose (Hamilton and Drysdale 1975)..

(3) Clear cutting should be in strips or patches to arrange food-producing strips next to strips providing dense cover. The size of strips cut should be arranged so that 60% to 80% of the area is in an age class of 35 years or older at all times (Telfer 1970).

(4) Cuts should not exceed 100 metres in width or 400 meters in length. Cuts should not exceed 5 hectares in area, and a clustering of small blocks of different shapes and orientations is recommended (Usher 1978).

(5) Cuttings should be small, irregular and scattered. Designated vehicle routes should be established among the numerous forestry roads to prevent increased harvest of moose by hunters. Most spur roads should be closed once logging operatings cease (Hildebrand and Imrie 1975)

The literature was relatively specific to the effects of forest harvesting on moose. Previous research on the impact of forestry access roads on wildlife populations is sparse. The literature is consistent regarding the effects of size, shape, age, type and residual cover of cutovers on their utilization by moose. Any difference in opinion primarily concern the magnitude of these effects. The range in the suggested maximum allowable size of cut emphasizes the need for further research regarding the effect of cutover area on utilization by moose. Although known to have a highly significant effect on cutover availability to moose, 'cover' has not been satisfactorily defined. The literature contains only brief observations on the effect of forestry access roads on moose populations. More research is needed in this area.

The difference among the conclusions drawn and recommendations made by previous researchers justify the need for site - specific evaluations regarding the effects of forestry practices on moose populations and habitat.

3.0 METHODS

3.1 Browse Survey

A field survey of the extent of browsing by moose on forest cutovers was conducted from May 10, 1979 until June 7, 1979, involving a total of 255 staff man-hours.

On the basis of the results of the 1978 moose age and sex survey conducted in the study area by wildlife personnel of the Manitoba Department of Natural Resources, cutovers showing high concentrations of moose were initially selected for closer examination. It was assumed that the presence of moose on one cutover as opposed to absence on another cut indicated preference for a cutover due to more favourable conditions, and that the nature of these conditions would become more apparent during field surveys. From this initial group of cutovers, the final 11 study cutovers were chosen on the basis of accessibility, age, size and soil category in an attempt to obtain a cross-section of the cutover characteristics hypothesized to affect moose utilization of these areas. Six additional cutovers which did not show high concentrations of moose were included in the latter part of the field survey to provide comparative data.

On each of the study cutovers of varying area, age, shape and soil type, transects were laid out using a compass and chain. Usually two transects were established for each cutover, running at approximately right angles to each other from the centre to the outer edge of the cut. One transect always crossed the widest part of the cutover. In one particularly large cutover (746 hectares), five transects were run. Every 50 meters along each transect, a 2-meter square quadrat was measured out. Within each quadrat, a count was made of both the number of twigs of browse available for moose and the number of twigs that had actually been browsed on by moose. Moose characteristically browse by pulling twigs from branches, leaving a rough end, as opposed to the diagonally scissored end of a twig that has been eaten by a snowshoe hare. Deer and woodland caribou browse in a similar manner to moose, however, there are few deer in the study area, and pellet droppings in the vicinity of the sample quadrats indicated the probable browser. To be included in the count, twigs had to be at least 2.0 inches (5.0 cm) long and had to be growing on stems with their base within the quadrat and which were from 1.0 feet (0.9 m) to 9.0 feet (2.7 m) in height. Only twigs of shrub species known to be preferred moose browse in north-central Manitoba were counted. Browse species included willow (Salix sp.), trembling aspen (Populus tremuloides), balsam poplar (Populus balsamifera), white birch (Betula papyrifera), speckled alder (Alnus rugosa), and dogwood (Cornus stolonifera).

The locations of the 17 cutovers chosen for study are shown in Figure 5. The identification number of each cut corresponds with the cutover number in Table 1, which records ages and areas of the study cutovers. Cutovers varied in size from 11 to 746 hectares. The most recent cutovers examined were cut in the winter 1975 - 1976, while harvesting of trees

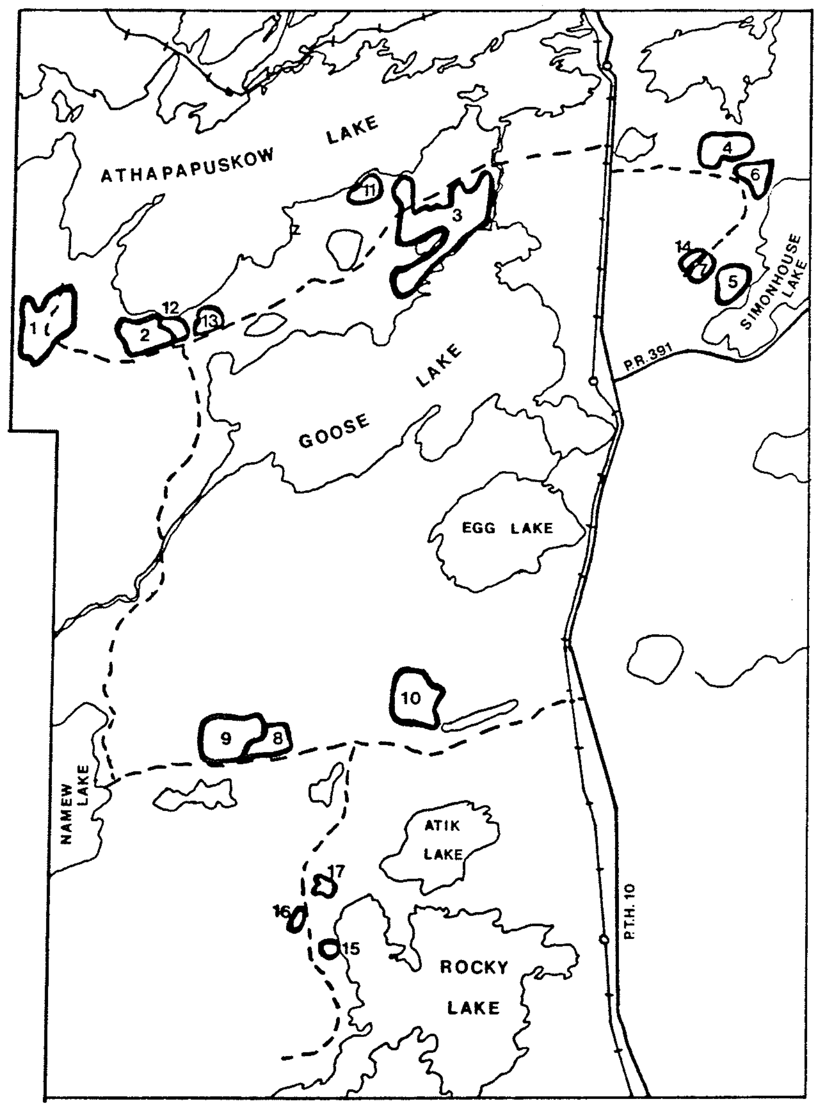

Figure 5. Location of study cutovers.
(Scale: 1:400,000)

Table 1. Characteristics of study cutovers.

(a)

CUTOVER NO.	AREA (HA.)	YEAR OF CUT
1	378	1972/73
2	220	1971/72
3	746	1969/70
4	348	1971/72
5	347	1975/76
6	259	1972/73
7	119	1974/75
8	234	1971/72
9	703	1972/73
10	223	1972/73
11	114	1973/74
12	53	1974/75
13	137	1975/76
14	100	1974/75
15	15	1975/76
16	11	1974/75
17	22	1974/75

(b)

	AREA (HA.)			
	0-99	100-199	200-299	300-750
NO. OF CUTOVERS	4	4	4	5

(c)

	YEAR OF CUT					
	1969/70	1971/72	1972/73	1973/74	1974/75	1975/76
NO. OF CUTOVERS	1	3	4	1	5	3

from the oldest cut occurred in the winter of 1969 - 1970.

Data Analysis

All cutovers and transects were plotted on forest inventory maps (4 inches to 1 mile). Using a planimeter, a line was drawn inside each cutover following the contours of the perimeter in such a way as to divide the cutover into an inner area and an outer area, the outer section comprising 70% of the total area of the cut. All sample quadrats falling in the outer 70% of the cutover area were designated 'outside' quadrats, while those located in the remaining 30% were classed as 'inside' quadrats. It was found that this 70% - 30% division generated approximately equal numbers of inside and outside quadrats.

The proportion of twigs browsed (i. e. the number of twigs browsed divided by the number of twigs available) was calculated for each quadrat. Student's t - test was used to test the null hypothesis that there was no overall significant difference between the mean proportion of twigs browsed on inside quadrats and the mean proportion of twigs browsed on outside quadrats. A significantly higher proportion browsed on outside quadrats would indicate that moose tend to browse closer to the outer edge of the cutovers.

The sample quadrats were then divided into groups according to the size of their corresponding cutover. Student's t - tests were again applied to determine if differences between inside and outside proportions of twigs browsed were dependent upon the size of the cutovers from which the quadrats were sampled.

As vegetation was relatively similar over all of the cutovers studied, the effect of soil type was determined to be insignificant and therefore, the cutovers were not divided into soil categories for testing.

As all of the 17 cutovers had been scarified, it was not possible to test for differences in browse production between scarified and unscarified cuts.

Regressions analysis was done to test for a linear relationship between the number and proportion of twigs browsed and the amount of browse available.

All statistical tests were carried out using I.B.M. statistical packages written in APL, available through the University of Manitoba computer facilities.

3.2 Moose Distribution

During the moose age and sex survey conducted in the fall and winter of 1979 in the study area, personnel of the Wildlife Branch of the Manitoba Department of Natural Resources recorded the locations of moose on forest cutovers as accurately as possible on aerial photographs (scale: 1:50,000). Measurements were then taken from the photographs to obtain the mean distance of moose from both the nearest cover and the nearest edge of the cutover. Due to the scale of air photos, strong significance should not be placed on the results of these measurements.

Using the methods of MacLennan (1975), a series of random dots were plotted on aerial photographs of the same cutovers to provide a set of random distances from the edge. The mean distance of moose from the edge was then compared to the mean random distance to see if animals were randomly dispersing throughout cutovers or were remaining closer to edges. The mean observed distance from cover was compared to the mean observed distance from the edge to test for the effect of cover on browsing by moose on a cut. A significantly smaller mean distance from cover would suggest that moose utilize existing cover on a cut to take advantage of browse further from the edge.

Distances from edges were separated into groups according to the age of cut on which they were measured. The mean observed distance of moose from the edge was then compared to the mean random distance for each age category, to test for the effect of age of a cutover on its utilization by moose.

In each case, student's t - test was used to test for significant differences between mean distances.

3.3 Hunter-Kill Survey

To determine the impact of forestry access roads on moose populations in north - central Manitoba, conservation officers from the Cranberry Portage and Flin Flon detachments collected information regarding exact locations where successful hunters first shot their moose during the 1979 fall moose season. The location of the moose kill was not the primary concern as the animal may have been shot from the road and then wandered, wounded, miles from the original siting.

Hunter-kill information was obtained for Game Hunting areas 5 and 7 which cover the study area.

4.0 RESULTS

4.1 Browse Survey

Student's t - test conducted on the sample quadrats from all of the cutovers grouped together rejected the null hypothesis of equal mean proportions of twigs browsed on inside and outside quadrats ($t_{.05,518} = 1.96$, computed $t = 3.05$). Contrary to expectations, the mean proportion of twigs browsed on inside quadrats was significantly higher (0.142) than the mean proportion browsed on outside quadrats (0.082).

Student's t - tests applied to the four size classes of cutovers failed to reject the null hypothesis of equal mean proportions browsed on inside and outside quadrats for the three smaller size groups, but rejected the null hypothesis for the largest size group (Table 2). The mean proportion of twigs browsed was significantly higher for inside quadrats than for outside quadrats in the 300 to 750 hectare size class ($t_{.05,240} = 1.96$, computed $t = 2.54$), while there was no significant difference in proportion browsed for cutovers smaller than 300 hectares.

Due to the transect system of the original data collection, larger cutovers had a larger number of sample quadrats. This factor, in conjunction with the extra cutover in the largest size class, resulted in 46% of sample quadrats falling into the largest size class. Consequently, data

Table 2 Mean proportions of twigs browsed per inside and outside quadrat according to size of cutover. t - test results.

SIZE CLASS (ha)	NO. OF CUTOVERS	NO. OF INSIDE QUADRATS	MEAN PROPORTION BROWSED (INSIDE)	NO. OUTSIDE QUADRATS	MEAN PROPORTION BROWSED (OUTSIDE)	CRITICAL t	COMPUTED t
0 to 99	4	30	0.172	26	0.163	2.005	0.249
100 to 199	4	45	0.181	37	0.152	1.991	0.807
200 to 299	4	74	0.219	68	0.183	1.977	1.024
300 to 750	5	146	0.303	94	0.218	1.970	2.541
All	17	295	0.250	225	0.190	1.965	3.049

for the 300 to 750 hectare cutovers weighted the results of the t - test comparing mean inside and outside proportions for all cutovers towards the same conclusion, i. e. rejection of the null hypothesis of equal mean proportions browsed for inside and outside quadrats.

A regression analysis of the number of twigs browsed per quadrat against the number of twigs available per quadrat for all cutovers led to rejection of the null hypothesis of zero slope ($F_{.05,518} = 3.86$, computed F = 126.006) (Appendix I). The r^2 factor showed that 20% of the variation in the number of twigs browsed can be explained by its relationship with the number of twigs available. This relationship is slightly more apparent for outside quadrats ($F_{.05,1,223} = 3.88$, computed F = 65.5) as the r^2 factor shows 23% of the variation to be explained while only 18% of the variation among inside proportions browsed is explained by the relationship ($F_{.05,1,293} = 3.87$, computed F = 65.49) (Appendix I).

A regression analysis of the proportion of twigs browsed per quadrat against the number of twigs available per quadrat for all cutovers again led to rejection of the null hypothesis of zero slope ($F_{.05,1,518} = 3.86$, computed F = 11.78). (Appendix II). However, even though there is a statistically significant relationship between the proportion of twigs browsed per quadrat and the number of twigs available per quadrat for all cutovers, the relationship is not likely to be important biologically, as it only explains 2% of the variation.

Regardless of the significance of this relationship, student's t - test failed to reject the null hypothesis of equal mean number of twigs available on inside and outside quadrats, both for all cutovers ($t_{.05,518} = 1.965$, computed $t = 1.094$), and also for cuts in the 300 to 750 hectare size category ($t_{.05,240} = 1.97$, computed $t = 1.018$). Therefore, the significantly larger mean proportion of twigs browsed on inside quadrats over outside quadrats for both of these classes cannot be explained by a greater abundance of browse available on the inside quadrats, as browse was equally available on inside and outside quadrats.

A regression analysis of the proportion of twigs browsed per quadrat against the size of the cutover in hectares for all cuts rejected the null hypothesis of zero slope ($F_{.05,518} = 3.87$, computed $F = 13.737$) (Appendix III). The r^2 factor showed that only 3% of the variation in the proportion browsed can be explained by its positive relationship with the size of the cutover. The significance of the analysis on all quadrats is due to the positive correlation between proportion browsed and size of the cutover for inside quadrats ($F_{.05,1,293} = 3.87$, computed $F = 13.47$). A regression conducted on outside quadrats only, failed to reject the null hypothesis of zero slope ($F_{.05,1,223} = 3.88$, computed $F = 0.756$) (Appendix III). Thus, the mean proportions browsed on inside quadrats appear to increase as the size of the cutover increases, while the mean proportion of twigs browsed on outside quadrats does not depend on the size of the cutover. There was no significant difference between inside and outside proportions of twigs browsed for the smallest size category of cut.

4.2 Moose Distribution

Student's t - test comparing the mean observed distance of moose from the edge of a cut with the mean randomly generated distance failed to reject the null hypothesis of equal mean distances from the edge ($t_{.05,124} = 1.98$, computed $t = 0.225$). Moose appeared to be randomly distributing themselves throughout the cutovers rather than browsing closer to the edge of cuts. The most recent cutovers in the analysis were cut in 1974/75. In every age category, student's t - test failed to reject the null hypothesis of equal means for observed and random distances from the edge (Table 3).

Student's t - test comparing the mean observed distance of moose from cover and the mean observed distance from the edge rejected the null hypothesis of equal means ($t_{.05,124} = 1.98$, computed $t = 32.49$). The mean distance from cover was significantly shorter (42.74 meters) than the mean observed distance from the edge (248.41 meters). Cover appears to have an effect on the distribution of moose over a cutover. A t - test comparing the mean random distance from cover with the mean random distance from edge also rejected the null hypothesis of equal means ($t_{.05,124} = 1.98$, computed $t = 19.79$). The significantly shorter random distance from cover (54.81 meters) as compared to the mean random distance

Table 3 t - test results comparing mean observed and mean random distances of moose from edge of a cutover.

AGE	df	MEAN OBSERVED DISTANCE (m)	MEAN RANDOM DISTANCE (m)	CRITICAL t	COMPUTED t
1969/70	32	234.80	244.12	2.037	0.143
1970/71	20	195.84	172.80	2.086	0.473
1972/73	36	360.15	303.46	2.028	0.866
1973/74	8	152.06	215.42	2.306	0.887
1974/75	20	172.80	293.76	2.086	1.357
All	124	248.41	255.95	1.98	0.225

from edge (255.95 meters) suggests that sufficient cover is available over the entire cutover to allow moose to utilize the inner areas to the same extent as the outer edge. This would explain the lack of a significant difference between the mean observed and the mean random distance of moose from the edge. The presence of cover on a cutover appears to be a significant factor in allowing moose to utilize the entire area of larger cuts.

4.3 Hunter-Kill Survey

Location of moose kills are shown in Figure 6. Of the 11 moose harvested by hunters in Game Hunting Area 5, 8 were shot from forestry roads. Two of these were killed by hunters walking along a forestry road which was not a designated vehicle route. The remaining 3 moose were shot from a boat on Rocky Lake.

Eleven moose were harvested in Game Hunting Area 7. Of these, one was shot by a hunter driving down P. R. 391. Three were shot at the Reed Lake microwave tower immediately adjacent to P. R. 391. Six moose were shot by hunters driving along forestry roads. The final moose was shot 50 meters from a forestry road.

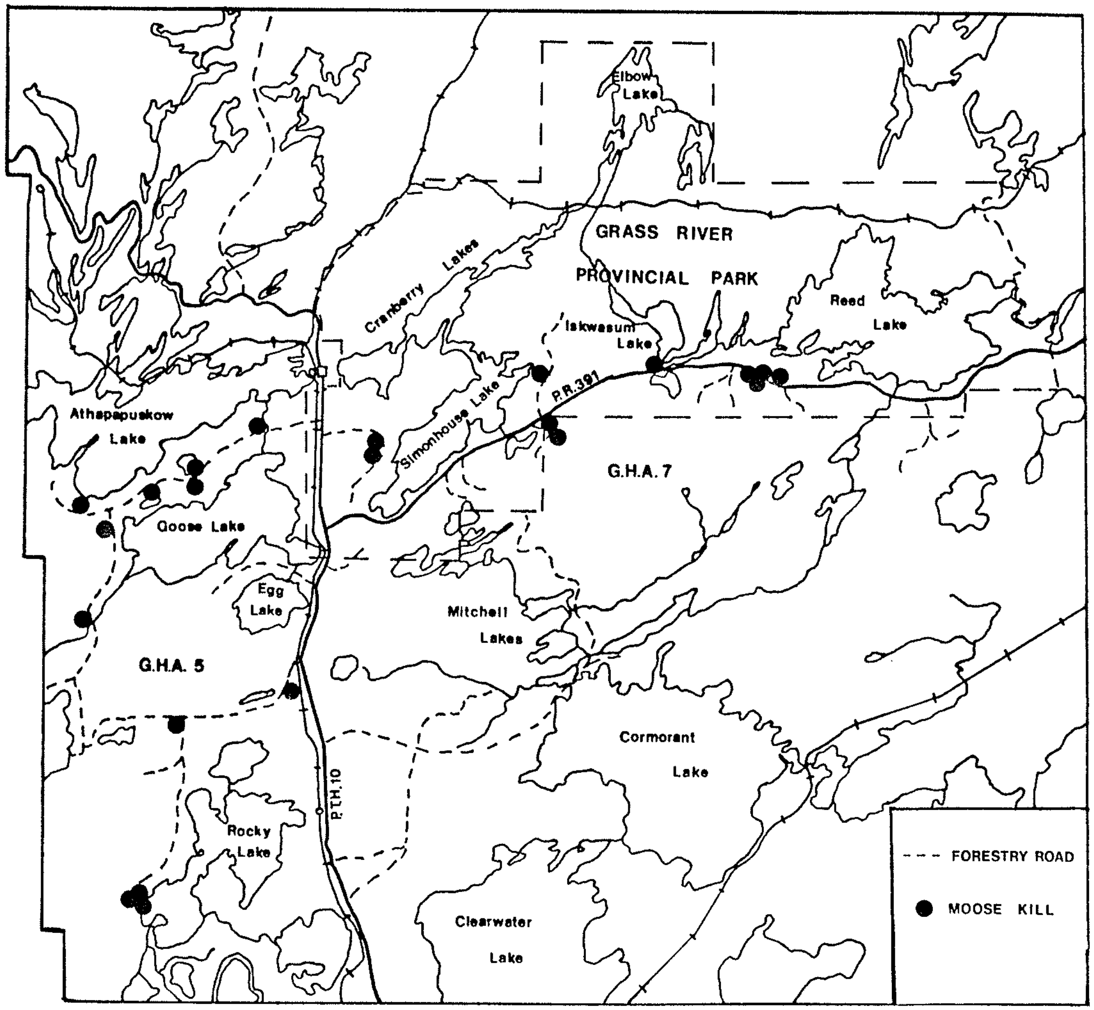

Figure 6. Location of moose kills in Game Hunting Areas 5 and 7. (Scale: 1:750,000)

5.0 DISCUSSION

5.1 Moose Utilization of Forestry Cutovers

According to the literature, cutover size is a major factor in determining the degree to which it is browsed by moose. However, the cutovers examined in this study showed no significant difference in browsing throughout cutovers smaller than 300 hectares in area, while the largest cutovers showed an increase in browsing towards the centre, directly contradicting reports from the literature. The moose distribution survey also failed to reveal any preference of moose in a cutover to utilize areas near the edge. Moose appeared to be randomly distributed over all cutovers on which they were sighted. Previous research indicates that if cutovers are small in area, moose may utilize the entire cut; a wide range has been suggested as to the maximum allowable size of cut. Research done in the Porcupine Forest in Saskatchewan offers the most suitable data for comparison due to the proximity of this area to north - central Manitoba. Hunt (1976) states that the size of cuts in the Smoking Tent cut block in the Porcupine Forest apparently was small enough to enable moose to use almost all of the cut portions. The only information offered on the size of these cuts is a maximum random distance from edge of 355 meters. Assuming square cutovers, a very rough estimate of the maximum area would be 50 hectares. Hunt (1976) found that the Piewi cut also was not large enough to hinder moose utilization of the entire cut. With a maximum random distance from edge of 369 meters, a rough estimate of its size is 54 hectares. Similar to the results from north - central Manitoba, the mean distance of moose from the nearest edge was equal to or slightly greater than the calculated random distance from edge for the largest cuts examined. With a maximum random distance from edge of 530 meters, maximum size of these cuts (in the Bertwell cut block) can be roughly estimated at 112 hectares. Thus, contrary to the literature, Hunt also found moose utilizing the entire area of the largest cuts in the study.

To explain this apparent contradiction, both Hunt (1976) and MacLennan (1975) examined the distance of moose from the nearest cover on the cut. The largest cuts, in the Bertwell block, also had the smallest random distances to cover, and moose tended to locate themselves closer to cover than a random distribution would indicate. The authors believed that enough residual cover was available on the large cuts for moose to venture further from the edge. The smaller size of the other cuts apparently allowed moose to utilize the entire area, even though these cuts had fewer cover patches than the larger Bertwell blocks. In a study in the foothills of Alberta, still in the boreal forest, Usher (1978) recommends clearcuts ranging in size from only 2 to 5 hectares. The difference in 5 hectares recommended by Usher and 112 hectares believed by Hunt (1976) to be non-restrictive to moose reinforces both the need for site specific studies and the importance of cover in enhancing cutovers as moose habitat.

The importance of cover to moose utilization of cutovers was demonstrated in the moose distribution survey in north - central Manitoba. Although moose were randomly distributed throughout the cutovers, they were significantly closer to cover than to the edge of the cuts. An abundance of residual cover on the newer cuts plus regrowth on the older ones enabled moose to distribute themselves throughout all of the cuts.

Due to the small sample size of cutovers examined in the browse survey, it was not possible to separate out and statistically compare proportions of twigs browsed according to age of cuts. Half of the cuts were either 4 or 5 years old while only one cut was 10 years old. However, age is believed to have influenced the amount of browsing throughout the study cutovers. In the moose distribution survey, moose appeared to be distributed randomly throughout cutovers of all ages even though it was expected that moose would be found significantly closer to the edge in more recent cuts. However, these cuts ranged from 5 to 10 years in age. Moose were not sighted on cuts less than 5 years old, suggesting that young cuts may not be utilized to a great extent. In the Porcupine Forest studies by MacLennan (1975) and Hunt (1976), the oldest available cut was 10 years of age. Moose were significantly closer to cover only in the smallest cuts that were less than 2 years old (Hunt 1976). In the largest cuts of the Bertwell block, moose preferred the 9 to 10 - year old cuts and tended to avoid the 3 to 6 - year old cuts, unless sufficient cover was available.

Of the 17 cutovers examined in the browse survey, five which were in the largest size class (greater than 300 hectares) were also some of the oldest cutovers, varying from 7 to 10 years. A great deal of residual cover, including uncut stands of black spruce in bog areas, individual hardwood trees, willows and new growth of aspen and poplar, was scattered throughout these cutovers. In some cases, habitat appearing as optimal occurred far from the outer edge of the cut, with spruce bogs and patches of mature trees, offering little browse, occurring closer to the edge of the cut. Both the age and the presence of cover are highly influential on browsing throughout the cuts. Although moose do tend to browse where food is the most abundant, the significantly higher proportion of twigs browsed on inside quadrats for the largest cutovers cannot be explained by a greater abundance of browse towards the centre as browse availability was shown to be uniform throughout the study cutovers.

Often the edge of a study cutover consisted of a forestry road. Moose may actually browse further from the edge on an older cut if the edge is more open than the cut itself, i. e. if the edge is either a road or a more recent cutover. In this study, transects were frequently run from a road into the centre of the cut for convenience. If moose were in fact avoiding the more open road area, laying out the transects in this manner may have caused the results to show a greater amount of browsing closer to the centre of the cut (i.e. further from the road). However, Hamilton and Drysdale (1975) state that browsing activity is often concentrated near road edges due to the easy access that is afforded to moose. If this is the case, browsing should be greater near the edge of a cut if that edge is actually a road.

On several of the smallest cutovers, which were clearcut and only 4 years old, browsing occurred around the edge with little or no browsing towards the centre. However, the sample quadrats at the outer end of the transects failed to fall in areas of browsing. A zero proportion of twigs browsed would result either from no twigs being available for browsing or from no browsing of numerous twigs available. With little or no browsing towards the centre of the cut, and low or zero proportions of twigs browsed near the outer edge, statistical tests would show no significant difference between proportions of twigs browsed on inside and outside quadrats. As a decrease in browsing was observed to occur within 5 meters from the edge of the smallest cutover (11 hectares), it must be too large in area to allow moose to browse throughout the entire cut. The maximum size of clear-cut that would not restrict browsing to the outer edge until sufficient cover had grown cannot be determined from the data, however, field observations suggest that it may be less than 11 hectares in area.

In the results, the mean proportion of twigs browsed on inside quadrats appearsto increase as the size of cutover increases, while the mean proportion of twigs browsed on outside quadrats does not depend on the size of the cut. Depedning on whether cutovers are bounded by forestry roads or more recent cuts with even less cover, edges of cutovers would offer the same degree of protection, regardless of the size of cut. If browse availability was similar among cutovers, there would likely be little difference in browsing by moose at the edge. The increase in browsing with increasing size of cut for inside quadrats could be due to several factors. The largest cuts were also the oldest and therefore provided sufficient food and cover throughout to draw moose further from the edge of the cut, causing an increase in browsing towards the centre. These cutovers were frequently bounded by roads while the smallest cuts usually consisted of clearcut patches surrounded by mature forest. The bordering roads may have caused moose to browse further from the edge in the large cuts.

The effect of scarification of forestry cutovers on sucker regeneration and therefore on availability of moose browse is the object of some controversy in the literature. Stelfox, et al. (1976) found that scarification generally retarded forage production of most species except poplars, while Usher (1978) recommended scarification to produce maximum sucker response. In north - central Manitoba, the Forestry Branch attempts to scarify cutovers, as it increases regeneration of all tree species. In particular, hardwoods , which include trembling aspen and balsam poplar, significantly increase suckering after scarification. Forestry

Branch considers scarification necessary to prepare the seed bed, exposing the mineral soil (Lamb 1980).

Although only a subjective observation, shape of a cut appeared to influence its use by moose. On two 4 - year old cuts similar in size, the irregularly - shaped cut showed greater activity of moose than the block - shaped cut. Both cuts were bare of substantial cover, however there was evidence of browsing by moose in some of the bays of the irregularly - shaped cut.

Moose utilization of the study cutovers was affected by the size, shape, age and residual cover of the cuts. As all cuts were scarified, the importance of scarification could not be determined from the study, although personnel of the Forestry Branch believe that scarification is beneficial to regeneration. Harvesting of timber and pulpwood can create moose habitat but the factors mentioned above affect both the time at which forestry - disturbed areas become optimal habitat and the extent to which this habitat is utilized by moose.

5.2 The Effect of Forestry Roads on Moose Populations

From the hunter - kill information, there is no doubt that forestry access roads provide access to moose populations for hunters. The majority of moose harvested (70%) in Game Hunting Areas 5 and 7 were shot by hunters standing on forestry roads. Although designated vehicle routes prevent hunters from using some of the minor forestry roads, hunters can still walk down non-designated routes. This may discourage the less athletic hunter who is not inclined to pack out his kill on his back, but the opportunity still exists.

The effect of the forestry access roads on moose utilization of forestry - disturbed areas is less apparent. The forestry roads discussed in this study are primarily all - weather haul roads. Some of the minor roads had not been open during the winter of 1978/79 and still showed no human activity at the time of the study in the spring of 1979. West of Simonhouse Lake, two 5-year old study cutovers separated by a forestry road were examined. Browsing by moose on the cutovers was limited, suggesting that the cutovers were too open to be fully utilized by moose. However, the forestry road separating the two cuts showed numerous moose tracks, and some vegetation at the road edge had been browsed upon to a small degree. The nearest cutting operation at the time was located approximately five kilometers to the north, and the road in the vicinity of the two study cutovers was rarely used. Moose may have been using the road as a travel lane. Roads provide easy access for moose and browsing activity is often concentrated on road edges (Hamilton and Drysdale 1975). If moose use forestry roads for travel, then an increase in browsing further from edges of cutovers could not be explained by avoidance of a bordering road, as suggested earlier. However, large older cuts in the study area primarily fell in the vicinity of the Athapap Road, which lies along the south shore of Lake Athapapuskow and receives steady use by pulp trucks. Avoidance of forestry roads by moose likely depends on the degree of man's activity on the access roads. If vehicles are rare or non-existent on the roads, moose may take advantage of the easy travel route provided.

5.3 The Feasibility of Creating Moose Habitat in Grass River Provincial Park Using Forest Management

Examination of both the literature and data from north - central Manitoba show that it is physically possible to create moose habitat with forestry operations. Depending on the objectives of managers of Grass River Provincial Park, forest harvesting could be used in the Park to develop suitable moose habitat. Much of the southwestern portion of Grass River Provincial Park has been cut, as well as areas immediately east and west of Simonhouse Lake. Moose have been seen in the Park on some cutovers which are 8 years and older. The size, shape, cover and position of cuts will affect the age at which cutovers provide optimal moose habitat. The optimal size of cutover is yet to be determined. Research in the Porcupine Mountains in Saskatchewan and the Alberta foothills has suggested maximum allowable cuts ranging from 4 to 112 hectares. Data from north - central Manitoba indicate that cuts up to 300 hectares do not restrict moose use and cuts larger than 300 hectares actually show an increase in browsing towards the cutover centre. The importance of cover as a likely cause of this trend has already been discussed. Observation of browsing restricted to the edge of the 11-hectare cut indicates the need for further research on maximum allowable size of cuts in north - central Manitoba.

Although the optimal size of cutovers requires further research, the preferred shape of cuts is the configuration which results in the smallest maximum distance from edge for cuts of a particular size. As cutovers become large enough to restrict moose utilization, irregularly-shaped cuts allow greater moose use than uniform cuts of similar size. Less of the area of irregularly-shaped cuts will be beyond the distance that moose are willing to venture from the edge.

The position of cutovers relative to mature stands and other cutovers is important in cutover utilization by moose. Cuts which are immediately adjacent to other cutovers tend to blend into one large cut, and likely have the same effect as a single large cut. Ideally, cuts should be separated by mature stands. This would also place limitations on the position of access roads to cutovers. Cuts should not be separated by only a road as this would again have the effect of creating a single large cut. Forestry roads should fall on one edge of a cut rather than crossing the centre. While access roads are in use by operators, moose may utilize more of the opposite end of a cut. Once forestry operations cease in the vicinity, moose likely would travel on the roads as they provide easy access to browse.

Cover is obviously an important factor in enhancing cutovers as potential moose habitat. However, a difficulty exists in the lack of concrete information as to what constitutes cover in cuts for moose (Hunt 1976). Uncut stands of spruce in the centre of a cut could successfully conceal or shelter a moose. The potential for regenerated young hardwoods to provide shelter on an older cut is less obvious. The largest study cutovers (greater than 300 hectares) had a significant amount of both residual stands and regenerated hardwoods, and were browsed throughout their entirety by moose. Residual stands scattered throughout the centre of large clearcuts would increase the area of the cuts available for moose utilization. Selective cutting involving primarily individual tree removal would increase browse production while retaining mature trees for cover over the entire cut.

Scarification of cutovers in north - central Manitoba appears to significantly increase suckering of hardwood tree species (Lamb 1980). As young hardwoods provide preferred moose browse, all cutovers in Grass River Provincial Park should be scarified.

A primary concern with creating additional moose habitat in Grass River Provincial Park is the effect of forestry access roads on the moose population. Designated hunting routes are a useful tool; careful monitoring of moose harvest in forestry - disturbed areas will determine whether increased access in the Park is a problem and greater restrictions are needed. Total restriction to no hunting in Grass River Provincial Park is not necessary if moose populations can increase with additional habitat availability.

However, stricter hunting regulations may be required if increased access increases hunting pressure to a point where the moose population cannot be sustained at desired levels.

Usher (1978) determined the age of maximum available browse and therefore maximum moose utilization of clearcuts to be approximately 15 years old. Cutovers showing heavy browsing by moose in the study area were only 8 to 10 years old. North - central Manitoba does not have the vast single - species stands of trees which occur in Alberta and British Columbia. Operators are often forced to cut in an extremely patchy pattern in the mixed - wood forests. Cutovers larger than 300 hectares in area are rarely clearcut in the strictest sense of the term. Frequently, small stands of trees are scattered over large cutovers. It may be that the distribution of desired stands cause operators to cut in a manner that is relatively beneficial to moose in north - central Manitoba.

Usher (1978) arrived at 15 years as the optimum age of cutovers for moose utilization on the basis of study clearcuts averaging only 4 hectares in area. The smallest size to which operators are willing to reduce their clearcuts generally depends on the economics of harvesting pulpwood and timber. However, under the Provincial Park Lands Act, Manitoba Regulation 101/77 states:

> 12. (1) The Director of Parks may regulate and administer all matters relating to or in any way connected with the preservation, management, control, development and improvement of all things of value within Provincial Park Lands, whether animal,

vegetable or mineral, and whether natural or otherwise.

(2) The Director of Parks may prescribe and impose such limitations, restrictions, conditions and requirements which in his opinion are necessary for the preservation, management, control, development and improvement of all things of value within Provincial Park Lands, whether animal, vegetable, or mineral, and whether natural or otherwise.

It is within the mandate of the Provincial Parks Act (s. 3 (1)) to maintain provincial parks for the use, benefit, health, enjoyment, recreation, and education of the citizens of Manitoba and visitors to the province. Parks Branch has the legislation to regulate harvesting of trees in Grass River Provincial Park in a manner prescribed for the creation of moose habitat. Some of these prescribed cutting practices may be economically unappealing to the quota holders in the Park. In a larger stand of an economically desirable tree species, operators may not be willing to leave behind residual patches of trees. Leaving mature stands of economically desirable species between cutovers would also reduce the operator's profit. Cutting an irregular shape may require leaving desirable stands. It is only economical to cut on both sides of forestry roads. Some of these problems may be ameliorated both by the existing patchy distribution of desirable stands and the possibility of locating roads on one side rather than through the centre of these stands.

Apart from regulating forest harvesting activities of quota holders in Grass River Provincial Park, Parks Branch may desire to create moose habitat elsewhere in the Park to increase moose viewing opportunities for visitors. The location of cutovers for the creation of moose habitat in Grass River Provincial Park should follow a recreation management plan. Possible sites would include suitable areas both in the vicinity of the Grass River system, offering canoeists the opportunity to view moose, and in remote areas near hiking trails or campsites. Buffer zones of uncut mature forest should be left between lakeshores or river banks and cuts, both to prevent erosion and to present an undisturbed natural setting for canoeists. Rather than creating cutovers near existing access roads, use of remote sites would encourage outdoor enthusiasts to get off the beaten track, and would provide additional recreational opportunities. Roads constructed for forest harvesting to develop habitat in these remote areas should be closed to vehicles once harvesting in the area is completed, as the primary purpose of these remote cuts is to provide non-consumptive recreation opportunities.

Ideally, the quota holders operating in the Park could be approached to undertake the prescribed cutting of these remote areas. With their small operations, they are able to cut in a very selective fashion. For a nominal salary, Parks Branch presently employs inmates from the rehabilitation camp at Egg Lake (approximately 25 kilometers south of Cranberry Portage) to cut roadways to new cottage subdivision sites. If quota holders in the Park find cutting of selective cuts to be uneconomical, it is feasible that the inmates could do the cutting.

Although research is still needed on optimal size of cutovers, there is sufficient evidence to suggest the following guidelines regarding forest harvesting in Grass River Provincial Park:

1. Cutovers should be irregularly - shaped rather than uniform in configuration.
2. Cutovers should be clustered, leaving either mature stands of trees or other cover vegetation between.
3. Forestry roads should be restricted to one side of a cut rather than crossing the centre.
4. Uncut stands of mature forest should be scattered throughout the centre of large cutovers.
5. All cutovers should be scarified to increase browse regeneration.
6. Hunter - kill of moose in forestry - disturbed areas in Grass River Provincial Park should be carefully monitored to determine whether increased access in the Park is detrimental to moose populations.

These guidelines are flexible in that alternatives are offered allowing operators to follow those which are the most suitable for the area of their timber sale.

The harvest of timber and pulpwood and the existence of a healthy moose population in Grass River Provincial Park need not be mutually exclusive. Timber can be harvested by forestry operations, creating optimal moose habitat. Moose may migrate into forestry - disturbed areas and increase in number, increasing the probability that visitors will view a moose and that hunters will be successful. Thus, with proper forest management, multiple objectives can be achieved in the management of Grass River Provincial Park.

6.0 SUMMARY AND CONCLUSIONS

To determine the impact of forestry practices on moose in north - central Manitoba, moose browse, distribution and hunter-kill surveys were conducted on cutovers and forestry access roads in the study area. A number of characteristics were shown to influence moose utilization of logged-over areas. Contrary to the literature,on cutovers relatively small in size (less than 300 hectares), there was no decrease in browsing as distance from the edge of the cut increased, and browsing actually increased towards the centre of cuts larger than 300 hectares. Cover was shown to be very important in enabling moose to venture further from the edge of a cut. It was believed that the existence of a substantial amount of residual cover on the largest cuts in the study was instrumental in causing the increase in browsing towards the centre of these cuts. Moose were distributed significantly closer to cover than to the edge of a cut. The most heavily utilized cutovers were the oldest (1972/73 and older). Relatively large irregularly - shaped cuts were browsed to a greater degree than were smaller uniformly shaped cuts of the same age.

As all study cutovers were scarified, the effects of scarification on moose utilization of cuts was not examined. However, personnel of the Forestry Branch have observed that scarification increases suckering of hardwood tree species in the study area. As young hardwoods provide preferred moose browse, scarification of cutovers appears to be beneficial to moose.

Hunter-kill of moose was concentrated in areas of forest harvesting, with most successful moose kills occurring in direct relationship with a forestry road.

An examination of the literature and the results of the browse and moose distribution surveys showed that forest harvesting can be used to create moose habitat in Grass River Provincial Park. From these results, a series of guidelines regarding pulpwood and timber extraction in the study area were developed. Under the Provincial Park Lands Act, Parks Branch has the right to regulate harvesting of trees in Grass River Provincial Park according to these guidelines.

An examination of the impact of forestry practices on moose in north - central Manitoba led to the following conclusions:

... A positive impact of forestry practices is the creation of favourable moose habitat which will in turn cause the moose population to increase in the harvested area. A negative impact of forestry practices is the increased access for hunters to the moose population.

... Residual cover on a cut enables moose to utilize the entire cut, even if the cut is relatively young (less than 4 years old).

... Depending on the amount of cover available, moose utilization of browse on cutovers increases on cuts of 6 years or older.

... Irregularly - shaped cuts enable moose to utilize clearcuts larger in area than cuts which are uniformly - shaped.

... Forestry roads have a direct effect on moose populations in that hunting pressure increases with the additional access. Designated hunting routes can be used to alleviate the problem.

... Forest management may be used to create moose habitat in Grass River Provincial Park on the condition that harvesting operations follow the suggested guidelines.

... Hunting success on cutovers and forestry access roads in Grass River Provincial Park should be carefully monitored. Stricter hunting regulations should be applied in the Park if increased access proves to be a problem.

... Suitable cutting operations can lead to the achievement of multiple objectives in Grass River Provincial Park, including: (1) the continuation of pulpwood and timber harvesting, (2) the enhancement of non-consumptive recreation (moose viewing), and (3) the enhancement of consumptive recreation (hunting).

... Further research is needed on the maximum allowable size of cut. As the maximum size that is non-restrictive to moose utilization is significantly affected by available cover on the cut, research should be done on what constitutes 'cover' for moose.

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APPENDIX I

APPENDIX I

1. Regression analysis of the <u>number</u> of twigs browsed per quadrat on the number of twigs available per quadrat.

   1.1 For all cutovers

   Test: Ho: $B_1=0$

   H1: $B_1 \neq 0$

   $\alpha=0.05$

   Critical $F_{.05,1,518} = 3.86$

REGRESSION ANALYSIS TABLE

SOURCE	SS	df	MS	F
Total (Corrected)	112427.44	519	216.62	
Regression (Cor.)	21997.53	1	21997.53	126.01
Residual	90429.92	518	174.58	
Correction Factor	20525.56	1		

Correlation Coefficient = 0.442

r^2 factor

Equation of Line: $Y=1.44 + 0.081\ X$

1.2 For all outside quadrats

Test: Ho: $B_1=0$

H1: $B_1 \neq 0$

$\alpha=0.05$

Critical $F_{.05,1,223} = 3.88$

REGRESSION ANALYSIS TABLE

SOURCE	SS	df	MS	F
Total (Corrected)	30732.64	224	137.20	
Regression (Cor.)	6977.48	1	6977.48	65.50
Residual	23755.16	223	106.53	
Correction Factor	4303.36	1		

Correlation Coefficient = 0.476

r^2 factor = 0.227

Equation of Line: Y=0.38 + 0.072 X

1.3 For all inside quadrats

Test: Ho: $B_1=0$

H1: $B_1 \neq 0$

$\alpha=0.05$

Critical $F_{.05,1,293} = 3.87$

REGRESSION ANALYSIS TABLE

SOURCE	SS	df	MS	F
Total (Corrected)	80248.90	294	272.96	
Regression (Cor.)	14659.96	1	14659.96	65.49
Residual	65588.94	293	223.85	

Correction Factor 17668.10

Correlation Coefficient = 0.427

r^2 factor = 0.183

Equation of Line: Y=2.34 + 0.085 X

APPENDIX II

APPENDIX II

Regression analysis of the proportion of twigs browsed per quadrat on the number of twigs available per quadrat, for all cutovers.

Test: Ho: $B_1=0$

H1: $B_1 \neq 0$

$\alpha=0.05$

Critical $F_{.05,1,518} = 3.86$

REGRESSION ANALYSIS TABLE

SOURCE	SS	df	MS	F
Total (Corrected)	25.90	519	0.050	
Regression (Cor.)	0.58	1	0.57	11.78
Residual	25.33	518	0.049	

Correction Factor 26.13

Correlation Coefficient = 0.149
r^2 factor = 0.022

Equation of Line: Y=0.199 + 0.0004 X

APPENDIX III

APPENDIX III

1. Regression analysis of the proportion of twigs browsed per quadrat against the size of the cutover in hectares.

   1.1 For all cutovers

Test: Ho: $B_1=0$

H1: $B_1 \neq 0$

$\alpha=0.05$

Critical $F_{.05,1,518} = 3.86$

REGRESSION ANALYSIS TABLE

SOURCE	SS	df	MS	F
Total (Corrected)	25.63	519	0.049	
Regression (Cor.)	0.66	1	0.66	13.73
Residual	24.97	518	0.048	
Correction Factor	26.17	1		

Correlation Coefficient = 0.161

r^2 factor = 0.026

Equation of Line: Y=0.17 + 0.0002 X

1.2 For all inside quadrats

Test: Ho: $B_1=0$

H1: $B_1 \neq 0$

$\alpha=0.05$

Critical $F_{.05,1,293}= 3.87$

REGRESSION ANALYSIS TABLE

SOURCE	SS	df	MS	F
Total (Corrected)	17.21	294	0.059	
Regression (Cor.)	0.76	1	0.76	13.47
Residual	16.45	293	0.056	
Correction Factor	18.45	1		

Correlation Coefficient = 0.21

r^2 factor = 0.044

Equation of Line: Y=0.18 + 0.0002 X

1.3 For all outside quadrats

Test: Ho: $B_1=0$

H1: $B_1 \neq 0$

$\alpha=0.05$

Critical $F_{.05,1,223} = 3.88$

REGRESSION ANALYSIS TABLE

SOURCE	SS	df	MS	F
Total (Corrected)	7.97	224	0.036	
Regression (Cor.)	0.027	1	0.027	0.76
Residual	7.94	223	0.036	

Correction Factor 8.17

Correlation Coefficient = 0.058

r^2 factor = 0.003

Equation of Line: Y=0.18 + 0.0 X