WINTER USE OF UPLAND CONIFER ALTERNATE STRIP CUTS AND CLEARCUTS BY MOOSE IN THE THUNDER BAY DISTRICT.

BY

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ABSTRACT

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Key Words: moose, Alces alces, alternate strip cuts, clearcuts, habitat, snow.

Moose (Alces alces) utilization of five paired strip cut - clearcut areas was studied during the winters of 1983 - 84 and 1984 - 85. Winter aerial reconnaissance flight data were supplemented by snow condition observations and spring browse and pellet group data. Greater ($P < 0.05$) numbers of moose were located in the clearcuts than the strip cuts in the first winter, and approximately equal numbers of moose were observed in both the following winter (non significant). Clearcuts had significantly ($P < 0.05$) more track aggregates and area covered by tracks during both winters. Forage production (kg/ha) and browse stem densities were significantly ($P < 0.05$) higher in the clearcuts. No significant correlations occurred between browse production or browse availability and observed utilization levels in the strip cuts or clearcuts. In the strip cuts, moose preferred the open harvested strips and 94% of all moose observed in the strip cuts were cows with calves or single cows. Moose preferred the 30 m influence zone edge habitat in the clearcuts, and adult bulls were the most often observed moose in the clearcuts (38% of all moose sighted). Wolf tracks were observed in both types of timber harvest, ranging freely across the clearcuts and only on road sytems or waterways in the strip cuts. Snow conditions in the strip cuts appear to inhibit wolf movements throughout these areas; however, they may preclude the use of strip cuts by moose in heavy snowfall winters. Alternate strip cuts provide suitable winter habitat for moose, particularly for the reproductive social groups. Clearcuts are not avoided by moose in the winter months, although seasonal utilization of individual habitats within the clearcuts does occur.

TABLE OF CONTENTS

	Page
ABSTRACT	i
LIST OF TABLES	iii
LIST OF FIGURES	v
ACKNOWLEDGMENTS	vi
INTRODUCTION	1
STUDY AREA	5
METHODS	9
RESULTS	18
Habitat Availability	18
Strip Cuts vs. Clearcuts	20
Habitat Utilization	33
Predation and Disease	49
Snow Conditions	51
DISCUSSION	59
Snow Conditions	59
Utilization of Strip Cuts	63
Utilization of Clearcuts	67
Browse Utilization	76
Management Implications	83
SUMMARY	86
LITERATURE CITED	89
APPENDICIES	99

LIST OF TABLES

		Page
Table 1.	Site characteristics of the five paired alternate strip cut - clearcut study areas selected north of Thunder Bay, Ontario.	8
Table 2.	Percent total area of habitat strata observed in each alternate strip cut study area.	18
Table 3.	Percent total area of all habitat strata observed in each clearcut study area.	19
Table 4.	Winter moose observations in alternate strip cuts and clearcuts.	21
Table 5.	Seasonal observations of moose in alternate strip cuts and clearcuts.	21
Table 6.	Age and sex structure of moose observed in alternate strip cuts and clearcuts.	23
Table 7.	Total number of track aggregates observed in all study sites for the winters of 1983 - 1984 and 1984 - 1985.	24
Table 8.	Track aggregate areas (ha) observed in all study sites for the winters of 1983 - 1984 and 1984 - 1985.	27
Table 9.	Availability of the ten browse species most often selected by moose in the alternate strip cuts and clearcuts	29
Table 10.	Utilization and preference ratings of the ten browse species most often selected by moose in alternate strip cuts and clearcuts	30
Table 11.	Production and consumption of browse in strip cuts and clearcuts.	31
Table 12.	Number of moose, track aggregates and area of track aggregates observed in alternate strip cut habitat strata.	34
Table 13.	Age and sex structure of moose observed in alternate strip cut habitat strata during the winters of 1983 - 1984 and 1984 - 1985.	34
Table 14.	Densities of available and browsed stems, pellet groups and the amount of browse produced and consumed in alternate strip cuts strata.	36

Table 15.	Relative utilization of ten browse species observed in strip cut strata.	37
Table 16.	Number of moose, track aggregates and area of track aggregates observed in clearcut habitat strata.	39
Table 17.	Age and sex structure of moose observed in clearcut habitat strata.	39
Table 18.	Densities of available and browsed stems, pellet groups and browse produced and consumed in clearcut habitat strata.	44
Table 19.	Relative utilization of ten browse species observed in clearcut habitat strata.	45
Table 20.	Selection of alternate strip cuts and clearcuts by moose as determined by observed moose sightings, track aggregates, browse consumed and pellet group densities.	46
Table 21.	Selection of alternate strip cut habitat strata as determined by observed moose sightings, track aggregates, browse consumed and pellet group densities.	47
Table 22.	Selection of clearcut habitat strata as determined by observed moose sightings, track aggregates, browse consumed and pellet group densities.	48
Table 23.	Observations of wolf tracks in strip cuts and clearcuts in the winters of 1983 - 1984 and 1984 - 1985.	49

LIST OF FIGURES

		Page
Figure 1.	Study sites located north of Thunder Bay, Ontario.	7
Figure 2.	Snow depth and snow condition measurement stations in strip cuts and clearcuts	10
Figure 3.	Seasonal observations of track aggregates in strip cuts and clearcuts during the winter of 1983 - 1984.	25
Figure 4.	Seasonal observations of track aggregates in strip cuts and clearcuts during the winter of 1984 - 1985.	26
Figure 5.	Seasonal utilization of clearcut habitat strata by moose.	40
Figure 6.	Seasonal observations of track aggregates in the open natural, 30 m influence zone and scattered residual clearcut habitat strata.	42
Figure 7.	Mean snow depths in harvested and leave strips - mid winter 1984.	52
Figure 8.	Mean snow depths in harvested and leave strips - late winter 1984.	53
Figure 9.	Mean snow depths in harvested and leave strips - mid winter 1985.	55
Figure 10.	Mean snow depths in harvested and leave strips - late winter 1985.	56
Figure 11.	Mean snow depths in open clearcut habitat - mid and late winter 1985.	58

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INTRODUCTION

Moose (*Alces alces*) are found primarily in the Boreal Forest Region of Ontario, although they also occur in the Great Lakes - St. Lawrence Forest Region and Hudson Bay Lowlands. They are adapted to living in harsh winter conditions due to their dark, heavy insulating coat, long legs and ability to survive on a reduced food intake (Telfer 1978b). Winter is a critical season for moose (Kelsall 1969) because less and nutritionally poorer food is available, and snow reduces movement and increases energy costs.

Ontario's moose herds have declined over the past 20 years by approximately 35 percent due to increased hunting pressure, predation, poaching and loss of suitable winter habitat (Euler 1983). Although habitat loss was not the most important cause of Ontario's declining moose herd, habitat management is an important technique for moose management (Thompson and Euler 1984). As winter is a stressful period for moose, a critical habitat required in the life cycle of a moose is that which is utilized in the winter. Telfer (1978b) stated that winter habitat selection by moose is dependent on cover and topographic features which reduce snow depth and provide pockets of warmer microclimates. Ideal winter moose habitat should provide a good interspersion of early successional plant communities which provide forage, and patches of mature conifer for shelter from predators and weather.

Forest fires, insect infestations and timber harvesting are major causes of habitat disturbance in the boreal forest (Krefting 1974). Telfer (1974) stated that most of the impact of forest harvesting on wildlife is in the pattern created by the size and shape of the cut, and by the amount, location and composition of the residual stands. Timber harvesting patterns that approximate a mosaic of dense conifer and early successional plant communities produced by light to medium intensity wildfires provide the variety of habitats required by moose (Anon. 1984). Clearcutting is the most common form of timber harvesting in the Boreal forest (Anon. 1985). In this system, all merchantable coniferous and deciduous trees are removed and only unmerchantable conifers and some hardwood trees are left.

Pre-1960 horse logging operations in Ontario's boreal forest region created small scattered openings in the forest canopy and produced excellent moose habitat (Euler 1985). The advent of mechanized logging equipment and an increased demand for wood fibre in the 1960's resulted in large progressive clearcuts as road systems were built, resulting in some clearcuts reaching sizes of 8 - 10,000 hectares by the mid - 1970's (Reed and Assoc. 1978). A shortage of economically accessible fibre in the early 1980's resulted in improved utilization of all available conifers and the harvesting of formerly unused hardwood species. Euler (1985) noted that the habitat produced as a result of mechanized harvesting was less favourable and probably not as capable of supporting moose populations as the habitat created by horse logging operations.

Large clearcuts may negatively impact on moose populations due to reduced visual cover and increased harvest by hunters (Eason 1985). Large clearcuts produce an abundant and diverse source of winter forage for moose; however, the distance from available winter cover may make large portions of them unavailable for winter utilization by moose (Hamilton et al. 1980). Clearcut sizes in Ontario are now regulated through provincially accepted moose habitat guidelines (Anon. 1984) and environmental guidelines (Anon. 1985).

In the Thunder Bay district, modified clearcutting by harvesting in alternate strips of cut and standing timber was originally used as a method of maintaining site conditions and inducing natural regeneration on cutover areas (Auld 1975). Alternate strip cutting incurs higher wood costs than clearcutting due to increased road access and maintenance, higher layout, planning and operating costs, and loss of merchantable timber to blowdown (Peacock 1975). However, alternate strip cuts should provide the diversity of early and late successional plant communities needed by wintering moose. Peterson (1955), Telfer (1974), McNicol (1976), the Ontario Moose Council (1978) and Euler (1979) recommended harvesting in alternate equal sized strips or blocks of cut and standing timber as a method of habitat management for moose.

These recommendations have not been tested, as few studies have been undertaken to determine if moose actually use strip cuts more than clearcut areas or if they use them at all. Eastman (1974) studied partially cut stands (alternate strip cuts, single tree and diameter selection), clearcuts and burns in the Sub-Boreal Forest of British Columbia. Stelfox (1976) studied ungulate utilization over seventeen years on a strip cut white spruce (*Picea glauca*) forest in western Alberta. Browse and pellet group data have been collected on Canadian Forestry Service experimental strip cut black spruce (*Picea mariana*) areas near Nipigon, Ontario; but have not yet been analyzed (Welsh, pers. comm.).

The purpose of this research is to compare winter utilizion of alternate strip cut areas with that of clearcut areas by studying:

1) the frequency of moose observations, track aggregates, browsed stems, and pellet groups and the amount of area covered by track aggregates;
2) the relationship of moose utilization to habitat type and browse availability, predation and snow conditions in both alternate strip cuts and clearcuts.

STUDY AREA

The study area is located in the Superior section of the boreal forest region (Rowe 1972) and is similar to that described by McNicol and Gilbert (1980). The forests of the region are of fire origin and primarily coniferous. Black spruce, white spruce, jack pine (Pinus banksiana) and balsam fir (Abies balsamea) are the predominant conifers found in the area. Trembling aspen (Populus tremuloides) and white birch (Betula papyrifera) are the most common deciduous tree species. Lowlands are forested with black spruce, tamarack (Larix laricina), and eastern white cedar (Thuja occidentalis). Upland areas are usually forested with a mixture of black spruce, jack pine, balsam fir, trembling aspen and white birch.

The topography, strongly influenced by the underlying Precambrian Shield, consists of weakly broken plains and moderately broken uplands which have been considerably modified by glacial action (Anon. 1982). A thin layer of glacial till was deposited over the bedrock in the upland areas and the lowland areas were covered with glacial till and fine grain lacustrine deposits. Local relief consists of sand and gravel eskers and kames up to 30 m in height and modified and unmodified end and interlobate moraines (Anon. 1965). Soils are silty to sandy till with large amounts of stones, gravel and boulders.

Thunder Bay's climate is modified by the influence of Lake Superior, with this influence decreasing as distance inland increases. The maximum and minimum mean temperatures are 8.7 and -3.7o C respectively (Anon. 1982). The area receives a mean rainfall of 53 cm and a mean snowfall of 213 cm with a range of 150 - 180 days per year where snow cover is 2.5 cm or deeper (Potter 1965).

Five study areas (Fig. 1) were located north east of Thunder Bay, Ontario between kilometres 50 and 120 on Spruce River Road. The study areas were harvested 7 to 14 years previously by the Abitibi Pulp and Paper Company and the harvested areas ranged in size from 135 to 530 ha (Table 1). The width of harvested strips varied between 40 and 50 m for all study areas, although a portion of the Buzzer Lake study area was cut in 120 m strips or "blocks". All alternate strip cuts had only the first coupe of timber removed.

In April 1984 it was discovered that the Buzzer Lake clearcut had been sprayed with 2,4 - D herbicide two weeks after it had been initially assessed for inclusion in the study. All winter moose and track aggregate observations were excluded from subsequent analysis of the 1983 - 1984 winter data. Another clearcut which met all of the selection criteria was selected for the spring browse and pellet group surveys and 1984 - 1985 winter observation data collection.

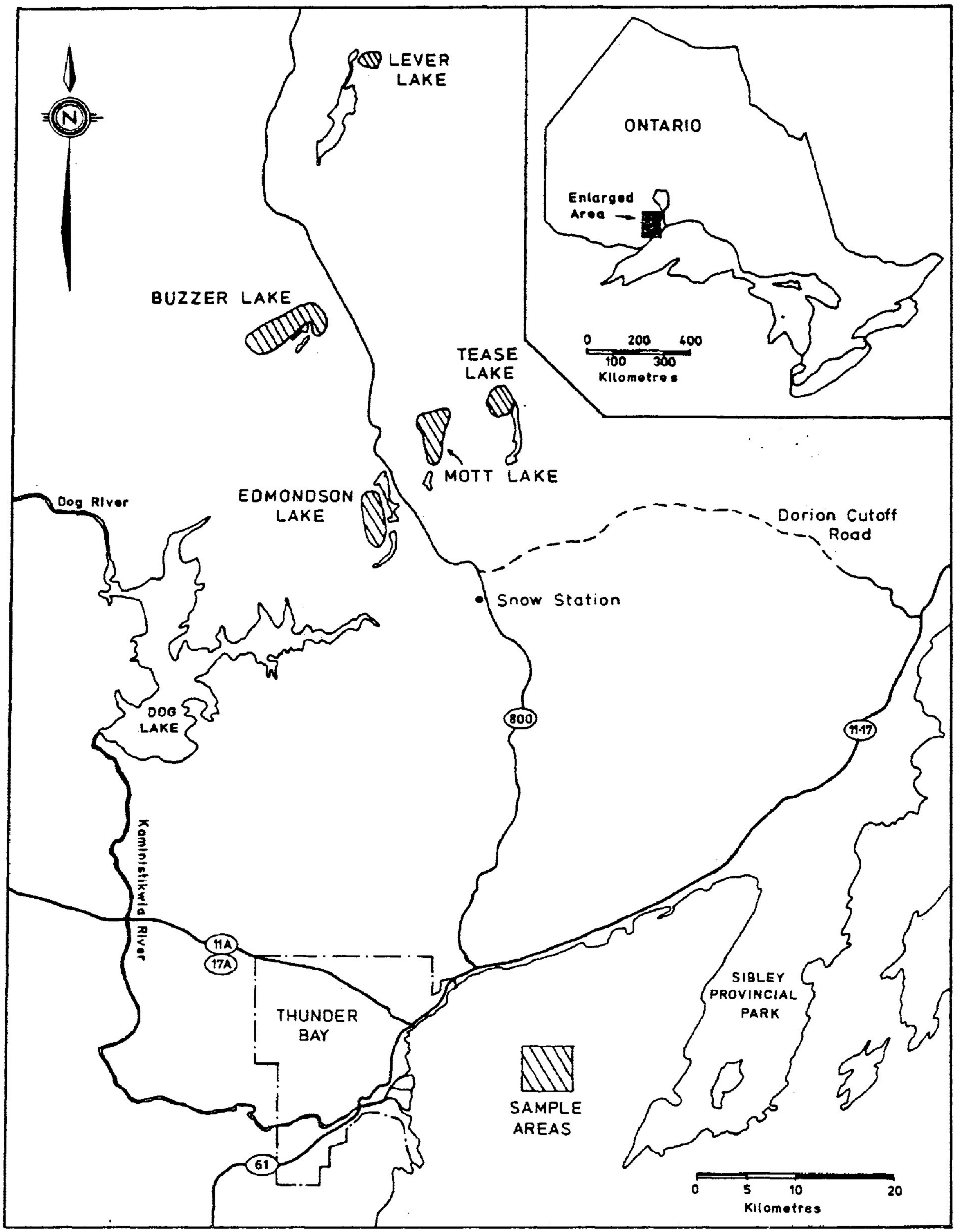


Figure 1. Study sites located north of Thunder Bay, Ontario.

Table 1. Site characteristics of the five paired alternate strip cut - clearcut study areas selected north of Thunder Bay, Ontario.

Study Area	Year Harvested	Timber[1] Type	Area (ha) Strip Cut	Area (ha) Clearcut	Soils	Dist. To Thunder Bay (km)
Edmondson Lake	1972	Sb, Pj, Bw	334	510	Shallow-deep sand till, rock outcrops	55
Mott Lake	1974	Sb, Pj	515	363	Shallow-deep sand till, rock outcrops	60
Tease Lake	1974	Sb, Pj, Bf	215	299	Deep sand till, no rock outcrops	70
Buzzer Lake	1970	Sb, Pj	372	192	Shallow-deep sand till, rock outcrops, & some swamp	100
Lever Lake	1977	Pj, Sb	149	162	Thin sand till, rock outcrops common in strip cuts	120

1 Sb = Black spruce   Bw = White birch
Pj = Jack pine   Bf = Balsam fir

METHODS

A field reconnaissance of approximately 50 potential study sites identified from cutover maps and silvicultural records was conducted in the summer of 1983. The five study areas consisted of one paired clearcut and one alternate strip cut, with selection criterea of similar soils, harvest areas, harvest age, original timber type, regeneration height and flight radius from Thunder Bay. All alternate strip cut areas were within one kilometre of the paired clearcuts so that moose would have equal opportunities to use either type of cut. The harvest areas for the pairs could not always be kept similar due to the selection constraints of having the strip cut and clearcut within 1 km of each other and pairing areas of similar harvest age.

WINTER DATA COLLECTION

Mid and late winter snow depth, density and hardness measurements were made in 1983 - 1984 and 1984 - 1985 in a representitive alternate strip cut and clearcut 50 km north of Thunder Bay. Snow condition measurements could not be made in the actual study areas due to inaccessibility during the winter months. The 40 m wide coniferous strips were oriented east - west and snow depth measurements were made every four metres across three harvested strips and three leave strips (Fig. 2). Depth measurements were made using a sharpened metre stick and

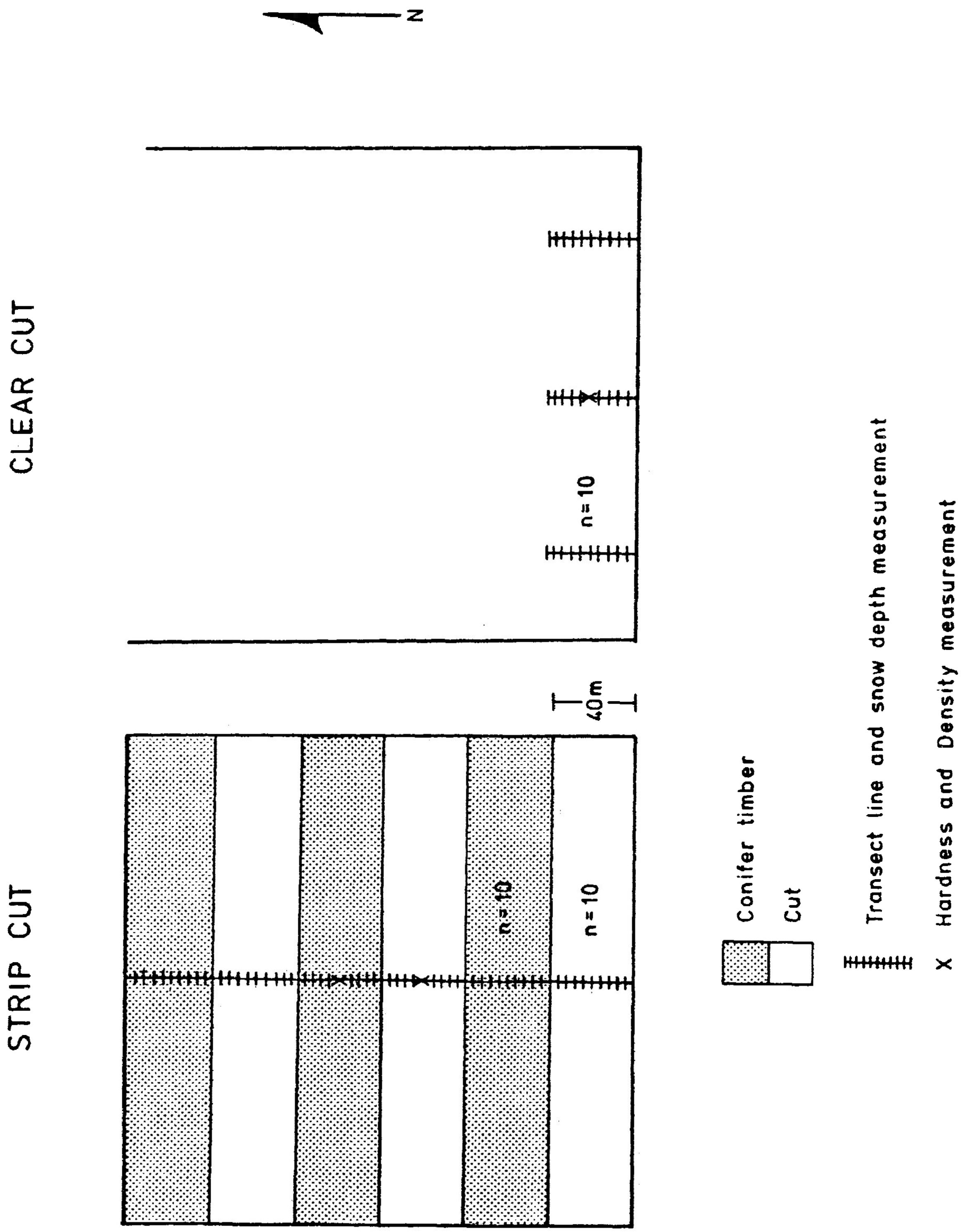


Figure 2. Snow depth and snow condition measurement stations in strip cuts and clearcuts

density and hardness was measured using equipment from a National Research Council snow kit. Snow density and hardness were measured in the centre of the second leave and harvested strips sampled. In the clearcut, snow depth was measured every four metres along three 40 m perpendicular transect lines from an east - west cutover boundary, and snow density and hardness were measured in the middle of the second transect line.

Weekly flights were made over all study locations in the winter of 1983 - 1984 and 1984 - 1985 from early January to the end of March. A Piper Supercub or a Cessna 172 were used for the reconnaissance flights, with the Cessna 172 used exclusively in the winter of 1984 -1985. Both aircraft were ideal for aerial reconnaissance due to their low airspeed, high manoeuvrability and excellent visibility afforded by the aircraft's overhead wings. Flights over the study sites were restricted to sunny days in order to make track aggregates easier to spot while flying at a height of 250 m above ground level at an airspeed of approximately 120 km / h. All flights were made between 1000 and 1500 hours to minimize the effects of long shadows cast by standing timber during the winter period of low sun angle.

Search patterns were similar to those used by McNicol (1976). Each study area was circled until all moose and track aggregates were believed to have been sighted and recorded. Track aggregates were discernible areas covered by a meandering, looped or interwoven set of one or more tracks. These areas are readily identified from the air, as such patterns usually have an obvious border (McNicol 1976).

Moose sightings, number and area of track aggregates and single tracks were recorded with alcohol based pens on acetate overlays placed over photomosaics of each study area. In order that the same track aggregates were not recorded on subsequent flights, the acetate overlays were retained until a major snowfall had obliterated all old tracks. Estimated distance to cover, activity at time of sighting, bedding orientation and age and sex of each animal sighted were noted for all moose observed. Unantlered animals were sexed using the vulval patch method described by Mitchell (1970).

SPRING DATA COLLECTION

Browse utilization and pellet group surveys were completed in the spring of 1984 on the alternate strip cuts and clearcuts at the Edmondson Lake, Mott Lake, Buzzer and Knocker Lake and Lever Lake study sites. The Tease Lake study area was not sampled due to leaf flush which prevented further surveys. The number of plots placed in each study location was calculated in proportion to it's area, with a minimum of 44 plots in each area to ensure sample size in the smaller areas. Each of the surveyed study locations was stratified into utilized and non utilized areas, based on the number of track aggregates observed in the 1983 - 1984 winter flights. Two-thirds of the required number of plots for a study location were randomly placed in the utilized areas and the remaining one-third were placed in the strata which showed no utilization.

Rectangular browse utilization plots (1 x 20 m) were nested within the pellet group count plots (2 x 20 m). A baseline divided into 20 m intervals was drawn through all study areas, and starting points of transect lines were randomly selected along this line. A random start location for the first plot on each transect line was calculated and plots were then systematically spaced at 100 m intervals. In the strip cuts, transect lines were perpendicular to the strip orientation.

A count of browsed and unbrowsed stems was conducted in the 1 x 20 metre browse utilization plots, and a total count of browsed and unbrowsed twigs per stem was done on every fifth plot. All browsed and unbrowsed twigs between 0.6 and 3.0 metres in height were recorded for each stem in the twig count plots. The diameter at point of browsing (d.p.b.) of the first two browsed twigs of each species encountered on all plots was measured and recorded. The basal area of residual timber was measured at both ends of the plot using a 2 m2 basal area factor (BAF) prism.

All pellet groups or strings of pellets in the 2 x 20 m pellet group plot on top of the previous autumn's leaf fall were tallied. Only pelletized droppings were recorded as they are formed during the period of late fall to early spring when the moose are feeding on woody browse (Peterson 1955). Groups and strings of pellets were only recorded when over half of the group or string fell within the plot boundary.

In the field, plot locations were classified into one of six strata:

1) Dense Conifer: > 10 merchantable coniferous trees within 20 m of plot centre

2) Open Natural: no merchantable coniferous or deciduous trees within 20 m of plot centre

3) Open Planted: same as open natural except artificially regenerated to spruce or jackpine through planting or aerial seeding (clearcuts only)

4) Scattered Residual: 5 - 9 merchantable coniferous and/or deciduous trees within 20 m of plot centre

5) 30 metre influence zone: plot centre within 20 m of dense conifer residual or dense conifer edge (clearcuts only)

6) Unclassified - i) Swamp: wet lowland areas not indicative of overall site, usually containing stunted, non merchantable coniferous trees.

   ii) Hardwood: > 10 merchantable deciduous trees within 20 m of plot centre

   iii) Blowdown: plots located in windthrown merchantable coniferous or deciduous trees

Merchantable trees were considered to be those which could provide at least one 2.33 m pulpwood stick. Plots which fell on boundaries between two strata were relocated to fit entirely within the stratum in which the plot centre was located.

A 30 metre influence zone was established around all dense conifer residual and the predominately conifer edge of the clearcuts. This stratum was created in order to compare the same influence of coniferous residual and edge in the clearcuts with the harvested strips where moose are never more than 30 m from standing mature coniferous timber. All clearcut habitat strata except the 30 m influence zone and unclassified are similar to those detailed by McNicol (1976). The open planted stratum did not occur in alternate strip cuts as conifer regeneration was accomplished from the seed source available from the leave strips of mature timber. Unclassified strata were considered to be those which did not occur on all study areas, yet were present in enough areas to warrant a separate classification.

DATA ANALYSIS

For each study area, all strata were mapped on a 1:15840 base map using aerial photographs and ground reconnaissance notes to locate the different habitat strata. Each habitat stratum was deliniated on the map and marked in a different colour. The area of each stratum in the study areas was calculated from the maps using a Planix 7 electronic planimeter. The acetate overlays locating moose observations and track aggregates were placed over the stratified base map of the corresponding study area. The number of moose and track aggregates observed in each stratum was recorded by each flight for the study area. The area covered by track aggregates in the different habitat strata was measured using the electronic planimeter for each flight.

Browse utilization data were analyzed using Passmore and Hepburn's (1955) formulae for frequency index, living stems per hectare, relative availability, relative utilization and overall utilization. Preference ratings were calculated using Petride's (1975) method of determining the ratio of one forage species in the animals diet to the availability of that species on the study area. The amount of forage (kg/ha) produced from each area was determined using the mean d.p.b. for each browse species, logarithmic regression equations calculated by Stronks (1985) and the formula used by Telfer (1978a):

> Total weight = (mean number of twigs per stem of species) x (mean weight per twig of species) x (number of stems of species per hectare)

The weight of forage consumed by moose was calculated using the formula:

> Total weight consumed = (total weight produced per species) x (% of browsed twigs per stem of species)

The density of pellet groups for each study area was calculated using Overton's (1971) formula, and used to compare relative moose densities between areas. Estimated populations of moose in the study areas were not derived from these data due to the inherant problems with this method as detailed by Timmerman (1974).

All utilization - availability data were analyzed using a chi-square goodness of fit test and a Bonferroni z test to determine if the different harvesting patterns or habitat strata were preferred or avoided. The assumption of this test is similar to Berg's (1971); if a particular habitat is chosen by a moose strictly by chance, then the percentage of occurrences in that habitat will be equal to the percentage of that habitat type availability. Preference for a habitat is indicated when the proportion of utilization is greater than the proportion of habitat availability. Avoidance of a habitat was indicated when the proportion of utilization was less than the proportion of habitat availability. These tests have been used to determine habitat preference or avoidance by moose (Nue et. al. 1974, Thompson and Vukelich 1981, Monthey 1984), white - tailed deer (Nelson, 1979), and bighorn sheep (Ovis canadensis) (Byers et. al. 1984).

Correlation analysis was completed to determine the influence of the amount of residual timber left on all of the clearcut study sites and moose utilization, and the influence of browse densities and production (kg/ha) with utilization levels observed in the clearcut habitat strata. Snow depth data were analyzed using paired or Student's t tests.

RESULTS

HABITAT AVAILABILITY

Strip Cuts

The dense conifer and open natural strata were almost equally distributed in each of the strip cut portions of each study area (Table 2). Small pockets of blowdown were observed in the Buzzer Lake and Lever Lake study areas. Scattered residual in the harvested strips was not common and when present, usually consisted of small pockets of hardwood species or a few unmerchantable conifer stems. Lowland swamp areas were found scattered throughout all study areas, but accounted for less than two per cent of any study area.

Table 2. Percent total area of habitat strata observed in each alternate strip cut study area.

Study Area	Open Natural	Dense Conifer	Scattered Residual	Swamp	Blwdn.	Total Area (ha)
Edmondson Lake	35	63	1	1	0	334.03
Mott Lake	43	55	1	2	0	515.30
Tease Lake	40	60	0	0	0	214.88
Buzzer Lake	59	37	2	2	0	372.03
Lever Lake	51	45	3	0	1	149.33

Clearcuts

The clearcuts at the Edmondson Lake and Mott Lake study areas had the poorest commercial utilization of available timber, and had 74 and 46 per cent of the total study area comprised of cover associated strata (dense conifer, scattered residual, hardwood and swamp). The Lever Lake, Tease Lake, and Buzzer Lake study areas had the greatest utilization of available merchantable timber in the clearcuts respectively (Table 3).

Table 3. Percent total area of all habitat strata observed in each clearcut study area.

Study Area	Open Natural	Open Plant.	Dense Conifer	Infl Zone	Scat. Resid.	Hdwd.	Swamp	Bldwn.	Total Area (ha)
Edmondson	13	0	9	12	48	12	5	0	510.4
Mott Lake	12	20	21	22	17	6	2	0	362.7
Tease Lk.	38	28	6	8	14	2	4	0	298.9
Buzzer Lk	52	0	6	21	12	2	7	0	192.2
Lever Lk.	17	40	6	12	10	0	15	0	162.3

Patches of dense conifer residual resulting from unmerchantable sized timber or inoperable terrain were found on all of the clearcut study areas. The Mott Lake and Edmondson Lake clearcuts had the most area covered with dense conifer residual timber, with the other study areas having similar relative amounts. The amount of influence zone was greatest in the Mott Lake and Buzzer Lake study areas, and was a function of dense conifer residual timber left in the interior of the cut and the amount of border area adjacent to uncut conifer. The Edmondson Lake clearcut had the most scattered residual habitat. The scattered residual in all study sites consisted of unmerchantable white birch and trembling aspen which were left after all merchantable conifer stems were removed.

Lowland swamp areas were found on all clearcut study areas, with Lever Lake having the most. Plantations of white and/or black spruce or aerially seeded jack pine were only found on the Mott, Tease and Lever Lake clearcuts. The Lever Lake clearcut was the only one which had any patches of conifer blowdown, but these accounted for less than one percent of the total area.

STRIP CUTS vs. CLEARCUTS

Moose Sightings

Nine flights were made in the winter of 1983 - 84 and 26 moose were observed in the study areas (Table 4). Significantly more ($P < 0.01$) moose were observed in the clearcuts (23) than in the strip cuts (3). Eleven flights were made in the winter of 1984 - 85 and 61 moose were observed. Approximately equal numbers of moose were observed in the alternate strip cuts (31) and in the clearcuts (30), and the difference was not significant ($P < 0.05$). No moose were observed in the Tease Lake strip cuts nor in the Lever Lake clearcut in either winter's data collection.

Table 4. Winter moose observations in alternate strip cuts and clearcuts.

Study Site	Strip Cut 1983/1984	Clearcut 1983/1984	Strip Cut 1984/1985	Clearcut 1984/1985
Edmondson Lake	0	4	2	7
Mott Lake	2	14	19	13
Tease Lake	0	5	0	5
Buzzer Lake	--	--	4	5
Lever Lake	1	0	6	0
Total	3	23*	31	30

* X^2 significant difference ($P < 0.01$, 1 d.f.)

In the winter of 1983-84, no moose were observed after February 6, 1984 in any of the study areas (Table 5), although track aggregates continued to be observed for the rest of the winter. Moose were observed throughout the following winter, with only two flights in which no moose were seen. Generally, more moose were located in the clearcuts in the early winter 1984-85 and the strip cuts had higher moose sightings in mid to late winter (after February 4, 1985).

Table 5. Seasonal observations of moose in alternate strip cuts and clearcuts.

	1984			1985	
Date	Strip cut	Clearcut	Date	Strip cut	Clearcut
Jan. 11	1	0	Dec. 19	2	3
Jan. 15	0	11	Jan. 10	3	9
Jan. 27	0	2	Jan. 19	5	5
Feb. 6	2	10	Jan. 28	0	4
Feb. 21	0	0	Feb. 4	4	0
Feb. 29	0	0	Feb. 8	4	4
Mar. 6	0	0	Feb. 13	7	2
Mar. 23	0	0	Feb. 28	0	0
Mar. 31	0	0	Mar. 6	4	0
			Mar. 12	0	0
			Mar. 18	2	3
Total	3	23		31	30

One adult cow with a calf was observed in the strip cuts during the winter of 1983 - 84, and this social unit comprised 77 per cent of the moose observed in the alternate strip cuts in 1984 - 85 (Table 6). Adult cows without calves were not observed in the strip cuts in 1983-84, yet six were observed the following winter. One adult bull moose was sighted in each winter in the strip cuts.

For both winters, adult bull moose were the most frequently observed social unit in the clearcuts. Observations of cows with calves increased from one sighting to eight from 1983 - 1984 to 1984 - 1985. Equal sightings of adult cow moose without calves were observed in both winters.

Aggregations of three or more moose were commonly observed in the clearcuts in 1983 - 1984. Four adult bull moose within 10 m of each other were sighted browsing in the Edmondson Lake clearcut, approximately 10 m from a patch of dense conifer residual. Four adult moose (two bulls, one cow and one unknown sex) within 20 m of each other were observed in the Tease Lake clearcut. Two were bedded adjacent to some conifer residual and the other two were browsing approximately 10 m away from another patch of dense conifer. A lone calf was observed approximately 80 m from a cow with twin calves in the Mott Lake clearcut. Only one aggregation of three moose was observed in 1984 - 1985. Two adult cows and a calf were observed approximately 40 m from scattered residual cover in the Buzzer Lake clearcut.

Table 6. Age and sex structure of moose observed in alternate strip cuts and clearcuts.

Age - Sex Class	1983 - 84 Strip cut	1983 - 84 Clearcut	1984 - 85 Strip cut	1984 - 85 Clearcut
Adult Bull	1	10	1	10
Adult Cow	0	4	6	4
Cow w/ Calf	1	1	12	8
Calf	0	1	0	0
Cow w/ Twin Calves	0	1	0	0
Unknown	0	3	0	0
Total No. Moose	3	23	31	30

Track Aggregate Locations

The observed number of track aggregates for the winter of 1983 - 1984 and 1984 - 1985 was significantly greater ($P < 0.01$) in the clearcut study sites than in the strip cut study sites. The number of track aggregates observed in the clearcuts was double that observed in the alternate strip cuts for the winter of 1983 - 1984, but decreased to 1.45 times greater in the winter of 1984 - 1985 (Table 7). The number of track aggregates observed in the Edmondson and Mott Lake alternate strip cuts increased from the winter of 1983 - 1984 to the following winter, but decreased for the Tease and Lever Lake study areas. All clearcut study sites except Tease Lake showed an increase in the number of track aggregates observed for the winter of 1984 - 1985 from the previous winter. The mean number of track aggregates observed per study site in the winter of 1984 - 1985 was almost double in the clearcuts and more than double in the strip cuts from the previous winter.

Table 7. Total number of track aggregates observed in all study sites for the winters of 1983 - 1984 and 1984 - 1985.

Study Site	Observed Number of Track Aggregates			
	Strip Cut 1983/1984	Clearcut 1983/1984	Strip Cut 1984/1985	Clearcut 1984/1985
Edmondson Lake	5	30	42	113
Mott Lake	36	115	90	136
Tease Lake	22	55	16	44
Buzzer Lake	--	--	102	86
Lever Lake	36	0	24	18
Total	99	200*	274	397*

* X^2 significant difference ($P < 0.01$, 1 d.f.)

The number of track aggregates in both types of cuts in 1983 -1984 rapidly increased and peaked at the end of January, and gradually declined over the rest of the winter (Fig. 3). One minor deviation in this pattern occurred on February 21, 1984, when the number of track aggregates dipped slightly. In 1984 - 1985, the number of track aggregates gradually rose and peaked at the end of February, but did not show as regular a pattern as observed in the previous winter (Fig. 4).

Track Aggregate Areas

The measured amount of area covered by track aggregates for both winters was significantly ($P < 0.01$) greater in the clearcuts than in the alternate strip cuts. The area covered by track aggregates was 2.75 times greater in the clearcuts than in the strip cuts for the winter of 1983 - 1984, and decreased to 1.58 times greater for the winter of 1984 - 1985 (Table 8). The area covered by track aggregates in 1984 - 1985 dramatically

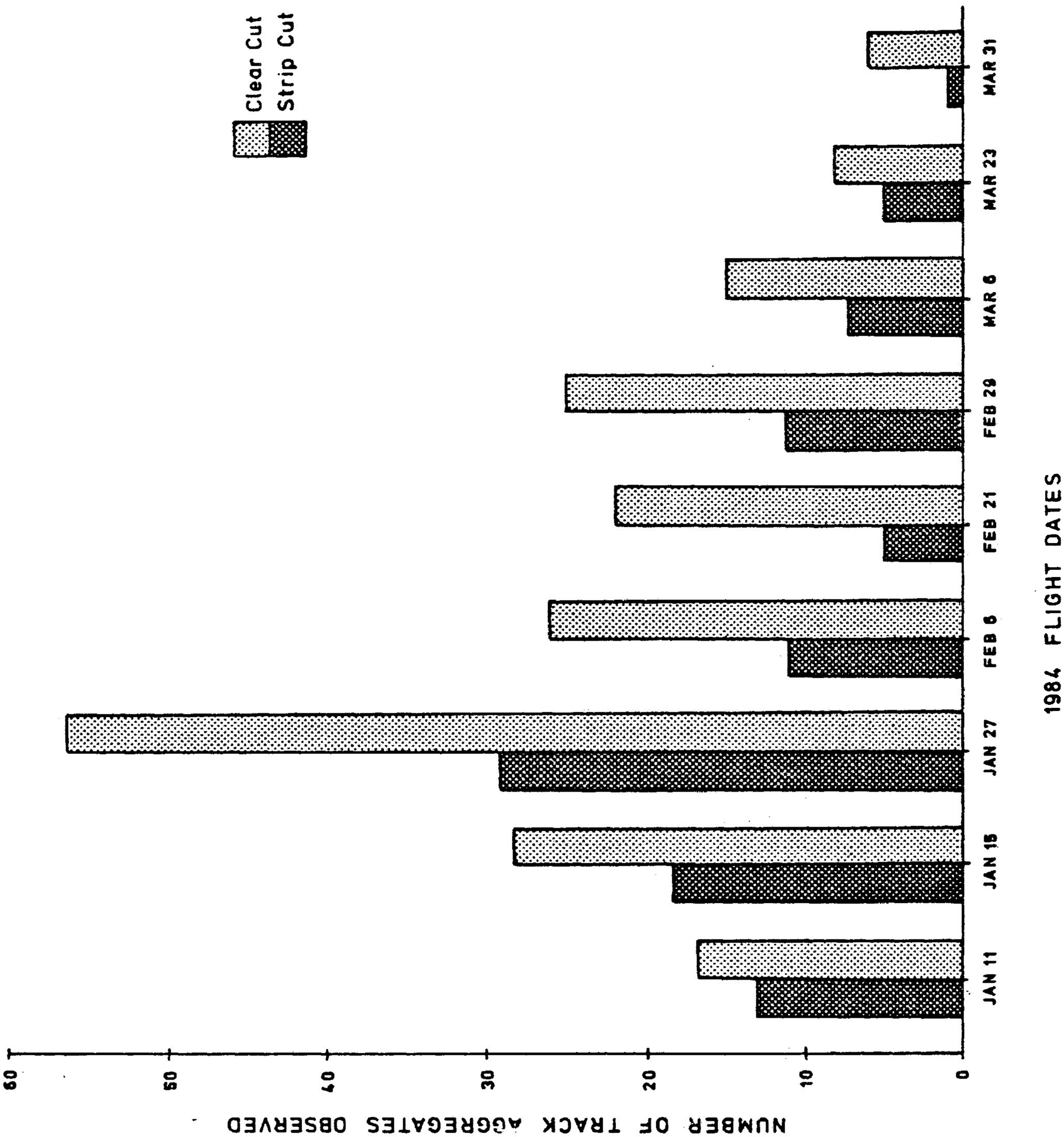


Figure 3. Seasonal observations of track aggregates in strip cuts and clearcuts during the winter of 1983 - 1984.

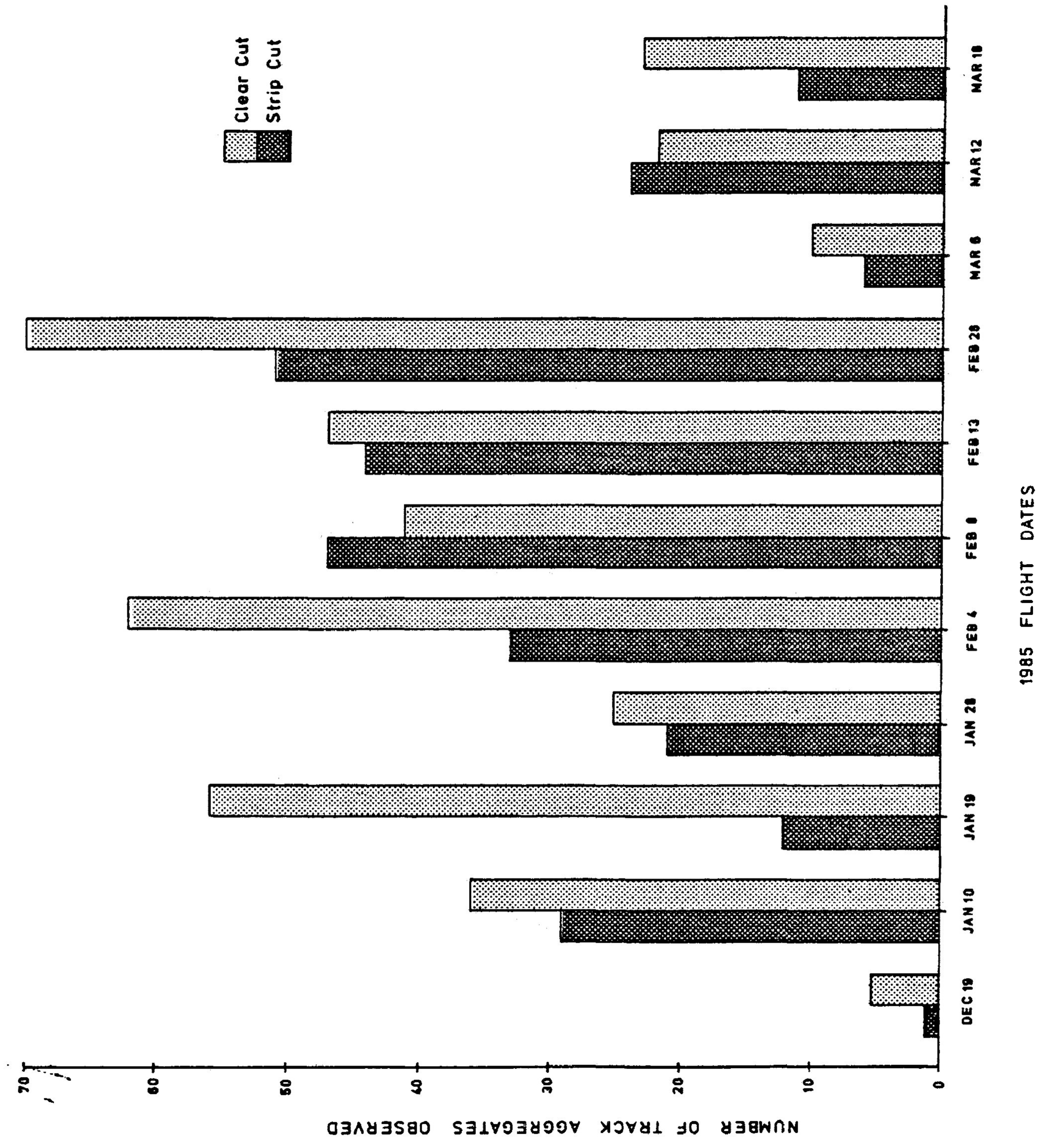


Figure 4. Seasonal observations of track aggregates in strip cuts and clearcuts during the winter of 1984 - 1985.

increased from 1983 - 1984 for the alternate strip cuts at Edmondson and Mott Lake, but decreased at the Tease and Lever Lake study sites. All clearcut study sites except Tease Lake showed an increase in the area covered by track aggregates for the winter of 1984 - 1985 from the previous winter. These data suggest that moose were more active during the winter of 1984 - 85 than the previous winter, and utilized greater areas within all study sites but Tease Lake, which had a decline in use.

Table 8. Track aggregate areas (ha) observed in all study sites during the winters of 1983 - 1984 and 1984 - 1985.

Study Site	Area Covered By Track Aggregates (ha)			
	Strip Cut 1983/1984	Clearcut 1983/1984	Strip Cut 1984/1985	Clearcut 1984/1985
Edmondson Lake	2.16	9.75	15.20	54.48
Mott Lake	16.10	55.52	44.65	74.52
Tease Lake	7.37	35.65	6.26	18.86
Buzzer Lake	----	-----	49.25	40.43
Lever Lake	14.30	0.00	6.02	3.61
Total	39.93	100.92	121.38	191.90

* X^2 significant difference ($P < 0.01$, 1 d.f.)

Browse Availability and Utilization

In the four weeks in which sampling for browse utilization took place, 284 plots were located in the strip cuts and 287 plots were located in the clearcuts. The 10 most utilized browse species were selected for calculations from the 17 species encountered in the field (Table 9). Significantly ($P < 0.01$) higher densities of available browse species stems were observed in the clearcuts than in the strip cuts. The two most northerly study sites, Buzzer Lake and Lever Lake, had significantly ($P < 0.01$) higher densities of available browse species stems than the Edmondson Lake and Mott Lake study sites for both types of cut. White birch and red osier dogwood (Cornus stolinifera) were the only two browse species that were more available in the strip cuts than in the clearcuts. White birch, trembling aspen and pin cherry (Prunus pennsylvanica) had the greatest relative availability (percentage of all available species) in both types of timber harvests. Based on the frequency index (percentage of the number of plots in which the species was observed), these three species were well distributed throughout both types of cuts.

The density of browsed stems was significantly ($P < 0.01$) higher in the clearcuts than in the strip cuts. The overall utilization (percent of available stems which were browsed) of browse species in the clearcuts was almost twice that observed in the strip cuts (4.47 % vs. 2.54%). There were no significant differences in the utilization of available browse in the strip cuts or clearcuts, except for the Edmondson Lake clearcut which had less than expected utilization of the available browse.

Table 9. Availability of the ten browse species most often selected by moose in alternate strip cuts and clearcuts.

Browse Species	Avail. stems/ha		Relative Avail.		Frequency Index	
	Strip Cut	Clearcut	Strip Cut	Clearcut	Strip Cut	Clearcut
White birch	3118	1887	43.6	22.0	51.7	63.1
Trembling aspen	938	1211	13.1	14.1	42.9	49.1
Pin cherry	893	1197	12.5	14.0	29.2	34.5
Mountain ash	136	378	1.9	4.4	12.3	22.6
Beaked hazel	209	493	2.9	5.8	5.3	4.2
Green alder	607	707	8.5	8.3	18.3	22.3
Willow spp.	505	502	7.1	5.9	21.5	31.0
Red osier dogwood	428	334	6.0	3.9	10.2	9.1
Mountain maple	64	850	0.9	9.9	2.1	15.7
Balsam fir	248	1007	3.5	11.8	20.1	47.0
Total	7146	8566*	100.0	100.1		

* X^2 significant difference ($P < 0.01$, 1 d.f.)

Six different browse species comprised over 80 % of the browsed stems in the two timber harvest methods (Table 10). In the strip cuts, red osier dogwood, white birch, trembling aspen, and mountain ash (Sorbus americana) were the four most consumed browse species respectively. In the clearcuts, white birch, mountain ash, pin cherry and mountain maple (Acer spicatum) had the greatest relative utilization (percent of utilization of all species). There was low relative utilization of beaked hazel (Corylus cornuta), green alder (Alnus crispa), willows (Salix spp.) and balsam fir in both types of timber harvest.

Red osier dogwood and mountain ash were the only preferred browse species (i.e. preference rating > 1.0) in the strip cuts. There were 5 preferred browse species in the clearcuts; mountain ash, mountain maple, pin cherry, white birch and red osier dogwood.

Table 10. Utilization and preference ratings of the ten browse species most often selected by moose in alternate strip cuts and clearcuts.

Browse Species	Browsed stems/ha		Relative Utiliz.		Preference Rating	
	Strip Cut	Clearcut	Strip Cut	Clearcut	Strip Cut	Clearcut
White birch	55	101	30.1	26.4	0.69	1.20
Trembling aspen	18	23	9.7	5.9	0.74	0.42
Pin cherry	14	75	7.8	19.5	0.62	1.57
Mountain ash	18	77	9.7	20.0	5.11	4.54
Beaked hazel	5	2	2.9	0.5	0.99	0.07
Green alder	7	7	3.9	1.8	0.46	0.22
Willow spp.	5	19	2.9	5.0	0.41	0.85
Red osier dogwood	60	16	33.0	4.1	5.51	1.05
Mountain maple	0	61	0	15.9	----	1.60
Balsam fir	0	2	0	0.9	----	0.08
Total	182	383*	100.0	100.0		

* X^2 significant difference ($P < 0.01$, 1 d.f.)

Using Stronks' (1985) logarithmic regression equations developed for all browse species (except green alder and balsam fir) and Peek et al.'s (1974b) regression equation for mountain maple (Appendix IV), the amount of forage (kg/ha) produced and consumed on each of the sampled clearcuts and strip cuts was calculated (Table 11).

Significant ($P < 0.01$) differences were observed in the amount of forage produced in the clearcuts versus the strip cuts; however, there was no significant difference in the weight of browse consumed per hectare by moose between the two different harvest methods. There were significant differences ($P < 0.01$) in the amount of forage produced among the individual strip cuts and clearcuts sampled (Appendix V). The Lever Lake strip cut produced significantly ($P < 0.05$) more forage than expected, and the Edmondson, Mott and Buzzer Lake strip cuts produced less than expected. There was significantly more than expected browse produced in the Buzzer and Lever Lake clearcuts, and less in the Edmondson and Mott Lake clearcuts.

Correlation analysis was completed to determine the influence of forage availability on moose utilization, and the influence of time since harvest on forage production on the four sampled strip cuts and clearcuts (Appendix VI). No significant correlations were dicovered between forage availability and utilization of strip cuts or clearcuts. There was a negative correlation between the age of the harvested area and the amount of forage produced in strip cuts ($r = -0.981$, significant $P < 0.05$) and clearcuts ($r = -0.936$, not significant). The negative correlations indicate decreasing forage production with increasing time since harvest.

Table 11. Production and consumption of browse in strip cuts and clearcuts.

	Available Browse (stems / ha)		Forage Produced (kg / ha)		Browsed Stems (stems / ha)		Forage Consumed (kg / ha)	
	Strip Cut	Clearcut	Strip Cut	Clearcut	Strip Cut	Clearcut	Strip Cut	Clearcut
Edmondson Lk.	6306	7579	102.94	155.03	67	152	1.32	1.42
Mott Lk.	4488	9109	208.84	170.85	224	583	15.35	12.01
Buzzer Lk.	4963	7717	80.26	142.52	142	460	2.49	14.32
Lever Lk.	19568	10598	299.81	260.27	364	239	3.09	3.04

Pellet Group Distribution

Pellet group densities were low in all of the study sites and therefore were of little value. There was no significant difference ($P < 0.05$) between the pellet group densities observed in the alternate strip cuts and clearcuts. In the strip cuts, only 14 pellet groups were observed in 284 plots (17 p.g./ha), and 25 pellet groups were observed in the 289 plots located in the clearcuts (23 p.g/ha).

HABITAT UTILIZATION

Strip Cuts

Significant ($P < 0.01$) differences were observed between the numbers of moose located in the different strip cut habitat strata for both winters (Table 12). The open natural stratum (harvested strips) were the preferred habitats ($P < 0.05$), and the dense conifer leave strips were utilized less than expected based on their availability (Appendix II). The scattered residual and swamp strata were utilized proportional to their availability.

Adult bull moose were observed only in the harvested strips, whereas adult cows without calves were observed in both the harvested and the leave strips (Table 13). Cow moose with calves were the most often observed social group in the strip cuts, and used a variety of habitats. Often when cows with calves were observed in the harvested strips, the adult cow would be located near the middle of the strip and the calf would be located within 5 - 10 m of the dense conifer leave strip.

For both winter's data, there were significant differences ($P < 0.05$) in the number and the area of track aggregates observed in the different habitat strata (Table 12). Track aggregates and track aggregate areas were significantly ($P < 0.05$) greater in the open natural stratum, and significantly fewer in the dense conifer stratum (Appendix II). The number of track aggregates and the area covered by track aggregates in the scattered residual and swamp strata was proportional to the availability of these strata, indicating no apparent preference nor avoidance. There were no track aggregates observed in the blowdown stratum in any strip cut over the two winters.

Table 12. Number of moose, track aggregates and area of track aggregates observed in alternate strip cut habitat strata.

Strata	Number of moose observed.		Number of track aggregates observed.		Area of track aggregates observed (ha).	
	1983/84	1984/85	1983/84	1984/85	1983/84	1984/85
Open Natural	3a	23a	72a	230a	30.45a	103.89a
Dense Conifer	0	4a	24a	33a	7.63a	15.18a
Scattered Residual	0	4	1	6	0.62	1.25
Swamp	0	0	2	5	0.29	0.65
Total	3	31	99	274	38.99	120.97

a Bonferroni Test difference ($P < 0.05$)

Table 13. Age and sex structure of moose observed in alternate strip cut habitat strata during the winters of 1983 - 1984 and 1984 - 1985.

	1983-84	1984-85		
Age and Sex of Moose Observed	Open Natural	Open Natural	Dense Conifer	Scattered Residual
Adult bull	1	1	0	0
Adult cow	0	4	2	0
Cow with calf	1	9	2	2
Total No. of Moose Observed	3	23	6	4

Significant ($P < 0.01$) differences were observed between the densities of available browse stems and the amounts of browse produced (kg/ha) in the strip cut strata (Table 14). The scattered residual and swamp strata had greater than expected browse densities and production (Appendix II). The open natural and the dense conifer strata had lower than expected browse densities and production.

Although there was a significant ($P < 0.01$) difference in the density of browsed stems in the strip cut strata, there was no significant difference between the observed and expected amount of browse consumed (kg/ha). Based on the density of browsed stems, the scattered residual and harvested strips were the preferred habitats for foraging. The use of the scattered residual stratum must have taken place in either early winter or spring, as data collected during aerial reconnaissance in mid to late winter indicated that this habitat was being used proportional to it's availability.

The density of pellet groups was significantly ($P < 0.01$) different among strip cut habitat strata (Table 14). There were significantly ($P < 0.05$) higher densities of pellet groups observed in the harvested strips with scattered residual present, and densities were significantly less in the harvested strips and conifer leave strips (Appendix II).

Table 14. Densities of available and browsed stems, pellet groups and amount of browse produced and consumed in alternate strip cut habitat strata.

Strata	Number of available stems per hectare.	Number of browsed stems per hectare.	Amount of browse produced (kg/ha).	Amount of browse consumed (kg/ha).	Number of pellet groups / hectare.
Open Natural	6987a	250a	98.44a	3.31	12a
Dense Conifer	1730a	29	19.57a	0.51	11a
Scattered Residual	8421a	316a	101.16a	4.63	50a
Swamp	18333a	167a	50.12a	0.21	0
Total	35471	762	269.29	8.66	73

a Bonferroni Test difference ($P < 0.05$)

White birch had the highest relative utilization (percentage of one utilized browse species over all consumed browse species) in the dense conifer and scattered residual strip cut strata (Table 15). Mountain ash had the second highest utilization in these strata. Red osier dogwood had the highest relative utilization in the open harvested strips, with white birch being the second most consumed species. Pin cherry was the third most consumed browse species in both the open harvested strips and in the scattered residual. Willow was the only browsed species observed in the swamp stratum.

Table 15. Relative utilization of ten browse species observed in strip cut strata.

Browse Species	Open Natural	Dense Conifer	Scatt. Residual	Swamp
	Habitat Strata			
White birch	26.3	80.0	58.3	0.0
Trembling aspen	10.5	0.0	8.3	N/A
Pin cherry	11.8	0.0	16.6	N/A
Mountain ash	7.9	20.0	16.7	0.0
Beaked hazel	3.9	0.0	N/A	N/A
Green alder	5.3	0.0	0.0	0.0
Willow spp.	2.6	0.0	N/A	100.0
Red osier dogwood	31.6	0.0	0.0	0.0
Mountain maple	0.0	N/A	N/A	N/A
Balsam fir	0.0	0.0	0.0	0.0

N/A: Species not encountered in sampling.

Clearcuts

There were significant ($P < 0.05$) differences in the number of moose observed in the different clearcut habitat strata (Table 16). The 30 m influence zone was preferred by moose for both winters (Appendix III). Except for the avoidance of the open planted strata in the first winter and dense conifer in the second winter, the number of moose observed in all other habitat strata was proportional to the availability of the habitats.

Adult bull moose were observed most often in the 30 m influence zone and scattered residual strata (Table 17). Five of the seven bulls observed utilizing this habitat strata in the winter of 1983 - 84 were prime adult animals, as were five of the six bulls observed in the winter of 1984 - 85. Cows with calves were most often observed in the 30 m influence zone, but were also observed in the open. Of the five observations of cows with calves using this strata, three of the cow - calf groups were located in the influence zone associated with the periphery of the clearcut. In all cases where cows with calves were observed in the open, they were associated with dense coniferous regeneration approximately 5 m in height. Adult cow moose used a variety of clearcut habitat strata, although usually those associated with mature timber.

Significant ($P < 0.01$) differences in the number of track aggregates observed in clearcut strata were found in both winters (Table 16). Preference was shown for the 30 m influence zone, while the number of track aggregates observed in the open natural, dense conifer and scattered residual strata was proportional to the availability of these habitats in both winters (Appendix III). The hardwood stratum was avoided in both winters, and differences in the utilization of the open planted and swamp strata was observed between the winters.

There were significant ($P < 0.05$) differences in the amount of area covered by track aggregates in the habitat strata for both winters (Table 16). Other than the swamp stratum which was avoided, all other habitat strata had track aggregate areas proportional to their availability in the winter 1983 - 1984 (Appendix III). For the winter of 1984 - 1985, there was preference for the 30 m influence zone, and avoidance of the hardwood and swamp strata.

Table 16. Number of moose, track aggregates and area of track aggregates observed in clearcut habitat strata.

Strata	Number of moose observed.		Number of track aggregates observed.		Area of track aggregates observed (ha).	
	1983/84	1984/85	1983/84	1984/85	1983/84	1984/85
Open Natural	3	3	34	99	22.18	53.36
Open Planted	0a	2	27	31a	12.22	18.96
Influence Zone	14a	14a	55a	114a	18.14	52.39a
Dense Conifer	0	0a	29	31	8.35	13.27
Scattered Residual	6	8	44	94	28.63	44.97
Hardwood	0	3	6a	9a	4.18	3.58a
Swamp	0	0	5a	19	1.52a	5.37a
Total	23	30	200	397	95.28	191.90

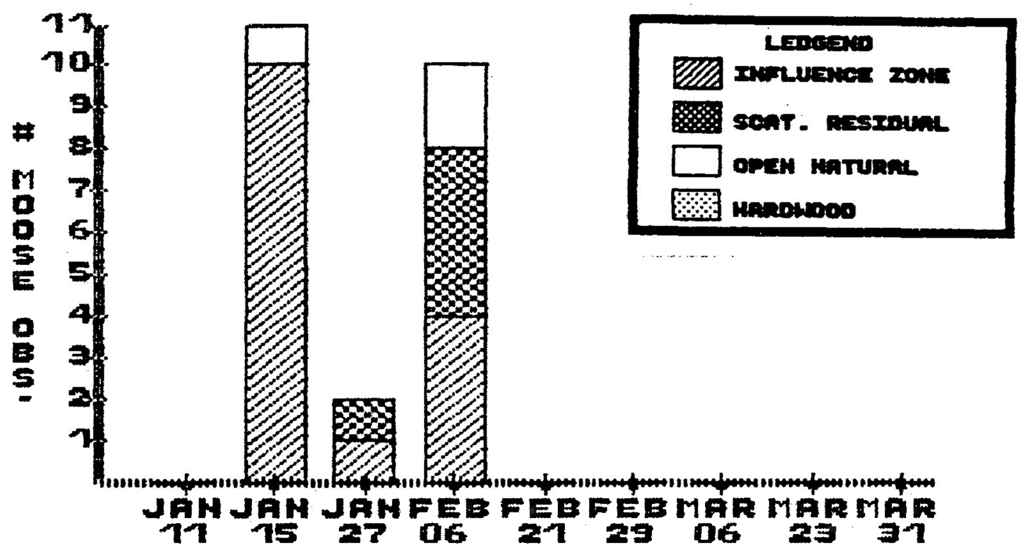
a Bonferroni Test difference ($P < 0.05$)

Table 17. Age and sex structure of moose observed in clearcut habitat strata.

Age - Sex Class	1983-84 Open Nat.	1983-84 Infl. Zone	1983-84 Scat. Res.	1984-85 Open Nat.	1984-85 Open Plant	1984-85 Infl. Zone	1984-85 Scat. Res.	1984-85 Hdwd.
Adult Bull	0	7	3	0	0	6	3	1
Adult Cow	0	2	2	1	0	0	1	2
Cow w/ Calf	1	0	0	1	1	4	2	0
Calf	1	0	0	0	0	0	0	0
Cow w/ 2 Calves	0	1	0	0	0	0	0	0
Unknown	0	3	0	0	0	0	0	0
Total # Moose	3	15	5	3	2	14	8	3

Monthly differences in the utilization of the clearcut habitat strata were observed in both winters. In early January 1984, moose were observed predominately in the 30 m influence zone (Fig. 5). By early February 1984, moose were observed equally in the 30 m influence zone and the scattered residual strata. Moose were observed in the hardwood habitats in early winter 1984-85, the 30 m influence zone in early to mid winter, and in the scattered residual stratum in mid to late winter.

1983-84



1984-85

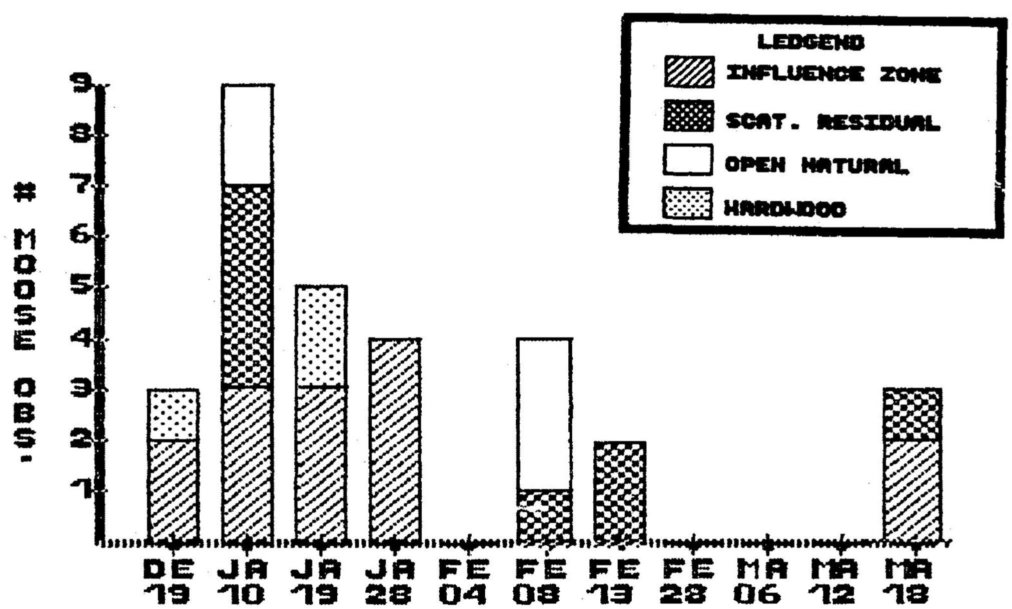
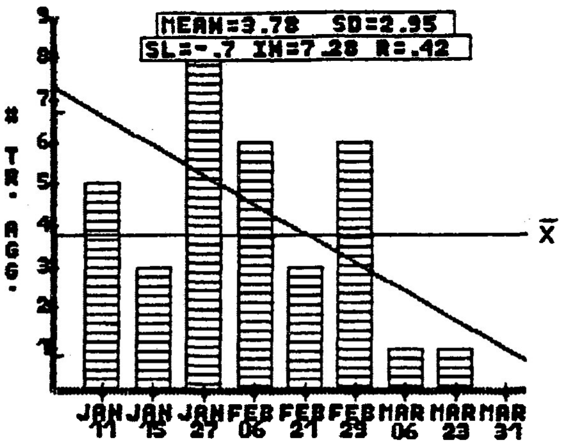


Figure 5. Seasonal utilization of clearcut habitat strata by moose.

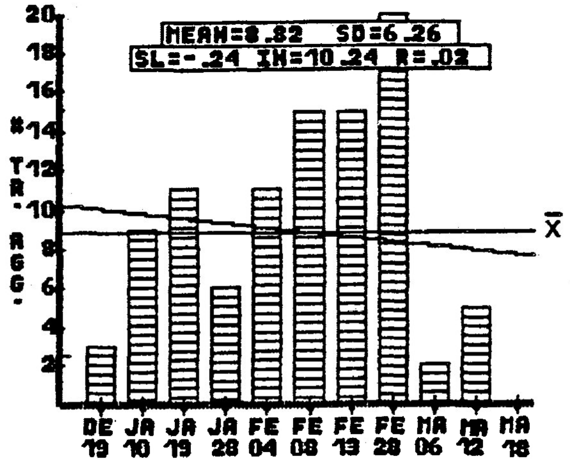
The number of track aggregates observed in the clearcut habitat strata also indicated monthly differences. The open natural, scattered residual and 30 m influence zone strata had the highest numbers of track aggregates for both winters. In the 1983-84, track aggregates were most consistantly found in the 30 m influence zone, with numbers peaking in early February (Fig. 6). The numbers of track aggregates in the scattered residual stratum rapidly increased and peaked in late January. Track aggregate observations in the open natural stratum were variable, peaking in late January and decreasing over the remainder of the winter.

Similar numbers of track aggregates were observed during 1984-85 in all three habitat strata for early and mid winter. The 30 m influence zone had the highest mean observations, with most observations in late February 1985. The number of track aggregates observed in the open natural stratum gradually increased over the course of the winter, and peaked in late February 1985. The number of track aggregates observed in the scattered residual stratum was highly variable.

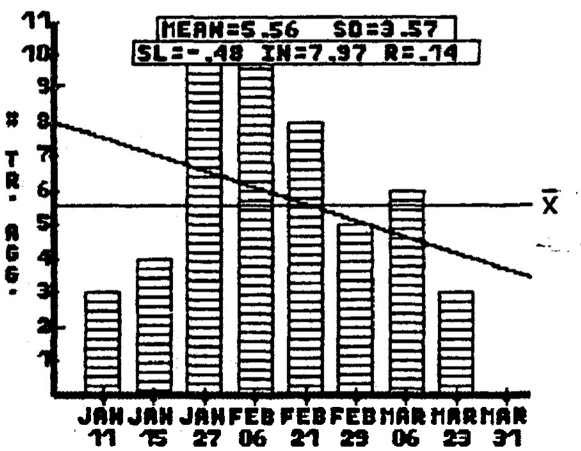
No significant correlations were observed between winter observations of moose, tracks, and aggregate area and the percentage of the area comprised of cover associated strata (dense conifer, scattered residual, hardwood and swamp), or 30 m influence zone (Appendix VII). Correlations were highest between all observations and the 30 m influence zone for both winters.



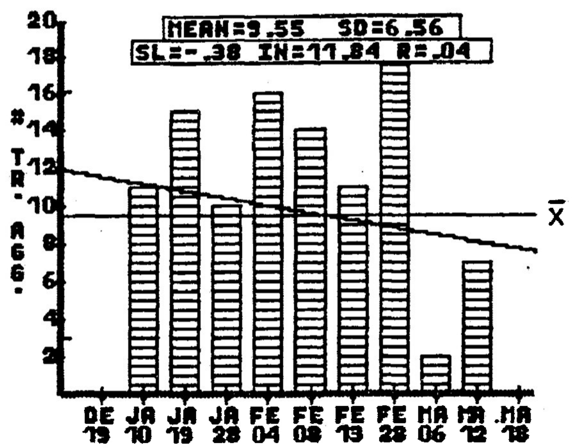
Open Natural 1983-84



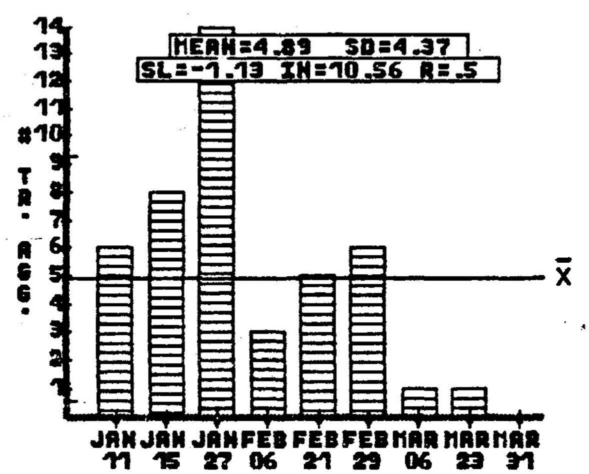
Open Natural 1984-85



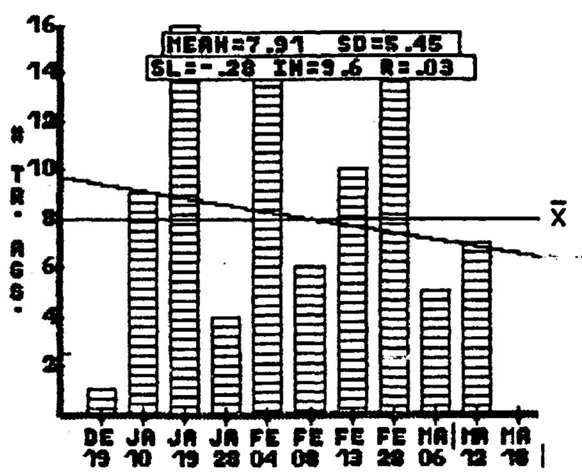
Influence Zone 1983-84



Influence Zone 1984-85



Scattered Residual 1983-84



Scattered Residual 1984-85

Figure 6. Seasonal observations of track aggregates in the open natural, 30 m influence zone and scattered residual clearcut habitats.

There were significant ($P < 0.01$) differences in the density of available browse stems and in the amount of forage produced (kg/ha) in the individual clearcut habitat strata (Table 18). Densities of available browse stems were greater than expected in the open planted, 30 m influence zone, hardwood, and swamp strata (Appendix III). Forage production was significantly higher in the hardwood, open planted and swamp strata, and significantly lower in the dense conifer and scattered residual strata.

Significant ($P < 0.05$) differences were observed in the density of browsed stems and consumed forage (kg/ha) in the individual clearcut strata (Table 18). Densities of browsed stems were higher than expected (based on availability) in the open planted and hardwood strata, and lower than expected in all other clearcut habitats (Appendix III). Consumed forage was proportional to availability in all strata except the dense conifer and swamp strata, which had less forage consumed than expected. No significant correlations were determined between moose utilization levels and browse densities or production (Appendix VIII).

Utilization of browse species varied greatly among clearcut habitat strata (Table 19). In general, white birch, pin cherry and mountain ash were highly utilized. Mountain maple was the most consumed species in the hardwood and scattered residual strata. Pin cherry was the only species observed browsed in the dense conifer habitat stratum, and willows were the only utilized browse in the swamp stratum.

There were significant differences (P < 0.01) among the observed densities of pellet groups in the clearcut habitat strata (Table 18). The density of pellet groups was greater than expected in the hardwood habitat strata, and lower than expected in all of the remaining habitat strata except dense conifer, in which the density was proportional to the availability of this habitat (Appendix III).

Table 18. Densities of available and browsed stems, pellet groups and amount of browse produced and consumed in clearcut habitat strata.

Strata	Number of available stems per hectare.	Number of browsed stems per hectare.	Amount of browse produced (kg/ha).	Amount of browse consumed (kg/ha).	Number of pellet groups / hectare.
Open Natural	7721a	511a	173.95	12.36	21a
Open Planted	6923a	462a	238.84a	15.77	0a
Influence Zone	10051a	316a	169.96	7.71	15a
Dense Conifer	5065a	22a	49.85a	0.30a	22a
Scattered Residual	10451a	287a	182.66a	3.64	12a
Hardwood	10357a	893a	116.12a	7.34	143a
Swamp	6136a	45a	123.98a	1.00a	0a
Total	56704	2535			213

a Bonferroni Test difference (P < 0.05)

Table 19. Relative utilization of ten browse species observed in clearcut strata.

Browse Species	Habitat Strata: Open Natural	Open Planted	30 m Influence Zone	Dense Conifer	Scatt. Residual	Hardwood	Swamp
White birch	38.1	25.0	12.9	0.0	23.4	8.0	0.0
Trembling aspen	5.2	33.3	12.9	0.0	2.1	0.0	0.0
Pin cherry	32.0	8.3	25.8	100.0	4.2	0.0	0.0
Mountain ash	9.3	25.0	32.3	0.0	23.4	4.0	0.0
Beaked hazel	N/A	N/A	0.0	N/A	2.1	0.0	N/A
Green alder	1.0	0.0	3.2	N/A	4.2	0.0	0.0
Willow spp.	6.1	0.0	3.2	0.0	2.1	4.0	100.0
Red osier dogwood	7.2	0.0	9.7	0.0	0.0	0.0	0.0
Mountain maple	0.0	N/A	0.0	0.0	38.3	84.0	N/A
Balsam fir	1.0	8.3	0.0	0.0	0.0	0.0	0.0

N/A: Species not encountered in sampling.

Summary of Habitat Utilization

Observations of the number of moose (1983 - 84), track aggregate densities and areas and browsed stem densities indicated a preference for clearcuts rather than strip cuts by moose under the conditions present in this study (Table 20). No significant differences were found between the two harvest methods for moose observed (1984 - 85), the amount of forage consumed and pellet group densities.

Table 20. Selection of alternate strip cuts and clearcuts by moose as determined by observed moose, track aggregates, browse removed, and pellet group densities.

Observed Variable	Strip Cut*	Clearcut*
Number of moose (1983-84)	-	+
Number of moose (1984-85)	No Sig. Difference	
Number of track aggregates[1]	-	+
Area of track aggregates[1]	-	+
Browse consumed (kg/ha)	No Sig. Difference	
Browsed stems / ha	-	+
Pellet groups / ha	No Sig. Difference	

* Selection: (+) observed variable significantly ($P < 0.05$) higher than expected level
(-) observed variable significantly ($P < 0.05$) lower than expected level
(0) observed variable not significantly ($P < 0.05$) different from expected level
1 observed both winters

In the alternate strip cuts, the individual habitat strata showed different levels of utilization (Table 21). The open harvested strips were preferred based on all of the observed indicators of use except the amount of forage consumed and the density of pellet groups. Pockets of scattered residual timber appeared to be selected for browsing, and produced significantly more browse per hectare than any of the other alternate strip cut strata. The scattered residual also had higher densities of pellet groups than expected. The dense conifer leave strips appeared to be avoided for all of the observed variables. No preference nor avoidance appeared to be indicated for the small patches of lowland swamp in the strip cuts.

Table 21. Selection of alternate strip cut habitat strata as determined by observed moose, number and area of track aggregates, browse consumed and pellet group densities.

Observed Variable	Habitat Strata*			
	Open Natural	Dense Conifer	Scattered Residual	Swamp
Number of moose (83-84)	+	NA	NA	NA
Number of moose (84-85)	+	-	0	0
Number of track aggregates1	+	-	0	0
Area of track aggregates1	+	-	0	0
Browse consumed (kg/ha)	No Significant Difference Observed			
Browsed stems / ha	+	0	+	-
Pellet groups / ha	-	-	+	0

* Selection: (+) observed variable significantly (P < 0.05) higher than expected level
(-) observed variable significantly (P < 0.05) lower than expected level
(0) observed variable not significantly (P < 0.05) different from expected level
(NA) variable not observed in sample
1 observed both winters

In the clearcuts, greatest preference was determined for the 30 m influence zone based on the indicators of use (Table

22). The open natural, dense conifer and scattered residual strata were utilized proportional to availability for all but one or two of the indicator variables. The open planted habitat strata had the highest availability and production of browse, and higher than expected densities of browsed stems. Hardwood stands appeared to be utilized for browsing based on browsed stem and pellet group densities. The swamp stratum was the most avoided habitat type in the clearcuts.

Table 22. Selection of clearcut habitat strata as determined by observed moose, number and area of track aggregates, browse consumed and pellet group densities.

Observed Variable	Habitat Strata*						
	Open Natural	Open Planted	Influence Zone	Dense Conifer	Scattered Residual	Hardwood	Swamp
Number of moose (83-84)	0	-	+	0	0	0	0
Number of moose (84-85)	0	0	+	-	0	0	0
Number of track aggregates (83-84)	0	0	+	0	0	-	-
Number of track aggregates (84-85)	0	-	+	0	0	-	0
Area of track aggregates (83-84)	0	0	0	0	0	0	-
Area of track aggregates (84-85)	0	0	+	0	0	-	-
Browse consumed (kg/ha)	0	0	0	-	0	0	-
Browsed stems / ha	-	+	-	-	-	+	-
Pellet groups / ha	-	-	-	0	-	+	-

* Selection: (+) observed variable significantly ($P < 0.05$) higher than expected level
(-) observed variable significantly ($P < 0.05$) lower than expected level
(0) observed variable not significantly ($P < 0.05$) different from expected level

PREDATION AND DISEASE

No evidence of wolf kills or loss of moose to poaching was observed in either winter in any of the study sites. No wolves were actually observed over the two winters; however, individual tracks and groups of up to five wolf tracks were observed on the Buzzer and Lever Lake study areas in 1983 - 84, and on all study sites in 1984 - 85 (Table 23). Although sightings were too few to indicate any significance ($P < 0.05$), wolf tracks were twice as numerous in the clearcuts as in the strip cuts in the winter of 1984 -85.

Table 23. Observations of wolf tracks in strip cuts and clearcuts in the winters of 1983/84 and 1984/85.

Date	Study Area	Strip Cut	Clearcut
27/Jan/84	Buzzer Lk.	1	0
29/Feb/84	Lever Lk.	0	1
31/Mar/84	Lever Lk.	1	1
Total 1983/84		2	2
19/Dec/84	Mott Lk.	1	1
	Lever Lk.	0	1
10/Jan/85	Edmondson Lk.	1	0
27/Jan/85	Tease Lk.	0	1
04/Feb/85	Mott Lk.	1	1
13/Feb/85	Tease Lk.	0	1
18/Mar/85	Edmondson Lk.	0	1
Total 1984/85		3	6

Wolf tracks were most commonly found on logging road systems or on the surface ice of creeks which traversed a cutover area. In the strip cuts, wolf tracks were only observed on logging roads or creek systems around or through the study sites, but never in the cut or leave strips.

In the clearcuts, wolf tracks were commonly observed throughout the harvested areas, usually in association with moose tracks. On January 27, 1985, two wolf tracks were observed following the tracks of two moose throughout the Tease Lake clearcut. On February 13, 1985 in the same clearcut, an apparent standoff had occurred between a wolf and a moose on one of the access roads. Wolf tracks were observed circled around a tight cluster of moose tracks, with a lone set of wolf tracks departing in one direction, and a lone set of moose tracks departing in the opposite direction.

One apparently weak and perhaps diseased cow moose was observed just outside the Mott Lake strip cut on February 6, 1984. When first observed, the cow was bedded with her legs uncharacteristically splayed out in the snow, with a young bull standing beside her. After numerous circles with the aircraft, the cow finally stood up and appeared extremely gaunt and emaciated compared to the bull. Neither animal was observed for the remainder of the winter. An adult bull moose with severe hair loss on both sides behind the front shoulders was observed on March 18, 1985 at the Buzzer Lake clearcut. This hair loss was similar to that described to Samuel and Barker (1979) and was probably associated with scratching from the hind hooves to relieve the irritation caused by winter ticks (Dermacentor albipictus).

SNOW CONDITIONS

Snowfall in Thunder Bay over the winter of 1983 - 1984 was not significantly different ($P < 0.05$) from the 30 year average snowfall for these months (Environment Canada 1981). No snow measurements were made in the clearcut in the winter of 1983 - 1984 due to mechanical problems encountered at the times of sampling.

During the winter of 1983 - 84, mean snow depths were significantly greater ($P < 0.01$) in the harvested strips than in the adjacent uncut strips (Appendix IX). Mid winter snows in the harvested strips tended to be shallowest against the edges of the standing timber, and deepest in the centre of the strip (Fig. 7). In the leave strips, mid winter snow depths were generally similar to the harvested strips, with some evidence of drifting at the edge of the standing timber. In late winter, snow depths showed the effect of the increased solar insolation caused by longer day lengths (Fig. 8). Snow was deepest on the south side of the harvested strips where it was shaded by standing timber and shallowest in the north portion of the strip where it was most exposed to the sun. Snow depths in the leave strips showed a similar, although reverse pattern: shallowest snow depths were in the south side of the uncut strips, and deepest on the north side.

Ontario Ministry of Natural Resources snow stations in nearby Thunder Bay, Dorion, Nipigon and Armstrong all reported

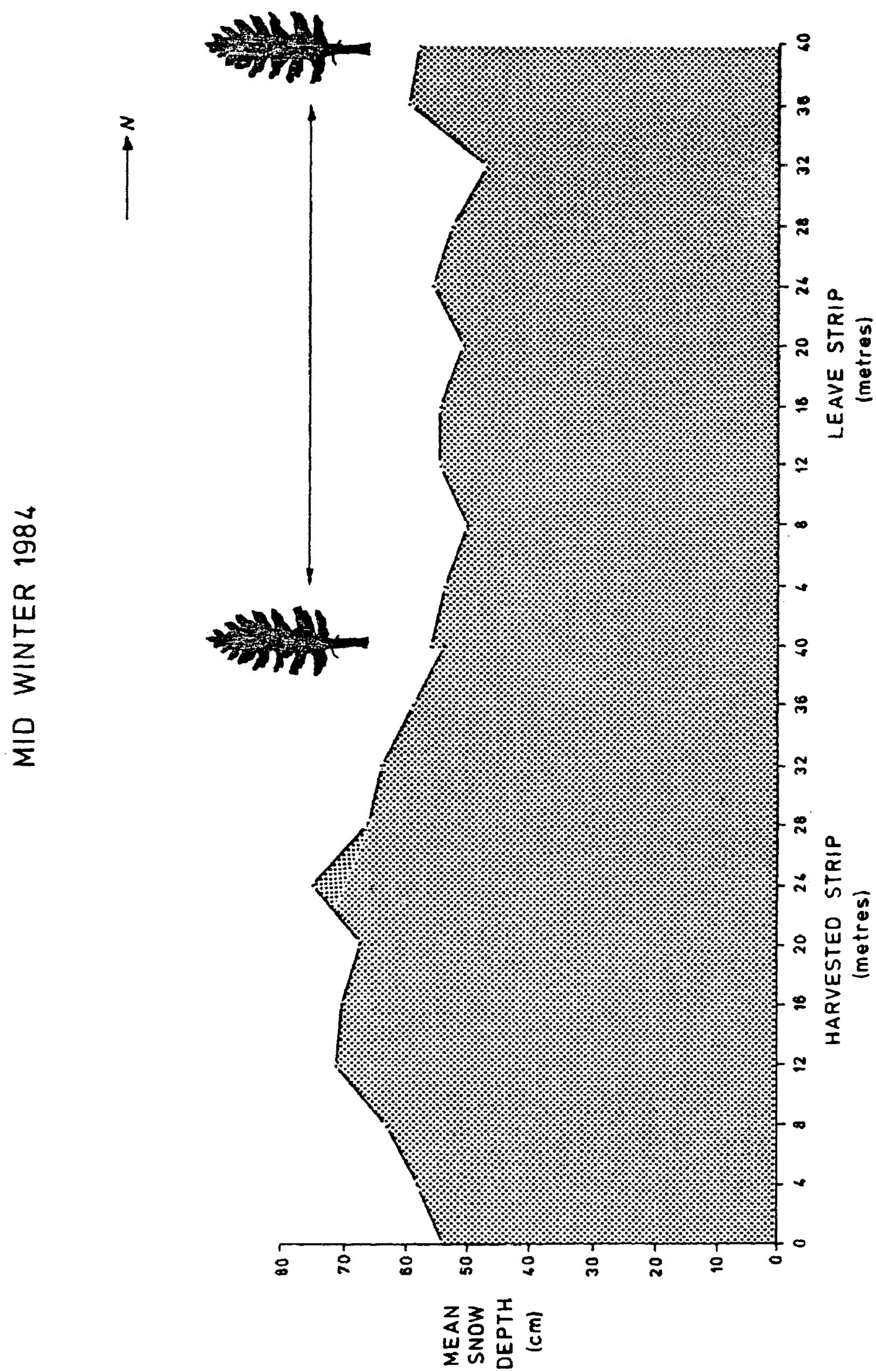


Figure 7. Mean snow depths in harvested and leave strips - mid winter 1984.

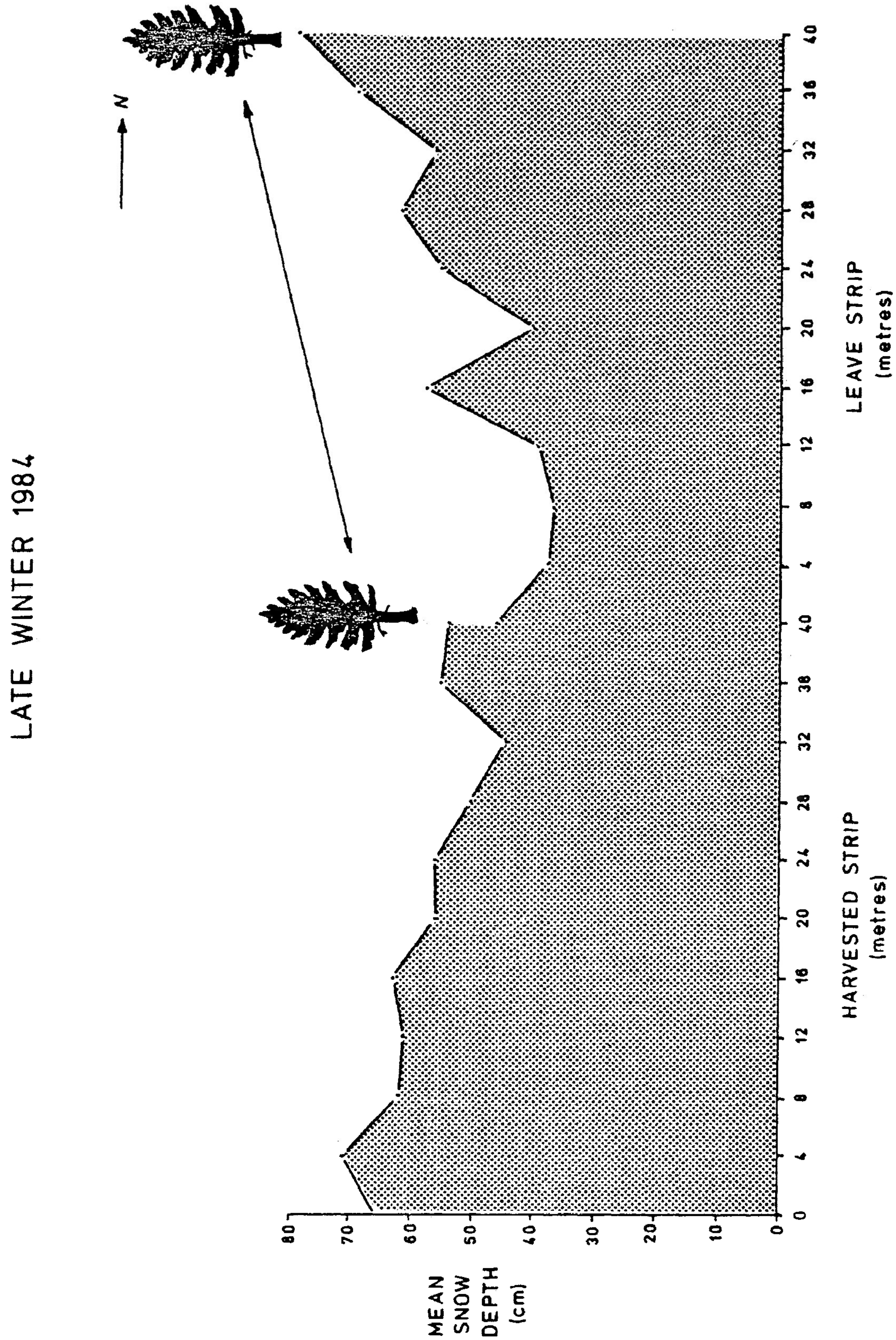


Figure 8. Mean snow depths in harvested and leave strips - late winter 1984.

heavy snow crusting conditions between February 13 - 20, 1984. Mild temperatures, fog and an unseasonable rainfall over this period reduced snow depths and formed an ice crust on top of the snow. Mid and late winter snow in the harvested strips was denser and harder than in the leave strips, although not significantly ($P < 0.01$). A 9 cm ice crust was observed on the snow in the harvested strips in late winter, but not on the snow in the uncut strips.

Snowfall in Thunder Bay over the period of December 1984 - March 1985 was not significantly different ($P < 0.01$) from the 30 year average, although only half the normal snowfall was received in January 1985. Snow measurements were obtained in the clearcut as well as the strip cut for both mid and late winter measurements.

Mid winter snow depths were significantly greater ($P < 0.05$) in the harvested strips than in the leave strips (Fig. 9), yet in late winter there was no significant difference in snow depths between the cut and uncut strips (Fig. 10). In mid winter, snow was deepest in the centre of the harvested strips, and was relatively uniform in depth across the leave strips. Late winter snow depths showed a pattern similar to those observed in the previous year's late winter measurements. Deepest snows were observed on the south side of the harvested strips where it was shaded by standing timber, and shallowest on the north side of the cut strips. In the leave strips,

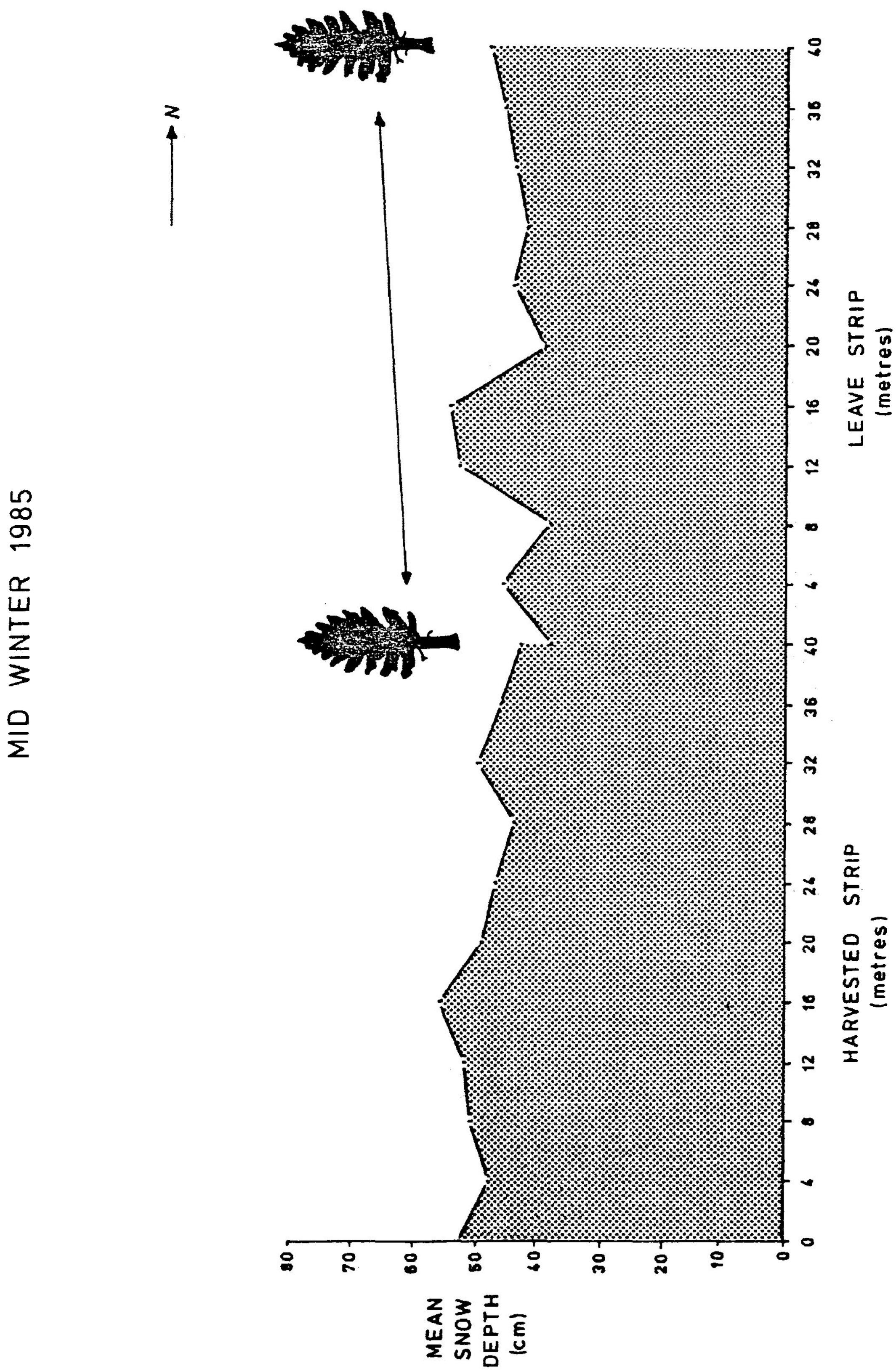


Figure 9. Mean snow depths in harvested and leave strips - mid winter 1985.

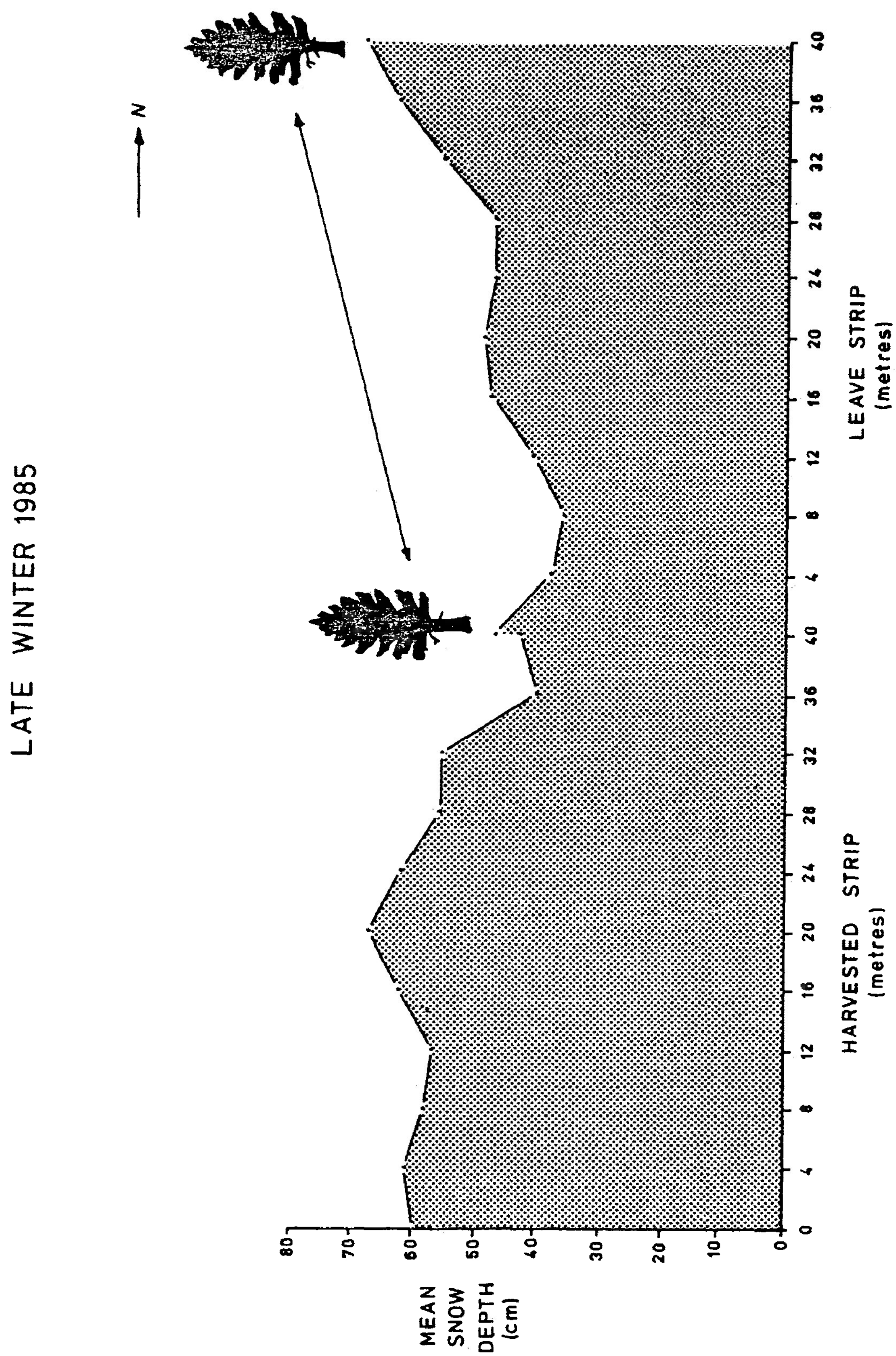
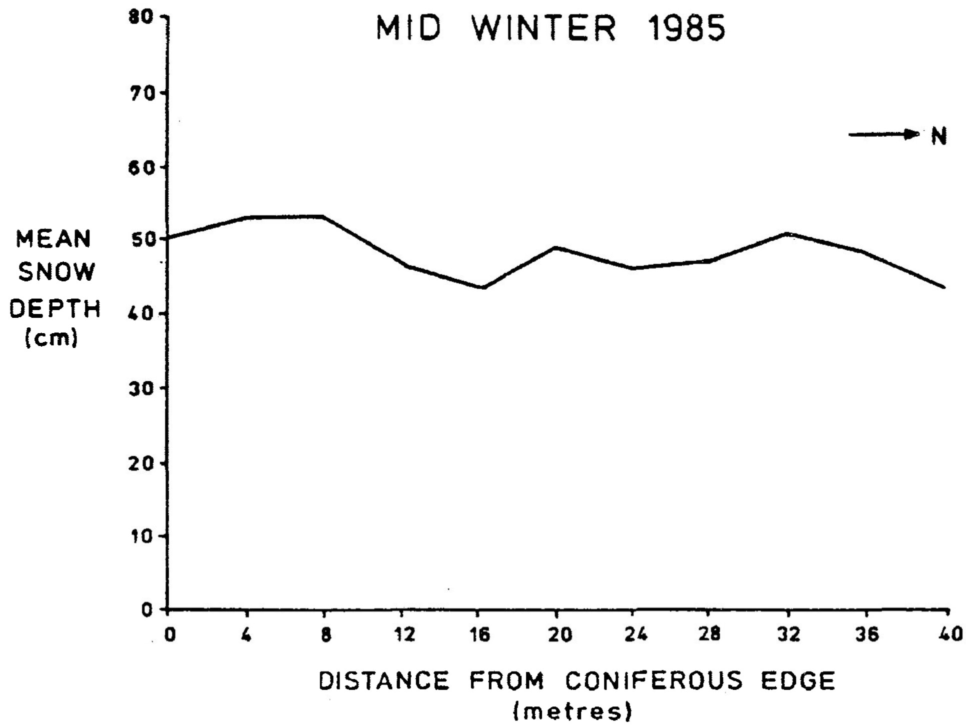


Figure 10. Mean snow depths in harvested and leave strips - late winter 1985.

shallowest snows were observed on the south side of the standing timber and deepest on the north side.

Snow depths in the harvested strips were not significantly different ($P < 0.05$) from those in the clearcut for both early and late winter measurements. Mid winter snow depths in the clearcut did not vary appreciably as distance increased from coniferous edge (Fig. 11). Late winter snow depths in the clearcut varied considerably and showed no distinct pattern.

Snow accumulation for the winter of 1984 - 1985 was significantly ($P < 0.05$) less than that received during the winter of 1983 - 1984 at M.N.R. snow stations at Thunder Bay, Dorion, Nipigon, and Armstrong. Heavy crusting conditions did not occur at these snow stations until mid to late March 1985, almost a full month later than the previous winter. The decreased snow depths and lack of crusting conditions allowed greater mobility and habitat utilization opportunities for moose during the winter of 1984 - 1985 than were available in the winter of 1983 - 1984.



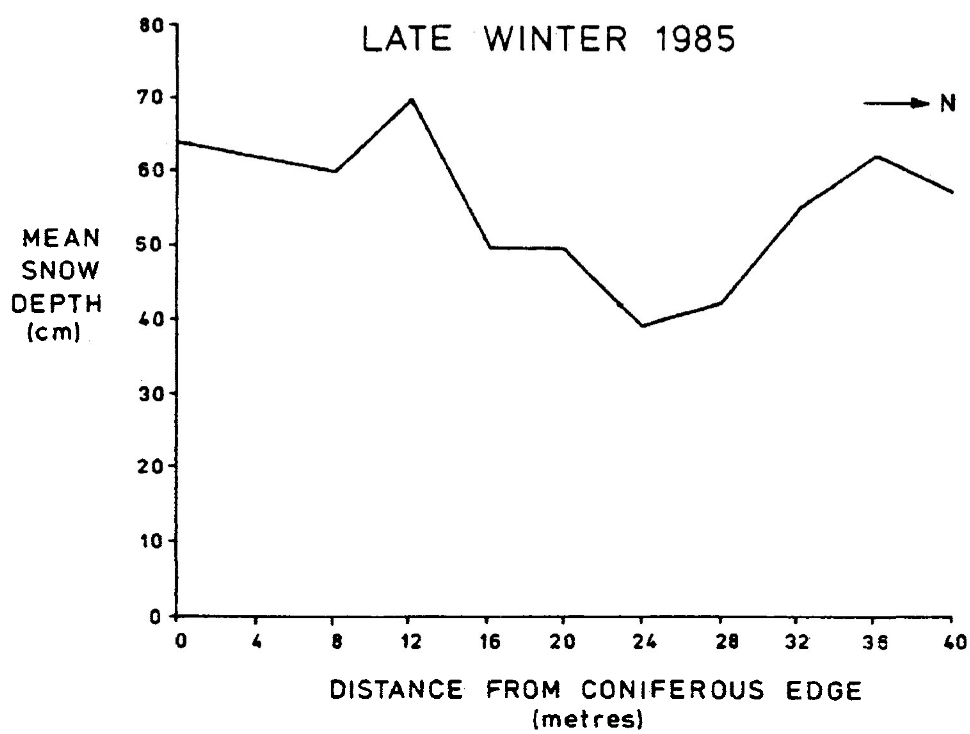


Figure 11. Mean snow depths in open clearcut habitat - mid and late winter 1985.

DISCUSSION

Possibly the best explanation of winter habitat utilization by moose was summarized by Sigman (1977):

> "moose do not occupy a winter range randomly. Rather, their behavior can be termed a "strategy", which implies that individual animals exhibit consistent choices or preferences for habitat or food type. These preferences are influenced by environmental conditions."

In this study, snow conditions, habitats provided by strip cuts and clearcuts, and forage availability were identified as factors which could influence moose utilization of strip cuts and clearcuts. Each of these factors was studied and the interpretation of these results will be discussed here.

SNOW CONDITIONS

The deep snow and heavy crusting conditions which occurred in the winter of 1983 - 84 obviously limited the area which could be utilized by moose. Rainfall in mid February 1984 formed a nine centimetre ice crust and is the most plausible explanation why no moose were observed in either the strip cuts or clearcuts after February 6, 1984. The lack of deep snow and crusting conditions in the winter of 1984 - 85 allowed moose to utilize a greater variety of habitat types.

Snow depth is an important factor in the winter ecology of moose (Coady 1974). Snow depths below chest height increase resistance to movement, and snow depths greater than chest height stimulate considerable energy expenditure as moose are required to plough or bound through snow (Coady 1974). Moose move freely through snows up to 50 cm in depth, and may have movements restricted as depths reach 70 cm. In deep snow conditions, the energy required to travel while foraging can exceed the energy provided by the forage (Kelsall 1969).

Welsh (pers. comm.) inquired if strip cuts acted like snow fences, causing deeper snow in the harvested strips than would be normally encountered in clearcuts, resulting in avoidance of strip cuts in late winter. Snow in harvested strips is deeper than in uncut strips or natural forests, as the openings in the forest canopy effectively trap snow (Bay 1955, Hoover and Leaf 1967, Clausen and Mace 1972). Hoover (1971) noted that snow trapping was most effective in forest openings where turbulence occurred near the top of clearings with relatively calm air near the bottom. Increased wind turbulence against the uncut leave strips results in deposition of snow lodged in the forest canopy into the adjacent harvested strips.

In 1983 - 84, mean snow depths throughout the harvested strips exceeded 50 cm (average 63.37 cm) in mid winter, and reached depths of 76 cm; well within the range which could inhibit moose movements and restrict habitat utilization. Snow depths in the harvested strips in 1984 - 85 did not exceed 56 cm (average 49 cm). It is conceivable that the increased snow depths in a heavy snow year such as 1983 - 84 could cause moose to avoid alternate strip cuts.

No comparisons can be made between snow depths in clearcuts and strip cuts for the first winter as no snow depths were taken in the clearcuts. In 1984 - 85, snow depths were taken in both types of timber harvest and no significant differences were observed. This helps explain the similar number of moose in the strip cuts and clearcuts for 1984 - 85.

Deep snows and heavy crusting conditions in 1983 - 84 limited most moose activities in clearcut habitats to the 30 m influence zone and scattered residual strata, and were rarely observed in the open natural stratum. Other studies have also shown movement from open areas to heavy cover when snow depths exceed 50 cm (Berg 1971, Peek 1971b, Phillips et al. 1973, Welsh et al. 1980, Thompson and Vukelich 1981, Monthey 1984, Connor 1986) or when snow crusting conditions occurred (Macfie 1961, Telfer 1970, Berg 1971, Kelsall and Prescott 1971, Lynch 1975, Peek et al. 1976, Addison et al. 1980, McNicol and Gilbert 1980).

Less restrictive snow conditions during the winter of 1984 - 85 allowed moose to range over a variety of clearcut habitats for a longer period of time. Open habitats were used until early March and similar results were observed by Peek et al. (1974) and Brusnyk (1981). McNicol (1976) observed that clearcut utilization was almost 75% greater in a winter of low snow depth and favourable crusting conditions compared to a more severe winter. In McNicol's study, moose ranged widely in clearcuts in a winter with favorable snow conditions, and avoided dense conifer habitats.

Snow hardness (a measure of snow particle bonding) and snow density (weight per unit volume) affect animal mobility (Coady 1974) and may influence habitat selection (Peek et al. 1976). Snow hardness and densities measured in the strip cut and clearcut provided little to moderate support for moose, using Coady's (1974) and Kelsall and Prescott's (1971) observations for comparison.

Snow conditions also influence the mobility and effectiveness of wolves as predators (Mech et al. 1971) due to their short chest height (ca. 50 cm) and low weight on track area ratio (g/sq. cm) (Telfer and Kelsall 1984). Nasimovitch (1955, cited by Peterson and Allen 1974) observed that wolves sank up to their chest in light snow (densities approx. 0.21 g/cu. cm) and that pursuit became difficult when depths exceeded 40 cm in light snow. Upper snow layers with densities of 0.33 to 0.35 g/cu. cm have sufficient strength to support wolves.

Snow in the cut and leave strips was softer and deeper than that required by wolves for hunting, and did not seem to provide suitable travel conditions for them. In the strip cuts, wolf tracks were only observed on waterways or logging roads; common travel routes used to avoid deep, light snow (Mech et al. 1971). Snow conditions formed by the micro-climate in strip cuts appear to inhibit wolf travel and result in wolves avoiding these cuts.

Due to the limited snow condition data collected in the clearcuts, only restricted interpretation of these data can be made. Wolves used waterways and logging roads as travel routes, and did not appear to hesitate in venturing across large open areas, especially in late winter. Snow hardness and densities in the clearcut were slightly greater than those in the strip cuts, similar to the results observed by Kelsall and Prescott (1971). The lack of conifer cover and increased wind action in clearcuts may provide snow densities which support wolves when snow conditions are unsuitable for travel in the strip cuts.

UTILIZATION OF ALTERNATE STRIP CUTS

Strip cuts were not utilized as heavily as clearcuts in both winters. There are few other studies of winter use of strip cuts by moose (Eastman 1974, Stelfox et al. 1976), and therefore it is difficult to draw general utilization comparisons with this study.

The open natural (harvested strips) was the most preferred habitat stratum, and was used along with scattered residual patches for browsing. High utilization of harvested strips by mule deer (Odocoileus hemionus), white - tailed deer and elk (Cervus canadensis) have been observed by Wallmo (1969) and Stelfox et al. (1976). In this study, moose observed in the leave strips were most often bedded down, indicating that this habitat was being utilized for shelter. Stelfox et al. (1976)

found that 100 m wide strips provided adequate winter cover for ungulates; however, when the leave strips were finally harvested, the utility of the area as winter habitat declined.

Use of alternate strip cuts peaked in mid January in the winter of 1983-84, and in mid February in the winter of 1984-85. Eastman (1974) observed greatest use of partial cutover areas during early winter in heavy snowfall locations, and during late winter in lighter snowfall locations. Thus, the presence of deep snow conditions in strip cuts appears to determine monthly utilization by moose.

Alternate strip cuts appeared to be preferred by single cows and cows with calves in the winter of 1984 - 85, as they were the most observed social units. These social units are non gregarious, utilize remote habitats and do not aggregate with other moose (Peek et al. 1974, Rounds 1978, Addison et al. 1980, Novak 1981, and Thompson and Vukelich 1981). Often more than one cow with calf or lone cow were observed utilizing the same strip cut, although never in close proximity to the other animal(s).

The preference shown by cows and cow - calf groups for the alternate strip cuts may be a predator avoidance strategy. Stephens and Peterson (1984) suggest that moose seek winter conifer cover to avoid predators, and they and Mech (1966) found moose commonly used the physical habitat structure of conifer cover or windfalls when wolves were encountered to reduce exposure from attack. Wolf predation which is selective for calves can limit a moose population by reducing recruitment into the reproductive portion of the population (Wolfe 1974, Gasaway et al. 1983). Use of isolated habitats allow cows and calves to remain dispersed and more difficult to locate by predators (Peek et al. 1974, Thompson and Vukelich 1981).

Bergerud (1981) suggested winter habitat management for moose should emphasize protection from wolf predation, and not the provision of food and cover. He hypothesized that traditional clearcuts increased the opportunity for interactions between wolves and moose by concentrating the moose into the scattered pockets of residual timber. To manage habitat for protection against predation, Bergerud suggested:

1) Increase the search area of predators
2) Create habitats where snow conditions favour moose and not wolves
3) Provide food and cover in escape habitats for moose

The alternate strip cuts studied provided all of these conditions. The relative difficulty of travelling across narrow strips of cut and standing timber and the high edge to area ratio allowing moose to quickly retreat to cover make alternate strip cuts difficult to hunt, both for wolves and humans. The strip cuts produced snow depths and densities which apparently inhibited travel by wolves; however, heavy snowfall years may cause moose to abandon these areas. The intricate mosaic of cover and open areas allow moose to range over large areas, while utilizing both food and shelter. Thus, the heavy use of strip cuts by these social groups indicates this type of timber harvesting produces conditions suitable for dispersal and reduced interactions with other moose and predators.

When cows with calf moose were observed bedded in the strip cuts, often the cow would be located in the open harvested strip and the calf in the conifer leave strip. Distance between animals usually varied between 5 and 30 m, similar to winter bedding distances observed by Sigman (1977). Calves are vulnerable to energy loss from cold and wind because of their high surface area to volume ratio, (Sigman 1977, Renecker et al. 1978), and bedding in conifer areas reduces exposure to winds and utilizes the most stable thermal environment (Moen 1973).

Monthey (1984) stated that forest practices which produced large quantities of browse while maintaining winter cover would enhance moose habitat. As Thompson and Vukelich (1981) recommend that a portion of moose range be managed particularly for cows with calves, alternate strip cuts could be implemented to provide the habitat requirements for this social group. Alternate strip cuts should aid winter survival of pregnant cows and cows with calves by providing open browse producing areas and suitable conifer cover for protection from the winter elements and predation by wolves. If strip cuts allow increased survival potential for the reproductive segment of the population, then they may be a viable habitat management tool for attempting to increase localized moose populations.

UTILIZATION OF CLEARCUTS

Clearcuts received greater utilization than strip cuts by moose in both of the winters sampled. Moose utilization of the clearcuts declined as the winters progressed, with utilization peaking earlier during the more severe winter of 1983-84. Results from other studies indicate that moose activity in clearcuts decreases with the progression of winter (MacLennan 1975, Hunt 1976, Thomas and Oswald 1979 and Welsh et al. 1980). As in this study, peak utilization of clearcuts occurs later in low snow fall winters and earlier in more severe winters (Peek 1971b, Welsh et al. 1980).

Timber harvest intensity was inconsistent among the sampled clearcuts, necessitating the stratification of clearcuts into different habitat strata to determine utilization preferences. At first, moose utilization of clearcuts appeared to be related to the amount of residual timber left in the clearcut; however, correlation analysis disproved this. Moose activities were best explained by the proportion of 30 m influence zone stratum available in the clearcut, particularly in late winter. Clearcut use was inversely related to the proportion of open habitats. Intensively logged areas are not used by moose in the mid to late winter months (Macfie 1961, Welsh et al. 1980), with numerous studies indicating that such habitats are used only in early winter (Telfer 1970, Peek et al. 1976 and Thompson and Euler 1984). Thus, clearcuts with high edge to area ratios are the most valuable to moose in the winter period, and those with large amounts of open area are less suitable.

The differences in utilization levels between the Mott Lake clearcut (highest) and the Lever Lake clearcut (lowest) may best be explained by the availability of different habitats. The Mott Lake clearcut had the highest proportion of 30 m influence zone strata and one of the lowest proportions of open habitat strata, while these habitat proportions were reversed for the Lever Lake clearcut. This difference cannot be explained by the absence of moose in the Lever Lake study site, as the strip cuts were actively utilized by moose in both winters. The Mott Lake clearcut provided the greatest habitat diversity, with approximately equal proportions of major habitat types. This created opportunity for moose to utilize a number of proximate, different habitats throughout the course of a winter, thereby increasing it's attractiveness to moose.

The majority of clearcut habitat strata were utilized proportional to their availability. The dense conifer stratum was comprised of pockets or islands of unharvested conifer within the perimeter of the clearcut. Although tracks were observed, no moose were ever observed in this stratum during the study. This could be attributed to a sightability factor (Gasaway et al. 1978); however, when tracks were located in this habitat, a concerted search was made to determine if moose were present.

Use of dense conifer areas by moose is usually associated with movement to heavy cover in mid to late winter when snow depths increase (Telfer 1970, Chamberlin 1972, Phillips et al. 1973, Peek et al. 1976, Crete and Jordan 1982a). This habitat provides reduced wind velocities and snow depths, and moderates weather extremes (Telfer 1970, Peek et al. 1982). The use of clearcuts by moose may be dependent on the availability of dense conifer patches (Girard and Joyal 1984), although the use of these patches is influenced by the snow depth and structure in the surrounding open area (McNicol 1976, Monthey 1984). The greater use of this stratum in the second winter may result from the favourable snow conditions in the open areas, allowing moose to range through the clearcuts and utilize these patches.

The dense conifer stratum was not preferred for foraging. This habitat has a low abundance and diversity of browse species due to poor sunlight penetration to the forest floor for the establishment of deciduous browse species. Dense conifer habitats in this study were utilized for the shelter capacities, and not for browsing, similar to observations made by Phillips et al. (1973).

The open natural stratum was comprised of cutover area devoid of mature or semi - mature timber, and further than 30 m from dense conifer cover. Greatest use was observed in the second winter with utilization levels declining in late winter, which was later than the rapidly declining use observed in mid to late winter in 1983 - 84. Previously discussed studies have found that open cutover areas receive greater utilization by moose in early winter than in late winter.

Declining utilization of this habitat was concurrent with the formation of snow crusting conditions for both winters. Crusting conditions can influence habitat utilization in open areas regardless of snow depths (McNicol 1976, Peek et al. 1976, Hamilton et al. 1980). Thus, utilization of this habitat stratum appears to be influenced more by snow crusting conditions than by snow depth.

The scattered residual stratum was composed of scattered hardwoods which remained after the removal of merchantable conifers, and was the second most heavily utilized clearcut habitat. Other studies have found that this habitat is used mainly in early to mid winter (Hamilton and Drysdale 1975, McNicol and Gilbert 1980, Monthey 1984). Hamilton et al. (1980) observed that even sparse aggregations of trees influenced moose similar to dense cover. Although most studies have shown this habitat was preferred for browsing (Hamilton and Drysdale 1975, McNicol and Gilbert 1980), moose in this study avoided these habitats based on densities of browsed stems and pellet groups.

The open planted stratum consisted of areas which had been artificially regenerated to spruce or jackpine through planting or aerial seeding, and such areas are not preferred winter moose habitat (McNicol and Gilbert 1980, Peek et al. 1976). This stratum received proportional use over both winters, and was utilized more in the milder winter of 1984 - 85, a trend similar to Peek et al.'s (1976) study. They also noted that although pine plantations were used, these plantations may become progressively less favourable moose habitat as they mature because pine forests are not preferred winter moose habitat. Conifer plantations in the boreal forest of North America do not appear to receive the utilization of those in Scandinavia, where extensive damage is reported to Pinus spp. by browsing moose (Markgren 1974, Lavsund 1981, Strandgaard 1982).

The hardwood stratum consisted of partial stands of pure hardwood species which was used in early winter for browsing, and then abandoned as winter progressed. Telfer (1970) and Peek et al. (1976) found that moose preferred hardwood stands in the early winter period, and avoided these stands in late winter. Moose were located in this stratum until mid - January 1985, and may have used these areas in the late fall - early winter period of 1983-84 (and would not have been detected during the course of this study). Sigman (1976) cited several references of deepest snow conditions being observed in the mature hardwood stands, and felt that this habitat was selected for browse availability, and not for cover or energenic advantages. Therefore, moose use the hardwood habitats in the early winter as foraging sites, and move to other areas as snow depths increase in mid to late winter.

Not all of the habitat types in the clearcuts were utilized proportional to their availability. Moose avoided the swamp stratum, results similar to Peek et al. (1976) who observed that moose preferred upland areas to lowland areas. These areas may be avoided due to low browse densities (Hamilton and Drysdale 1975), high densities of poor quality browse species such as speckled alder (Hamilton and Drysdale 1975, Brusnyk 1981), or because these areas have early and deep snow accumulations (Stardom 1975, Darby and Pruitt 1984, Ranta et al. 1982). Based on these factors, lowland areas do not appear to provide suitable winter habitat for moose, either on a nutritional or energetic basis.

Moose preferred the 30 m influence zone, which is a unique habitat type as it is not a visibly identifiable entity, but instead an interaction between two distinct habitat types. The 30 m influence zone reaffirms the importance of the "edge" effect for moose. The edge formed by two adjoining habitat types is often more important to wildlife than either of the individual habitats (Dasmann 1964). The importance of the conifer edge area for moose habitat has been documented in a number of studies (Neu et al. 1974, Schoultz 1978, McNicol and Gilbert 1980, Brusnyk and Gilbert 1983) and most studies have indicated that moose prefer the edge area within 30 m of conifer cover (Hamilton and Drysdale 1975, Scaife 1980, Thompson and Vukelich 1981).

The 30 m influence zone stratum had the greatest use of all the clearcut habitat strata excluding browsing. Although it was not preferred for browsing in this study, Brusnyk (1981) observed the edge area had lower snow depths and allowed browsing adjacent to conifer cover when snow depths limited mobility in open cutovers. It is evident that moose actively seek out the "edge" area between dense conifer cover and open cutover, and in this study the 30 m influence zone was the most important habitat for moose utilizing clearcuts.

Adult bull moose were the most often observed social unit in the clearcuts, and prime adult bulls preferred the 30 m influence zone. Bull moose may use different habitats from cows or cows with calves due to larger home ranges and higher mobility (Bonar 1983), and bulls have been observed to be twice as numerous in extensive cutovers (Girard and Joyal 1984). Peek et al. (1976) observed that adult bulls outnumbered yearling bulls by as much as 14 times in edge habitats within 30 m of dense conifer cover. Preference for this habitat stratum by adult bull moose may indicate that these areas are sought out by dominate males as select prime wintering areas, as theorized by Peek et al. (1974).

Adult cows used a variety of clearcut habitats, although usually those associated with some sort of cover. Adult cow moose use localized cover associated habitats in the winter months (Peek et al. 1976, Addison et al. 1980), and do not favour extensive open cutovers (Girard and Joyal 1984, Payne et al. 1987).

Cows with calves were the second most observed social group in the clearcuts, and were most often located in the 30 m influence zone. These results are analogous to those observed by Thompson and Vukelich (1981), who found cows with calves were an average distance from cover of 27 m in early winter and 12 m in late winter. Most of the cow calf groups observed using this stratum were located in the periphery edge around the clearcut, and rarely in the edge area around conifer islands or patches, similar to observations by McNicol (pers. comm.) and Payne et al. (1987). Although conifer island areas may produce suitable edge area for other social groups, some component is apparently lacking for the use of these areas by the cow - calf social unit. McNicol (1976) and Novak (1981) observed that cows with calves avoided open cutover areas, as did this study. From the results observed and cited, cows with calves most often utilize areas within close proximity to dense conifer in clearcuts, particularly in the periphery area of the cutover.

Aggregations of three or more moose (excluding cow - calf pairs) were only observed in the clearcuts, and were most prevalent during the winter of 1983- 84. Peek et al. (1974) defined aggregations as a group of animals within a reasonable proximity to each other, and have been explained as a response to snow conditions, predation, vegetative cover and seasonal variations in food supply (Peek et al. 1974, Rounds 1978). Moose observed in this study aggregated in early winter, and became more solitary as the winter progressed, findings similar to other studies (Berg and Phillips 1972, Thomas and Oswald 1979, Novak 1981, Bonar 1983). Peek et al. (1974) concluded early winter aggregations allowed access to high quality browse areas, perhaps by replacing the role of vegetative cover for individuals and providing inducement to use these open habitats (Crook 1970, as cited by Peek et al. 1974).

Moose aggregated most often in the winter which had the deepest snow conditions. Peek et al. (1974) felt that snow depths were not as important in causing moose to aggregate in boreal forest regions as in mountain areas; however, Novak (1981) reported that a rapid accumulation of snow in late winter reversed the trend of decreasing group size. Thus, aggregations of moose appear to be a function of snow conditions as well as the period of winter.

Winter moose utilization of clearcuts in this study is similar to that observed in numerous other studies. Clearcuts are not avoided during the winter months; however, preference, avoidance or seasonal utilization of individual habitats within the clearcuts was observed. The most important result of this research project has been the distinction of the 30 m influence zone strata. Therefore, clearcuts planned in a manner providing maximum interspersion of conifer cover and open habitats (through irregular cut boundaries or maintenance of suitable conifer islands) should allow moose to utilize greater proportions of these areas.

BROWSE UTILIZATION AND PREFERENCES

Sampling for browse utilization was conducted only once, following the winter of 1983 - 84. The browse availability calculations in strip cuts and clearcuts are not impacted by this; however, utilization results could be influenced by the snow and weather conditions observed in the winter of 1983 - 84. Therefore, all browse utilization results must be interpreted as those for that winter only, and not for comparison between the two winters.

Densities of available browse species were significantly higher in the clearcuts than in the strip cuts. Highest browse densities were observed in the swamp and scattered residual strata in the strip cuts and the 30 m influence zone, scattered residual and hardwood strata in the clearcuts. McNicol and Gilbert (1980) observed highest densities of available browse stems in the scattered residual, dense conifer, open natural and open planted clearcut habitats respectively, however; densities were lower than those observed in this study. Scattered residual habitats have high browse densities due to an open residual canopy and disturbed ground surfaces which promote browse establishment (Hamilton and Drysdale 1975). Hardwood stands had the highest densities of browse stems in Armstrong's (1983) study and are selected for food availability until snow depth prevent use of these areas (Sigman 1977).

Clearcuts produced significantly more available browse than did the strip cuts. Habitats producing less than 20 kg/ha of winter browse are considered to be below the optimum range required by moose (Wolff 1980), and productive, high quality moose habitats produce between 100 - 150 kg/ha of winter browse (Strangaard 1982). All study areas sampled produced over 100 kg/ha of browse except the Buzzer Lake strip cut and browse production in all but the dense conifer habitat strata was approximately 100 kg/ha. Therefore, all but one study site can be considered as highly productive browse producing sites, and all sites and habitat strata produced more than the minimum level of browse required by moose.

Browse production was negatively correlated with the time since harvest, with highest production after seven years for both types of cuts. Browse production levels in both Stone's (1977) and Parker and Morton's (1978) studies of clearcuts were approximately equal to the levels observed in this study, and peaked at seven and eight years respectively. Research by Telfer (1972) and Bedard et al. (1978) found that forage production peaked between 10 - 12 years after harvest. Thus, the optimum period for browse production on a cutover site appears to be between 8 - 12 years.

There was no significant correlation between available browse production and utilization levels by moose in both the strip cuts and clearcuts, and for all habitat strata. Correlations were poor and often negative, and are in contrast to the findings of a number of other studies (Telfer 1978, Brassard et al. 1974, Kearney 1975, Irwin 1975, Crete 1976, Schoultz 1978). However, studies by Brusnyk (1981) and Crete and Jordan (1982b) found moose observations were not directly related to browse availability. In Telfer's (1978) study, a study block which had medium browse production but no cover was not utilized by moose. The Lever Lake clearcut (which had the least residual conifer cover) had the highest browse densities and production, yet received the least winter utilization. As utilization levels were strongly related to the amount of area within 30 m of coniferous cover and not forage production, moose apparently prefer shelter proximate to browse in the winter months, which is an important habitat management consideration.

Browsed stem densities were significantly greater in the clearcuts than in the strip cuts, with low overall utilization (< 6.5 %) observed in both types of cuts. Crete and Jordan (1982a) found that moose rarely browsed on more than 10 percent of the available browse. Browse consumed (kg/ha) in this study was far below that observed by Wolff (1976) and Bedard et al. (1978). Low utilization of browse in this study may be related to snow conditions and the severity of the 1983 - 84 winter. Peek et al. (1976) observed highest browse utilization during mild winters, and lowest utilization after a severe winter which confined moose to dense conifer.

In the strip cuts, the open natural strips and scattered residual strata had significantly higher densities of browsed stems and the highest amount of forage removed by moose. Wallmo et al. (1972) observed that mule deer spent most of their time in harvested strips, and obtained 70% of their forage from these areas. Although the scattered residual patches were utilized proportional to their availability, the fact that high quantities of browse was consumed indicates these patches were used in the late fall - early winter prior to data collection. The swamp stratum had the highest densities and production of available browse, and was avoided for feeding, indicating that lowland shrub species such as alder are not desirable browse and may cause moose to avoid such areas (Hamilton and Drysdale 1975).

In the clearcuts, the open natural, open planted and hardwood strata had the highest browsed stem densities and the open planted and open natural had the greatest amount of forage removed. Moose use open areas with high forage production for feeding during early winter periods (Peek et al. 1976, Crete and Jordan 1982a). Low utilization levels of these habitats were observed during the winter of 1983 - 84, suggesting that browse utilization occurred in the late fall - early winter, prior to data collection. Snow depths and conditions during this winter may have prevented moose from extensively utilizing these areas for browsing in mid to late winter.

The 30 m influence zone and dense conifer strata in the clearcuts had fewer than expected densities of browsed stems. Similar results were observed by Wolfe (1980), who observed browsing by moose was reduced in the edge area and not observed in closed canopied stands. Scaife (1980) found significantly more browsed twigs in the inner quadrats of large clearcuts. Although the 30 m influence zone had less than expected browsed stem densities, the amount of forage removed was proportional to its availability. This would indicate that although moose browsed fewer stems than expected, they removed enough forage from these stems to remain within the expected utilization range.

Red osier dogwood was a preferred species in both types of cuts, and was the most available and heavily utilized species in the strip cuts. It is generally considered to be an early winter browse species, as availability decreases when snow depths greater than one metre cover the stems (Peek 1974, Peek et al. 1976, Thompson and Vukelich 1981, Florkiewicz 1984). Early seasonal utilization corresponds with the stem's reddening as starches decrease and sugar concentrations increase (Peek et al. 1976 citing Li et al. 1965). Thompson and Vukelich (1981) observed that red osier dogwood was the most preferred species of browse for cows with calves in early winter. These references and observations made in this study strongly indicate that the strip cuts studied provided suitable browse for cows with calves, and that these areas were utilized in the winter of 1983 - 84 prior to aerial reconnaissance. The shallower snow depths observed in the winter of 1984 - 85 would have made red osier dogwood more available than the previous winter, and may explain the increased observations of cows with calves in the strip cuts.

White birch was the most heavily utilized species in the clearcuts, and the second most utilized species in the strip cuts, and is a staple browse species for moose throughout North America (Peek 1974). It has been highly utilized in a number of other studies (LeResche and Davis 1973, McNicol 1976, Peek et al. 1976, Oldemeyer 1983) and the heavy use of white birch in this study supports these observations.

Mountain ash was a highly preferred and heavily utilized species, similar to results observed in other studies (McNicol 1976, McNicol et al. 1980, Thompson and Vukelich 1980, Brusnyk 1981). Mountain ash has high crude protein levels and low crude fibre levels, and browsing by moose is positively correlated with the former, and negatively correlated with the latter (McNicol 1976, Hjeljord et al. 1982). Thus, the chemical components of mountain ash appear to make it a highly preferred browse species for moose.

Pin cherry was the third most utilized browse species in the clearcuts and the fourth most utilized species in the strip cuts. Other browse utilization surveys in Ontario have found that pin cherry was the third to fourth most utilized browse species in clearcuts (McNicol 1976, McNicol et al. 1980, Brusnyk 1981, Thompson and Vukelich 1981). Peterson (1955) noted that pin cherry is often heavily browsed, and is a preferred species in all seasons. Utilization levels of pin cherry in this study indicate that it continued to be an important browse species in both types of cuts.

Trembling aspen was not a preferred food species, yet it was a consistently used browse species, similar to results observed by McNicol (1976). Trembling aspen browse is utilized primarily in mid to late winter (Thompson and Vukelich 1981, Oldemeyer 1983), probably as it's height makes it more available than other browse species during deep snow periods (Peek et al. 1976). Trembling aspen was predominately used in the open planted stratum, where it's high availability was most probably result of suckering occurring after scarification of the sites (Scaife 1980).

Mountain maple was a highly utilized and a preferred species in the clearcuts, but was not utilized in the strip cuts. This species is heavily utilized in early winter (Peek et al. 1976, Thompson and Vukelich 1981), and had highest use in the hardwood stratum. These references and results further support the previous discussion that this habitat is used for early winter foraging, and abandoned as snow depths increase.

Willows, beaked hazel, and balsam fir were not important browse species in this study. Willow has been observed as an important browse species in other studies (McNicol 1976, Peek et al. 1976, Brusnyk 1981). It may become unavailable as snow depths exceed 70 cm (McNicol 1976), and the deep snow in the winter of 1983 - 84 may explain the low utilization observed. Beaked hazel is considered to be an important forage for moose

(Trottier 1981), and is usually utilized during deep snow periods when other foods are restricted (McNicol 1976, Peek et al. 1976). Low availability may have contributed to a lack of utilization in this study. Balsam fir is a late winter forage for moose (Peek et al. 1976), and is an especially important browse species in eastern North America (Peek 1974). Although it is heavily utilized in some parts of Ontario (Peterson 1955, Thompson and Vukelich 1981), it is not an important browse species on logged areas near Thunder Bay (Hamilton and Drysdale 1974, McNicol 1976, McNicol et al. 1980).

The results of this study have indicated that although the study areas provided more than sufficient amounts of winter forage to sustain moose populations, browse alone did not influence habitat selection to any great extent. It does not appear that browse is a limiting factor to moose in this study.

FOREST MANAGEMENT IMPLICATIONS

Although there have been many studies regarding moose utilization of clearcuts in Ontario, there have been few studies regarding the use of habitat reserves left specifically for moose. Alternate strip cuts have been recommended by a number of authors as a habitat management technique for maintaining moose habitat, yet there have been no direct studies undertaken to assess the amount of use or importance of these areas to local moose populations. Results from this study indicate that alternate strip cuts may provide the mid to late winter habitat requirements of cows and cows with calves, possibly as a predator avoidance strategy. Clearcut areas were occupied by moose over the entire winter, with specific habitats influencing levels of utilization. The amount of edge area between dense conifer and open areas had the strongest correlation with utilization levels, and these areas may be selected as prime wintering areas.

From the results observed in this study, the following recommendations for moose habitat management can be made:

1) The results of this study indicate that strip cuts are not a panacea for moose habitat management. However, strip cuts on upland sites can be used to provide the habitat requirements for moose, particularly for the reproductive social units. If this type of cutting allows increased survival potential of the reproductive social units through reduced exposure to predators, it would not be unreasonable to assume that localized populations may increase. It must be recognized that in heavy snowfall years, use of these areas may be precluded by deep snows, however; orientation of strip cuts parallel to prevailing winds may ameliorate this problem.

2) During the timber management planning process, habitat reserves for moose in proposed clearcuts should be implemented in a manner which maximizes the interspersion of open areas with patches of suitable conifer (ie. - not treed muskeg or swamp). Clearcut size and browse production do not appear to be critical factors if sufficient conifer shelter promoting high edge to area ratios are left on the site. This is well illustrated by the almost non existent utilization observed on the Lever Lake clearcut, which had the smallest cutover area, the highest available browse production, and the least availability of residual conifer shelter. Thus, clearcuts designed to maximize the conifer edge to area ratio should provide suitable winter moose habitat.

3) In clearcuts where moose habitat reserves have been implemented and herbicide tending is proposed, a 50 m "no - spray" buffer zone should be implemented adjacent to the reserve. As moose preferred the edge area between conifer and open habitats, this would maintain browse species for utilization by moose in the mid to late winter period. Such a buffer zone would allow the achievement of both forest management and wildlife management program objectives, and is operationally feasible with the increased use of helicopters for aerial herbicide applications.

Research projects of this type often generate as many new questions as answers. The following areas require further research in order to more completely understand the observations made in this study:

1) A long term study of winter wolf movements through alternate strip cut and clearcut areas in the winter period is required, with particular emphasis on the relationship between movement patterns and the associated snow conditions in each type of cut.

2) Although enough data were collected in this study to make generalized conclusions, more information is required to definitely prove that use of alternate strip cuts by cows with calves and lone adult cows is a predator avoidance strategy.

3) A further study of the value of strip cuts as moose habitat after the leave strips have been removed is needed to determine if the conifer regeneration established in the harvested strips provides suitable winter cover for moose. The strip cuts at Mott Lake will have the leave strips harvested in the 1988 - 89 Annual Work Schedule period, and would provide a suitable study site for such a project.

SUMMARY

The purpose of this study was to compare the winter utilization of alternate strip cuts and clearcuts by moose, and to determine the influence of habitat types, browse availability, snow conditions and predation on utilization levels. Moose utilization of clearcuts was greater than utilization of strip cuts in both winters. Browse production levels were more than sufficient to sustain moose populations in both types of cuts; however, no significant correlations were observed between browse availability and moose utilization. While no direct comparison of snow depths and conditions was made between the two types of timber harvest, deep snows and heavy crusting conditions in mid winter 1983 - 84 restricted moose movements, while shallower snows and late winter crusting conditions allowed greater mobility in the following winter. No evidence of poaching nor predation was observed in either winter in the study areas, however; it was observed that wolves travelled freely throughout the clearcuts but did not venture through alternate strip cuts.

The alternate strip cuts were used primarily by the reproductive segment of the population, cows with calves and lone cows, while clearcuts were preferred by bulls. Utilization of the alternate strip cuts by these solitary and non-gregarious social units could be a predator avoidance response. Strip cuts

provide a good interspersion between foraging habitats and escape cover, and snow conditions which did not facilitate travel by wolves. Bull moose most often utilized the areas within 30 m of dense conifer cover in the clearcuts and were predominately prime bulls. Early winter aggregations of three or more moose were only observed in the clearcuts, and appeared to be a function of snow depths and conditions.

In the alternate strip cuts, the open harvested strips received greatest utilization, although pockets of scattered residual in the harvested strips were utilized for browsing. Microclimactic conditions in the alternate strip cuts facilitate the accumulation of deep soft snow in the harvested strips which may inhibit moose mobility in high snowfall winters. Such conditions were apparent in the winter of 1983 - 84, with snow depths in the harvested strips exceeding the critical depth of 70 cm. Heavy utilization of an early winter browse species, red osier dogwood, indicates that the alternate strip cuts were used prior to data collection in late fall - early winter, and were abandoned as snow depths increased. Less than critical snow accumulations the following winter best explain the tenfold increase in moose located in the alternate strip cuts from the winter of 1983 - 84. Snow depths and conditions observed in the alternate strip cuts appeared to prevent the establishment of travel routes by wolves, as wolf tracks were only observed on road or creek systems. If alternate strip cuts provide the food and cover requirements for the reproductive segment of the population and offer protection from predators, then this timber harvest technique is a viable management technique for the maintenance of moose habitat and possibly populations.

Although moose did not avoid clearcuts in the winter months, preference, avoidance, and seasonal utilization of the individual habitats of clearcut habitats was observed. Clearcuts were most heavily used in early winter, with utilization levels decreasing as the winter progressed. Snow conditions influenced the use of clearcuts, with greatest activity observed in the winter of least snow accumulation, and open habitats were avoided commencing with the occurrence of heavy crusting conditions. Moose utilization of the clearcuts in this study was a function of the amount of edge area within 30 m of coniferous cover, and not a function of the clearcut size or browse availability. Thus, clearcuts which maximize the edge to area ratio through the interspersion between open harvested areas and suitable dense conifer shelter should maintain moose habitat.

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APPENDICIES

APPENDIX I: OBSERVATIONS MADE IN BOTH ALTERNATE STRIP CUTS AND CLEARCUTS

TABLE 1: Number of moose observed in all strip cuts and clearcuts sampled (1983 - 1984).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF MOOSE OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
STRIP CUT	1213.54	0.476	3	12	0.115	0 < P1 < .255	-
CLEARCUT	1334.44	0.524	23	14	0.885	.744 < P2 < 1.00	+
TOTAL	2547.98		26				

$X^2 = 12.54$ (P<0.05, 1 d.f.= 3.84)

TABLE 2: Number of moose observed in all strip cuts and clearcuts sampled (1984 - 1985).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF MOOSE OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)
STRIP CUT	1585.57	0.509	31	31		No significant differences
CLEARCUT	1526.70	0.491	30	30		observed.
TOTAL	3112.27					

$X^2 = 0.0274$ (P<0.05, 1 d.f.=3.84)

TABLE 3: Number of track aggregates observed in all strip cuts and clearcuts sampled (1983 - 1984).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF TRACK AGGREGATES OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
STRIP CUT	1213.54	0.476	99	142	0.331	.271 < P1 < .392	-
CLEARCUT	1334.44	0.524	200	157	0.669	.608 < P2 < .730	+
TOTAL	2547.98		299				

X2 = 24.78 (P<0.05, 1 d.f.= 3.84)

TABLE 4: Number of track aggregates observed in all strip cuts and clearcuts sampled (1984 - 1985).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF TRACK AGGREGATES OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
STRIP CUT	1585.57	0.509	274	341	0.408	.365 < P1 < .451	-
CLEARCUT	1526.70	0.491	397	330	0.592	.549 < P2 < .635	+
TOTAL	3112.27		671				

$X^2 = 27.17$ (P<0.05, 1 d.f. = 3.84)

TABLE 5: Area of track aggregates observed in all strip cuts and clearcuts sampled (1983 - 1984).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AREA OF TRACK AGGREGATES OBSERVED	EXPECTED AREA	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
STRIP CUT	1213.54	0.476	39.93	64.36	0.295	.133 < P1 < .457	-
CLEARCUT	1334.44	0.524	95.28	70.85	0.705	.601 < P2 < .810	+
TOTAL	2547.98		135.21				

$X^2 = 17.70$ (P<0.05, 1 d.f.= 3.84)

TABLE 6: Area of track aggregates observed in all strip cuts and clearcuts sampled (1984 - 1985).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AREA OF TRACK AGGREGATES OBSERVED	EXPECTED AREA	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
STRIP CUT	1585.57	0.509	121.38	159.46	0.359	.261 < P1 < .456	-
CLEARCUT	1526.70	0.491	191.90	153.82	0.641	.563 < P2 < .719	+
TOTAL	3112.27		313.28				

X2 = 18.52 (P<0.05, 1 d.f. = 3.84)

TABLE 7: Densities of available browse species stems in all strip cuts and clearcuts sampled.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF BROWSE STEMS /HA OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
STRIP CUT	1368.75	0.53	7146	8372	0.455	.446 < P1 < .463	-
CLEARCUT	1227.52	0.47	8566	7385	0.545	.536 < P2 < .553	+
TOTAL	2596.27		15712				

$X^2 = 356.33$ (P<0.05, 1 d.f.= 3.84)

TABLE 8: Densities of browsed stems in all strip cuts and clearcuts sampled.

STRATA	AVAILABLE BROWSE (stems/ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF BROWSED STEMS /HA OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
STRIP CUT	7146	.455	181	258	0.320	.276 < P1 < .364	-
CLEARCUT	8566	.545	387	310	0.680	.636 < P2 < .724	+
TOTAL	15712		568				

$X^2 = 42.11$ (P<0.05, 1 d.f.= 3.84)

TABLE 9: Amount of forage produced (kg/ha) in all strip cuts and clearcuts sampled.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AMOUNT OF FORAGE PRODUCED (kg/ha)	EXPECTED AMOUNT	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
STRIP CUT	1368.75	0.53	136.96	164.61	0.441	.379 < P1 < .504	-
CLEARCUT	1227.52	0.47	173.62	145.97	0.559	.495 < P2 < .622	+
TOTAL	2596.27		310.58				

X2 = 9.88 (P<0.05, 1 d.f.= 3.84)

TABLE 10: Amount of forage consumed (kg/ha) in all strip cuts and clearcuts sampled.

STRATA	TOTAL FORAGE PRODUCED (kg/ha)	PROPORT. TOTAL AREA (Pio)	AMOUNT OF FORAGE CONSUMED (kg/ha)	EXPECTED AMOUNT	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)
STRIP CUT	136.96	0.45	2.87	4.58		No significant differences observed.
CLEARCUT	167.79	0.55	7.31	5.60		
TOTAL	304.75		10.18			

$X^2 = 1.161$ (P<0.05, 1 d.f.= 3.84)

TABLE 11: Densities of pellet groups observed in all strip cuts and clearcuts sampled.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF PELLET GROUPS /HA OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)
STRIP CUT	1368.75	0.53	13	19		No significant differences observed.
CLEARCUT	1227.52	0.47	22	16		
TOTAL	2596.27		35			

$X^2 = 3.53$ (P<0.05, 1 d.f.= 3.84)

APPENDIX II: OBSERVATIONS MADE IN ALTERNATE STRIP CUTS.

TABLE 1: Number of moose observed in strip cut strata (1984 - 1985) (Transformed data).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF MOOSE OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	720.89	0.455	24	16	0.686	.488 < P1 < .883	+
DENSE CONIFER	827.80	0.523	5	18	0.142	0 < P2 < .291	-
SCATTERED RESIDUAL	15.80	0.009	5	1	0.142	0 < P3 < .291	0
SWAMP	18.58	0.012	1	1	0.030	0 < P4 < .103	0
TOTAL	1582.99		35				

$X^2 = 83.03$ (P<0.05, 3 d.f.= 7.81)

TABLE 2: Number of track aggregates observed in strip cut strata (1983 - 1984).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF TRACK AGGREGATES OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	500.50	0.413	72	41	0.727	.614 < P1 < .840	+
DENSE CONIFER	691.78	0.571	24	56	0.243	.134 < P2 < .351	-
SCATTERED RESIDUAL	8.62	0.006	1	1	0.010	0 < P3 < .035	0
SWAMP	11.47	0.010	2	1	0.010	0 < P4 < .055	0
TOTAL	1212.37		99	99			

$X^2 = 42.72$ (P<0.05, 3 d.f.= 7.58)

TABLE 3: Number of track aggregates observed in strip cut strata (1984 - 1985).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF TRACK AGGREGATES OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	720.89	0.455	230	125	0.839	.783 < P1 < .894	+
DENSE CONIFER	827.80	0.523	33	143	0.120	.071 < P2 < .169	-
SCATTERED RESIDUAL	15.80	0.009	6	2	0.022	0 < P3 < .044	0
SWAMP	18.58	0.012	5	4	0.019	0 < P4 < .040	0
TOTAL	1582.99		274	274			

$X^2 = 181.07$ (P<0.05, 3 d.f.= 7.58)

TABLE 4: Area of track aggregates observed in strip cut strata (1983 - 1984).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AREA OF TRACK AGGREGATES OBSERVED	EXPECTED AREA	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	500.50	0.413	30.45	16.10	0.781	.614 < P1 < .948	+
DENSE CONIFER	691.78	0.571	7.63	22.26	0.196	.036 < P2 < .356	-
SCATTERED RESIDUAL	8.62	0.006	0.62	0.24	0.016	0 < P3 < .067	0
SWAMP	11.47	0.010	0.29	0.39	0.007	0 < P4 < .041	0
TOTAL	1212.37		38.99	38.99			

$X^2 = 23.03$ (P<0.05, 3 d.f.= 7.58)

TABLE 5: Area of track aggregates observed in strip cut strata (1984 - 1985).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AREA OF TRACK AGGREGATES OBSERVED	EXPECTED AREA	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	720.89	0.455	103.89	55.04	0.859	.779 < P1 < .939	+
DENSE CONIFER	827.80	0.523	15.18	63.27	0.125	.049 < P2 < .201	-
SCATTERED RESIDUAL	15.80	0.009	1.25	1.09	0.010	0 < P3 < .033	0
SWAMP	18.58	0.012	0.65	1.45	0.006	0 < P4 < .024	0
TOTAL	1582.99		120.97	120.97			

$X^2 = 80.37$ (P<0.05, 3 d.f.= 7.58)

TABLE 6: Number of available browse stems per hectare observed in strip cut strata.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF AVAILABLE STEMS / HA OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	635.97	.465	6987	16494	0.196	.191 < P1 < .201	-
DENSE CONIFER	698.35	.510	1730	18090	0.049	.046 < P2 < .052	-
SCATTERED RESIDUAL	15.80	.012	8421	426	0.237	.231 < P3 < .243	+
SWAMP	18.01	.013	18333	461	0.517	.511 < P4 < .524	+
TOTAL	1368.13		35471	35471			

$X^2 = 863182$ (P<0.05, 3 d.f.= 7.81)

TABLE 7: Densities of browsed stems observed in strip cut strata.

STRATA	AVAILABLE BROWSE (stems/ha)	PROPORT. TOTAL (Pio)	NUMBER OF BROWSED STEMS / HA OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	6987	.196	250	150	0.328	.285 < P1 < .371	+
DENSE CONIFER	1730	.049	29	37	0.038	.021 < P2 < .055	0
SCATTERED RESIDUAL	8421	.237	316	181	0.415	.371 < P3 < .460	+
SWAMP	18333	.517	167	394	0.219	.182 < P4 < .256	-
TOTAL	35471		762	762			

$X^2 = 299.9$ (P<0.05, 3 d.f.= 7.81)

TABLE 8: Amount of available forage (kg / ha) produced in the strip cut strata.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AMOUNT OF FORAGE PRODUCED KG / HA	EXPECTED AMOUNT	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	635.97	.465	98.44	125.22	0.366	.292 < P1 < .440	-
DENSE CONIFER	698.35	.510	19.57	137.34	0.072	.032 < P2 < .112	-
SCATTERED RESIDUAL	15.80	.012	101.16	3.23	0.376	.302 < P3 < .450	+
SWAMP	18.01	.013	50.12	3.50	0.186	.126 < P4 < .246	+
TOTAL	1368.13		269.29	269.29			

$X^2 = 3696$ (P<0.05, 3 d.f.= 7.81)

TABLE 9: Amount of forage consumed (kg / ha) in the strip cut strata.

STRATA	TOTAL FORAGE PRODUCED (kg/ha)	PROPORT. TOTAL (Pio)	AMOUNT OF FORAGE CONSUMED (kg/ha)	EXPECTED AMOUNT	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)
OPEN NATURAL	98.44	.366	3.31	3.17	0.383	
DENSE CONIFER	19.57	.072	0.50	0.63	0.058	No Significant
SCATTERED RESIDUAL	101.16	.237	4.63	3.25	0.535	Differences Observed
SWAMP	50.12	.516	0.21	0.11	0.024	
TOTAL	269.29		8.65	8.65		

$X^2 = 1.84$ (P<0.05, 3 d.f.= 7.81)

TABLE 10: Number of pellet groups per hectare observed in strip cut strata (Transformed data).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF PELLET GROUPS / HA	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	635.97	.465	13	36	0.169	.062 < P1 < .276	-
DENSE CONIFER	698.35	.510	12	39	0.156	.053 < P2 < .259	-
SCATTERED RESIDUAL	15.80	.012	51	1	0.662	.527 < P3 < .797	+
SWAMP	18.01	.013	1	1	0.013	0 < P4 < .045	0
TOTAL	1368.13		77	77			

$X^2 = 2533.4$ ($P<0.05$, 3 d.f.= 7.81)

APPENDIX III: OBSERVATIONS MADE IN CLEARCUTS.

TABLE 1: Number of moose observed in clearcut habitat strata (1983 - 1984) (Transformed data).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF MOOSE OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	253.63	0.190	4	6	0.133	0 < P1 < .300	0
OPEN PLANTED	219.27	0.164	1	5	0.033	0 < P2 < .121	-
INFLUENCE ZONE	183.60	0.138	15	4	0.500	.254 < P3 < .746	+
DENSE CONIFER	148.30	0.110	1	3	0.033	0 < P4 < .121	0
SCATTERED RESIDUAL	365.32	0.273	7	8	0.233	.025 < P5 < .441	0
HARDWOOD	91.06	0.068	1	2	0.033	0 < P6 < .121	0
SWAMP	73.11	0.055	1	2	0.033	0 < P7 < .121	0
TOTAL	1334.29		30	30			

$X^2 = 36.58$ ($P<0.05$, 6 d.f.= 12.59)

TABLE 2: Number of moose observed in clearcut habitat strata (1984 - 1985) (Transformed data).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF MOOSE OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	353.65	0.232	4	9	0.108	0 < P1 < .246	0
OPEN PLANTED	219.27	0.144	3	5	0.081	0 < P2 < .202	0
INFLUENCE ZONE	223.23	0.146	15	5	0.405	.189 < P3 < .624	+
DENSE CONIFER	160.01	0.105	1	4	0.027	0 < P4 < .099	-
SCATTERED RESIDUAL	388.05	0.254	9	10	0.243	.052 < P5 < .434	0
HARDWOOD	95.10	0.062	4	2	0.108	0 < P6 < .246	0
SWAMP	87.15	0.057	1	2	0.027	0 < P7 < .099	0
TOTAL	1526.46	1526.46	37	37			

$X^2 = 24.20$ ($P<0.05$, 6 d.f.= 12.59)

TABLE 3: Number of track aggregates observed in clearcut habitat strata (1983 - 1984).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF TRACK AGGREGATES OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	253.63	0.190	34	38	0.170	.098 < P1 < .242	0
OPEN PLANTED	219.27	0.164	27	33	0.135	.069 < P2 < .201	0
INFLUENCE ZONE	183.60	0.138	55	28	0.275	.189 < P3 < .361	+
DENSE CONIFER	148.30	0.110	29	20	0.145	.077 < P4 < .213	0
SCATTERED RESIDUAL	365.32	0.273	44	56	0.220	.141 < P5 < .299	0
HARDWOOD	91.06	0.068	6	14	0.030	0 < P6 < .063	-
SWAMP	73.11	0.055	5	11	0.025	0 < P7 < .055	-
TOTAL	1334.29		200	200			

$X^2 = 42.88$ ($P<0.05$, 6 d.f.= 12.59)

TABLE 4: Number of track aggregates observed in clearcut habitat strata (1984 - 1985).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF TRACK AGGREGATES OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	353.65	0.232	99	92	0.249	.191 < P1 < .308	0
OPEN PLANTED	219.27	0.144	31	57	0.078	.041 < P2 < .114	-
INFLUENCE ZONE	223.23	0.146	114	58	0.278	.225 < P3 < .348	+
DENSE CONIFER	160.01	0.105	31	38	0.078	.041 < P4 < .114	0
SCATTERED RESIDUAL	388.05	0.254	94	104	0.237	.179 < P5 < .295	0
HARDWOOD	95.10	0.062	9	25	0.023	.003 < P6 < .043	-
SWAMP	87.15	0.057	19	23	0.048	.019 < P7 < .077	0
TOTAL	1526.46	1526.46	397	397			

$X^2 = 79.65$ (P<0.05, 6 d.f.= 12.59)

TABLE 5: Area of track aggregates observed in clearcut habitat strata (1983 - 1984).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AREA OF TRACK AGGREGATES OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	253.63	0.190	22.18	18.10	0.232	.115 < P1 < .349	0
OPEN PLANTED	219.27	0.164	12.22	15.62	0.128	.035 < P2 < .221	0
INFLUENCE ZONE	183.60	0.138	18.14	9.62	0.190	.081 < P3 < .299	0
DENSE CONIFER	148.30	0.110	8.35	13.15	0.088	.009 < P4 < .167	0
SCATTERED RESIDUAL	365.32	0.273	28.63	27.06	0.300	.173 < P5 < .427	0
HARDWOOD	91.06	0.068	4.18	6.49	0.044	0 < P6 < .101	0
SWAMP	73.11	0.055	1.52	5.24	0.017	0 < P7 < .053	-
TOTAL	1334.29		95.28	95.28			

$X^2 = 14.43$ (P<0.05, 6 d.f.= 12.59)

TABLE 6: Area of track aggregates observed in clearcut habitat strata (1984 - 1985).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AREA OF TRACK AGGREGATES OBSERVED	EXPECTED AREA	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	353.65	0.232	53.36	44.52	0.278	.191 < P1 < .366	0
OPEN PLANTED	219.27	0.144	18.96	27.63	0.099	.041 < P2 < .158	0
INFLUENCE ZONE	223.23	0.146	52.39	28.02	0.273	.186 < P3 < .360	+
DENSE CONIFER	160.01	0.105	13.27	18.42	0.069	.019 < P4 < .119	0
SCATTERED RESIDUAL	388.05	0.254	44.97	50.47	0.234	.151 < P5 < .317	0
HARDWOOD	95.10	0.062	3.58	11.90	0.019	0 < P6 < .046	-
SWAMP	87.15	0.057	5.37	10.94	0.028	0 < P7 < .060	-
TOTAL	1526.46	1526.46	191.90	191.90			

$X^2 = 36.63$ (P<0.05, 6 d.f.= 12.59)

TABLE 7: Number of available browse stems per hectare observed in clearcut habitat strata.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF AVAILABLE STEMS / HA OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	240.56	0.196	7721	11114	.136	.132 < P1 < .140	-
OPEN PLANTED	137.09	0.112	6923	6351	.122	.118 < P2 < .126	+
INFLUENCE ZONE	199.32	0.163	10051	9243	.177	.173 < P3 < .181	+
DENSE CONIFER	155.49	0.126	5065	6521	.089	.086 < P4 < .092	-
SCATTERED RESIDUAL	331.46	0.270	10451	15934	.184	.181 < P5 < .188	-
HARDWOOD	89.58	0.073	10357	4139	.182	.178 < P6 < .186	+
SWAMP	74.02	0.059	6136	3402	.108	.104 < P7 < .112	+
TOTAL	1227.52	1227.52	56704	56704			

$X^2 = 14908$ ($P<0.05$, 6 d.f.= 12.59)

TABLE 8: Number of browsed stems per hectare observed in clearcut habitat strata.

STRATA	AVAILABLE BROWSE (stems/ha)	PROPORT. TOTAL (Pio)	NUMBER OF BROWSED STEMS / HA OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	7721	.136	511	345	.201	.179 < P1 < .223	-
OPEN PLANTED	6923	.122	462	310	.182	.161 < P2 < .204	+
INFLUENCE ZONE	10051	.177	316	449	.125	.107 < P3 < .143	-
DENSE CONIFER	5065	.089	22	227	.009	.004 < P4 < .014	-
SCATTERED RESIDUAL	10451	.184	287	467	.113	.096 < P5 < .130	-
HARDWOOD	10357	.182	893	463	.352	.326 < P6 < .378	+
SWAMP	6136	.108	45	275	.018	.011 < P7 < .025	-
TOTAL	56704			2536			

$X^2 = 1040.0$ ($P<0.05$, 6 d.f.= 12.59)

TABLE 9: Amount of available forage (kg. per hectare) observed in clearcut habitat strata.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AMOUNT OF AVAILABLE FORAGE (kg / ha)	EXPECTED AMOUNT	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	240.56	0.196	173.95	206.85	.165	.134 < P1 < .196	0
OPEN PLANTED	137.09	0.112	238.84	118.20	.226	.191 < P2 < .260	+
INFLUENCE ZONE	199.32	0.163	169.96	172.02	.161	.131 < P3 < .191	0
DENSE CONIFER	155.49	0.126	49.85	132.98	.047	.029 < P4 < .064	-
SCATTERED RESIDUAL	331.46	0.270	182.66	284.95	.173	.142 < P5 < .204	-
HARDWOOD	89.58	0.073	116.12	77.04	.110	.084 < P6 < .135	+
SWAMP	74.02	0.059	123.98	62.27	.117	.090 < P8 < .144	+
TOTAL	1227.52	1227.52	1055.36	1055.36			

$X^2 = 297.8$ ($P<0.05$, 6 d.f.= 12.59)

TABLE 10: Amount of consumed forage (kg. per hectare) observed in clearcut habitat strata.

STRATA	TOTAL FORAGE PRODUCED (kg/ha)	PROPORT. TOTAL (Pio)	AMOUNT OF CONSUMED FORAGE (kg / ha)	EXPECTED AMOUNT	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	173.91	.171	12.36	8.23	.256	.087 < P1 < .425	0
OPEN PLANTED	238.84	.235	15.77	11.31	.378	.146 < P2 < .510	0
INFLUENCE ZONE	163.49	.161	7.71	7.74	.160	.017 < P3 < .302	0
DENSE CONIFER	45.53	.045	0.30	2.17	.006	0 < P4 < .035	-
SCATTERED RESIDUAL	176.08	.174	3.64	8.37	.076	0 < P5 < .179	0
HARDWOOD	92.83	.091	7.34	4.38	.153	.013 < P6 < .193	0
SWAMP	123.98	.122	1.00	5.87	.021	0 < P7 < .077	-
TOTAL	1014.66		48.12	48.12			

$X^2 = 14.15$ ($P<0.05$, 6 d.f.= 12.59)

TABLE 11: Number of pellet groups per hectare observed in clearcut habitat strata (Transformed data).

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF PELLET GROUPS /HA OBSERVED	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
OPEN NATURAL	240.56	0.196	22	43	0.100	.046 < P1 < .154	-
OPEN PLANTED	137.09	0.112	1	25	0.004	0 < P2 < .015	-
INFLUENCE ZONE	199.32	0.163	16	36	0.073	.026 < P3 < .120	-
DENSE CONIFER	155.49	0.126	23	25	0.103	.049 < P4 < .159	0
SCATTERED RESIDUAL	331.46	0.270	13	62	0.059	.016 < P5 < .102	-
HARDWOOD	89.58	0.073	144	16	0.655	.569 < P6 < .741	+
SWAMP	73.11	0.059	1	13	0.004	0 < P7 < .015	-
TOTAL	1227.52	1227.52	213	213			

$X^2 = 1118.4$ ($P<0.05$, 6 d.f.= 12.59)

APPENDIX IV: REGRESSION EQUATIONS USED TO CALCULATE TWIG WEIGHT AND CALCULATED MEAN WEIGHT OF BROWSE SPECIES SAMPLED.

TABLE 1. Regression of twig weight on basal diameter including the correction for skewness for 7 selected browse species (from Stronks 1985).

Species	Regression Equation
Pin cherry	y = e(2.69(ln d) - 2.59)
White birch	y = e(2.65(ln d) - 2.46)
Trembling aspen	y = e(2.41(ln d) - 2.37)
Red osier dogwood	y = e(2.79(ln d) - 3.11)
Mountain ash	y = e(2.44(ln d) - 2.97)
Willow species	y = e(2.86(ln d) - 2.97)
Beaked hazel	y = e(2.62(ln d) - 2.65)
Mountain maple*	y = 0.210(d) - 0.034

From Peek et al. (1974b).

TABLE 2. Mean diameters at point of browsing (mm), number of twigs per stem and calculated mean weight of twigs and browse produced per stem (g) in strip cuts an clearcuts sampled.

SPECIES	STRIP CUTS				CLEARCUTS			
	MEAN DIA. POINT OF BROWSING (mm)	TWIG WEIGHT (g)	MEAN # TWIGS PER STEM	WEIGHT OF BROWSE / STEM (g)	MEAN DIA. POINT OF BROWSING (mm)	TWIG WEIGHT (g)	MEAN # TWIGS PER STEM	WEIGHT OF BROWSE / STEM (g)
White birch	2.33	0.800	28.8	23.04	2.75	1.247	19.56	24.39
Trembling aspen	3.50	1.910	24.4	46.60	4.17	2.919	19.50	56.92
Pin cherry	2.27	0.681	22.0	14.98	2.18	0.610	20.50	12.51
Mountain ash	4.21	1.721	5.3	9.12	4.67	2.204	6.90	15.18
Balsam fir	0.00	N.A.	360.1	N.A.	1.87	N.A.	111.20	N.A.
Beaked hazel	2.65	0.908	11.0	9.99	2.70	0.953	16.00	15.25
Green alder	0.00	N.A.	29.1	N.A.	2.43	N.A.	29.00	N.A.
Willow spp.	1.79	0.271	16.2	4.39	2.80	0.975	33.40	32.57
Red osier dogw.	2.94	0.904	6.4	5.79	4.40	2.783	8.90	24.77
Mountain maple	0.00	N.A.	8.7	N.A.	3.19	0.635	10.80	6.86

APPENDIX V: DENSITIES OF AVAILABLE BROWSE AND BROWSED STEMS AND FORAGE PRODUCTION IN SAMPLED STRIP CUTS AND CLEARCUTS.

TABLE 1. Densities of available browse stems in the four sampled clearcuts.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF BROWSE STEMS / HA	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
Edmondson Lk.	510.40	0.416	7579	14550	0.217	.211 < P1 < .223	-
Mott Lk.	362.78	0.295	9109	10343	0.260	.254 < P2 < .266	-
Buzzer Lk.	192.27	0.157	7717	5482	0.220	.214 < P3 < .226	+
Lever Lk.	163.32	0.132	10598	4628	0.303	.297 < P4 < .309	+
TOTAL	1227.27		35003				

$X^2 = 12099$ ($P<0.05$, 3 d.f. = 7.81)

TABLE 2: Amount of browse produced in the four clearcuts sampled.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AMOUNT OF BROWSE PRODUCED (kg / ha)	EXPECTED AMOUNT	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
Edmondson Lk.	510.40	0.416	155.03	303.13	0.213	.175 < P1 < .251	-
Mott Lk.	362.78	0.295	170.85	214.95	0.234	.194 < P2 < .273	-
Buzzer Lk.	192.27	0.157	142.52	114.40	0.196	.159 < P3 < .233	+
Lever Lk.	163.32	0.132	260.27	96.18	0.357	.312 < P4 < .401	+
TOTAL	1227.27		728.67				

$X^2 = 362.26$ ($P<0.05$, 3 d.f. = 7.81)

TABLE 3: Densities of browsed stems in the four clearcuts sampled.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF BROWSED STEMS / HA	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
Edmondson Lk.	510.40	0.416	2.00	6.92	0.120	0 < P1 < .321	-
Mott Lk.	362.78	0.295	6.40	4.91	0.385	.084 < P2 < .686	0
Buzzer Lk.	192.27	0.157	5.97	2.61	0.359	.062 < P3 < .655	0
Lever Lk.	163.32	0.132	2.26	2.19	0.136	.076 < P4 < .348	0
TOTAL	1227.27		16.63				

$X^2 = 8.28$ ($P<0.05$, 3 d.f. = 7.81)

TABLE 4: Densities of available browse stems in the four strip cuts sampled.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	NUMBER OF AVAILABLE BROWSE STEMS / HA	EXPECTED NUMBER	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
Edmondson Lk.	344.03	0.247	6306	8609	0.179	.174 < P1 < .184	-
Mott Lk.	515.30	0.376	4488	13280	0.127	.123 < P2 < .131	-
Buzzer Lk.	372.03	0.271	4963	9588	0.140	.135 < P3 < .144	+
Lever Lk.	149.33	0.109	19568	3848	0.554	.547 < P4 < .561	+
TOTAL	1370.69		35325				

$X^2 = 72887$ (P<0.05, 3 d.f. = 7.81)

TABLE 5: Amount of browse produced in the four strip cuts sampled.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	AMOUNT OF BROWSE PRODUCED (kg / ha)	EXPECTED AMOUNT	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)	
Edmondson Lk.	344.03	0.247	102.94	170.89	0.148	.113 < P1 < .182	-
Mott Lk.	515.30	0.376	208.87	260.15	0.302	.258 < P2 < .346	-
Buzzer Lk.	372.03	0.271	80.26	187.50	0.116	.085 < P3 < .147	-
Lever Lk.	149.33	0.109	299.81	75.41	0.433	.386 < P4 < .481	+
TOTAL	1370.69		691.88				

$X^2 = 766.22$ (P<0.05, 3 d.f. = 7.81)

TABLE 6: Utilization of available browse stems in the four strip cuts sampled.

STRATA	TOTAL AREA (ha)	PROPORT. TOTAL AREA (Pio)	PERCENTAGE OF STEMS BROWSED	EXPECTED PERCENTAGE	PROPORT. OBSERVED IN EACH AREA (Pi)	CONFIDENCE INTERVAL ON PROPORTION OF OCCURRENCE (Pi) (95 % CONFIDENCE INT.)
Edmondson Lk.	344.03	0.247	1.10	2.64		No significant differences observed.
Mott Lk.	515.30	0.376	4.98	4.06		
Buzzer Lk.	372.03	0.271	2.86	2.93		
Lever Lk.	149.33	0.109	1.86	1.18		
TOTAL	1370.69		10.80			

$X^2 = 1.50$ (P<0.05, 3 d.f. = 7.81)

APPENDIX VI: CORRELATIONS BETWEEN OBSERVATIONS IN STRIP CUT AND CLEARCUTS AND AMOUNT OF AVAILABLE FORAGE.

TABLE 1. Correlation between observations in strip cut study areas and densities of available forage.

STRATA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	DENSITY OF AVAILABLE FORAGE
Edmond. Lk.	0	2	5	42	2.16	15.20	6306
Mott Lk.	2	19	36	90	16.10	44.65	4488
Buzzer Lk.	--	4	--	102	-----	49.25	4963
Lever Lk.	1	6	36	24	14.30	6.02	19568
r =	-0.110	-0.232	0.401	-0.784	0.289	-0.775	

TABLE 2. Correlation between observations in strip cut study areas and available forage.

STUDY AREA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	AVAILABLE FORAGE (kg/ha)
Edmond. Lk.	4	7	30	113	9.75	54.48	102.94
Mott Lk.	14	15	115	136	55.52	74.52	208.87
Buzzer Lk.	--	5	---	86	-----	40.43	80.26
Lever Lk.	0	0	0	18	0.00	3.61	209.81
r =	0.232	0.150	0.259	0.228	0.343	-0.140	

TABLE 3. Correlation between observations in clearcut study areas and available forage.

STUDY AREA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	AVAILABLE FORAGE (kg/ha)
Edmond. Lk.	0	2	5	42	2.16	15.20	155.03
Mott Lk.	2	19	36	90	16.10	44.65	170.85
Buzzer Lk.	--	4	--	102	-----	49.25	142.52
Lever Lk.	1	6	36	24	14.30	6.02	260.27
r =	0.139	0.331	0.615	-0.723	0.518	-0.701	

TABLE 4. Correlation between observations in clearcut study areas and densities of available forage.

STUDY AREA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	DENSITY OF AVAILABLE FORAGE
Edmond. Lk.	4	7	30	113	9.75	54.48	7579
Mott Lk.	14	15	115	136	55.52	74.52	9109
Buzzer Lk.	--	5	---	86	-----	40.43	7717
Lever Lk.	0	0	0	18	0.00	3.61	10598
r =	-0.269	-0.303	-0.244	-0.643	-0.157	-0.570	

TABLE 5. Correlation of amount of browse produced (kg / ha) and age of clearcuts sampled.

STUDY AREA	TIME SINCE HARVEST OF STUDY AREA (years)	AMOUNT OF BROWSE PRODUCED (kg / ha)
Edmondson Lk.	12	155.03
Mott Lk.	10	170.85
Buzzer Lk.	14	142.52
Lever Lk.	7	260.27

Sum x^2 = 26.75
Sum y^2 = 8536.4
Sum xy = -447.2
r = -0.936

TABLE 6. Correlation of amount of browse produced (kg / ha) and age of strip cuts sampled.

STUDY AREA	TIME SINCE HARVEST OF STUDY AREA (years)	AMOUNT OF BROWSE PRODUCED (kg / ha)
Edmondson Lk.	12	102.94
Mott Lk.	10	208.87
Buzzer Lk.	14	80.26
Lever Lk.	7	299.81

Sum x^2 = 26.75
Sum y^2 = 8415.04
Sum xy = -423.87
r = -0.981

APPENDIX VII: CORRELATIONS BETWEEN OBSERVATIONS IN CLEARCUTS AND HABITAT STRATA

TABLE 1. Correlation of clearcut utilization and open habitat strata.

STUDY AREA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	% AREA OF OPEN HABITAT STRATA
Edmondson	4	7	30	113	9.75	54.48	13
Mott	14	15	115	136	55.52	74.52	32
Tease	5	3	55	44	35.65	18.86	65
Buzzer	--	5	---	86	-----	40.43	52
Lever	0	0	0	18	0.00	3.61	57
Sum x^2 =	105	128	7150	9399	1902	3159	
Sum y^2 =	1695	1779	1695	1779	1695	1779	
x.y =	-135	-288	-705	-3210	7	-1778	
r =	-0.32	-0.60	-0.20	-0.78	0.004	-0.75	

TABLE 2. Correlation of clearcut utilization and 30 m influence zone strata.

STUDY AREA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	% AREA OF INF. ZONE STRATA
Edmondson	4	7	30	113	9.75	54.48	12
Mott	14	15	115	136	55.52	74.52	22
Tease	5	3	55	44	35.65	18.86	8
Buzzer	--	5	---	86	-----	40.43	21
Lever	0	0	0	18	0.00	3.61	2
Sum x^2 =	107	292	107	152	107	292	
Sum y^2 =	105	128	7150	9399	1902	3159	
x.y =	86	153	630	767	261	806	
r =	0.81	0.79	0.72	0.64	0.58	0.84	

TABLE 3. Correlation of clearcut utilization and cover associated strata.

STUDY AREA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	% AREA OF COVER ASS. STRATA
Edmondson	4	7	30	113	9.75	54.48	74
Mott	14	15	115	136	55.52	74.52	46
Tease	5	3	55	44	35.65	18.86	27
Buzzer	--	5	---	86	-----	40.43	27
Lever	0	0	0	18	0.00	3.61	31
Sum x^2 =	1361	1606	1361	1606	1361	1606	
Sum y^2 =	105	128	7150	9399	1902	3159	
x.y =	52	194	95	2409	252	1304	
r =	0.14	0.43	0.03	0.62	-0.16	0.58	

APPENDIX VIII: CORRELATIONS BETWEEN OBSERVATIONS IN STRIP CUT AND CLEARCUT HABITAT STRATA AND AMOUNT OF AVAILABLE FORAGE.

TABLE 1. Correlation between observations in strip cut strata and densities of available forage.

STRATA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	DENSITY OF AVAILABLE FORAGE
Op. Nat.	3	23	72	230	30.45	103.89	6987
D. Conif.	0	4	24	33	7.63	15.18	1730
S. Resid.	0	4	1	6	0.62	1.25	8421
Swamp	0	0	2	5	0.29	0.65	18333
r =	-0.181	-0.342	-0.417	-0.287	-0.369	-0.289	

TABLE 2. Correlation between observations in strip cut strata and available forage.

STRATA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	AVAILABLE FORAGE (kg/ha)
Op. Nat.	3	23	72	230	30.45	103.89	98.44
D. Conif.	0	4	24	33	7.63	15.18	19.57
S. Resid.	0	4	1	6	0.62	1.25	101.16
Swamp	0	0	2	5	0.29	0.65	50.12
r =	0.52	0.54	0.28	0.31	0.36	0.43	

TABLE 3. Correlation between observations in clearcut strata and densities of available forage.

STRATA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	DENSITY OF AVAILABLE FORAGE
Op. Nat.	3	3	34	99	22.18	53.36	7721
Op. Plan.	0	2	27	31	12.22	18.96	6923
In. Zone	14	14	55	114	18.14	52.39	10051
D. Conif.	0	0	29	31	8.35	13.27	5065
S. Resid.	5	8	44	94	28.63	44.97	10451
Hardwood	0	3	6	9	4.18	3.58	10357
Swamp	0	0	5	19	1.52	5.37	6136
r =	0.581	0.740	0.336	0.448	0.468	0.420	

TABLE 4. Correlation between observations in clearcut strata and available forage.

STRATA	# MOOSE OBSERVED 1983-84	# MOOSE OBSERVED 1984-85	# TRACKS OBSERVED 1983-84	# TRACKS OBSERVED 1984-85	AREA OF TRACKS (ha) 1983-84	AREA OF TRACKS (ha) 1984-85	AVAILABLE FORAGE (kg/ha)
Op. Nat.	3	3	34	99	22.18	53.36	173.95
Op. Plan.	0	2	27	31	12.22	18.96	238.84
In. Zone	14	14	55	114	18.14	52.39	163.96
D. Conif.	0	0	29	31	8.35	13.27	49.85
S. Resid.	6	8	44	94	28.63	44.97	182.66
Hardwood	0	3	6	9	4.18	3.58	116.12
Swamp	0	0	5	19	1.52	5.37	123.98
r =	0.28	0.37	0.35	0.40	0.51	0.47	

APPENDIX IX: SNOW DEPTH, HARDNESS, AND DENSITY MEASUREMENTS MADE IN SAMPLED STRIP CUT AND CLEARCUT 1983-84, 1984-85.

TABLE 1. Mean mid and late winter snow depths (cm) measured in cut and leave strips: 1983 - 1984.

DISTANCE FROM EDGE OF CONIFER (m)	MEAN SNOW DEPTH (cm)			
	MID - WINTER		LATE WINTER	
	CUT STRIP	LEAVE STRIP	CUT STRIP	LEAVE STRIP
0	54.1	55.5	65.8	45.7
4	57.7	53.5	70.7	38.0
8	62.6	49.6	62.0	36.8
12	71.5	54.5	61.3	39.3
16	69.8	55.0	63.2	57.3
20	66.6	51.4	56.0	40.3
24	75.2	55.8	55.8	55.5
28	65.5	53.7	50.2	62.0
32	63.9	42.7	43.8	56.0
36	59.3	60.0	54.8	69.3
40	54.2	58.3	53.3	78.5
Average:	63.4	53.6	57.9	52.6

TABLE 2. Mean mid and late winter snow depths measured in cut and leave strips and clearcut: 1984 - 1985.

DISTANCE FROM EDGE OF CONIFER (m)	MEAN SNOW DEPTH (cm)					
	MID - WINTER			LATE WINTER		
	CUT STRIP	LEAVE STRIP	CLEAR-CUT	CUT STRIP	LEAVE STRIP	CLEAR-CUT
0	53.0	37.5	50.0	59.6	47.0	64.3
4	47.6	45.5	52.7	61.6	38.3	61.3
8	51.3	38.0	52.7	58.0	36.6	60.0
12	52.3	53.0	46.0	57.0	40.7	70.0
16	55.6	54.5	43.6	63.0	48.3	49.6
20	48.6	38.5	48.7	67.0	49.3	49.3
24	46.7	44.0	46.3	63.0	48.3	39.0
28	43.7	42.0	47.3	56.0	47.6	42.3
32	50.3	44.0	51.0	55.6	55.5	55.0
36	45.6	45.5	48.0	40.0	63.3	63.0
40	42.7	48.0	43.0	43.0	68.0	57.0
Average:	48.9	44.6	48.2	56.7	49.4	55.5

TABLE 3. Snow depth (cm), hardness (g/sq. cm) and desity (g/cu. cm) measurements in cut and leave strips and clearcut sampling stations (mid winter 1984).

	LAYER NUMBER	DEPTH (cm)	HARDNESS (g/sq.cm)	DENSITY (g/cu.cm)
CUT STRIP	1	11.6	0.035	0.091
	2	7.5	0.900	0.114
	3	31.5	0.100	0.181
	4	7.5	75.00	0.298
LEAVE STRIP	1	13.0	0.010	0.096
	2	27.0	0.055	0.231
	3	5.0	45.00	0.321
CUTOVER		Not Sampled		

TABLE 4. Snow depth (cm), hardness (g/sq. cm) and desity (g/cu. cm) measurements in cut and leave strips and clearcut sampling stations (late winter 1984).

	LAYER NUMBER	DEPTH (cm)	HARDNESS (g/sq.cm)	DENSITY (g/cu.cm)
CUT STRIP	1	9.0	7.00	0.361
	2	41.0	0.650	0.271
	3	5.0	43.30	0.361
LEAVE STRIP	1	3.0	0.867	0.316
	2	5.0	0.710	0.294
	3	19.5	0.380	0.271
	4	5.0	9.670	0.406
CUTOVER		Not Sampled		

TABLE 5. Snow depth (cm), hardness (g/sq. cm) and desity (g/cu. cm) measurements in cut and leave strips and clearcut sampling stations (mid winter 1985).

	LAYER NUMBER	DEPTH (cm)	HARDNESS (g/sq.cm)	DENSITY (g/cu.cm)
CUT STRIP	1	9.0	0.035	0.114
	2	31.0	0.100	0.271
LEAVE STRIP	1	7.0	0.040	0.069
	2	20.0	0.250	0.204
	3	10.0	0.083	0.249
CUTOVER	1	9.0	0.035	0.115
	2	33.0	0.097	0.265

TABLE 6. Snow depth (cm), hardness (g/sq. cm) and desity (g/cu. cm) measurements in cut and leave strips and clearcut sampling stations (late winter 1985).

	LAYER NUMBER	DEPTH (cm)	HARDNESS (g/sq.cm)	DENSITY (g/cu.cm)
CUT STRIP	1	4.0	0.480	0.227
	2	17.0	0.350	0.204
	3	43.0	0.015	0.181
LEAVE STRIP	1	2.0	9.500	0.271
	2	7.0	0.150	0.204
	3	38.0	0.260	0.180
CUTOVER	1	3.0	9.00	NA
	2	7.0	0.380	0.226
	3	1.0	4.300	NA
	4	45.0	0.370	0.206