WINTER MOOSE UTILIZATION OF ALTERNATE STRIP CUTS AND CLEARCUTS IN NORTHWESTERN ONTARIO: PRELIMINARY RESULTS

C.J. Todesco and H.G. Cumming

School of Forestry, Lakehead University, Thunder Bay, Ontario

and

J.G. McNicol

Ontario Ministry of Natural Resources, Thunder Bay, Ontario

Abstract: Moose (Alces alces) utilization was studied in 1984 in five paired alternate strip cuts and clearcuts located northwest of Thunder Bay, Ontario. Use was determined by the number of moose and track aggregates observed from a small aircraft from January to March, and by browse utilization and pellet group data collected in May. Significantly ($P < 0.05$) more utilization of clearcuts than of strip cuts occurred in a normal snowfall winter. Moose observations and track aggregates in clearcuts were well correlated with the amount of area within 30 m of coniferous cover, but not well correlated with the amount of area covered in residual standing timber. Avoidance of alternate strip cuts in mid winter may be related to increased snow depths created by the microclimatic conditions resulting from this type of timber harvest.

Timber harvesting is one of the major causes of disturbance in boreal forests. Today, the most common form of mechanized timber harvesting is clearcutting, where all merchantable conifer stems are removed, advanced growth is destroyed and only unmerchantable sized coniferous stems and hardwood species1 are left. Mechanized harvesting has increased the size of clearcuts in order to extract wood economically. In time, large clearcuts may produce an abundant and diverse source of winter forage for moose (Alces alces); however, the distance from available cover may restrict the utilization of large portions of these clearcuts by moose in mid winter.

In the Thunder Bay district of northwestern Ontario, modified clearcutting by harvesting in alternate strips or blocks of cut and standing timber was originally used to maintain site conditions and induce conifer regeneration on cutover areas (Auld 1975). Although alternate strip cutting incurs higher wood costs than clearcutting (Peacock, 1975), it should provide the diversity of early and late successional plant communities preferred by wintering moose. McNicol (1976), the Ontario Moose Council (1978) and Euler (1979) have recommended harvesting in alternate equal sized strips or blocks of cut and standing timber as a method of habitat management for moose.

Unfortunately, most of the reasons for such recommendations are largely theoretical. Few studies have been undertaken to determine if moose use the costlier alternate strip cut areas more than clearcut areas, or if they even use them at all. The purpose of this study is to compare the winter utilization by moose of alternate strip cut areas with that of clearcut areas, by studying the frequency of track aggregates, moose observations, browsed stems and pellet groups.

STUDY AREA

The general 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 are of fire origin and are primarily coniferous. Black spruce (Picea mariana), white spruce (Picea glauca), jack pine (Pinus banksiana) and balsam fir (Abies balsamea) are the predominant conifers. Trembling aspen (Populus tremuloides) and white birch (Betula papyrifera) are the most common deciduous species.

The topography of the area is strongly influenced by the underlying Precambrian Shield and consists of weakly broken plains and moderately broken uplands. A thin layer of glacial till covers the bedrock in the upland areas. Lowlands are covered with glacial till and fine textured 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 generally podzolic silty to sandy till with large amounts of stone, gravel and boulders.

Five specific study sites were located northeast of Thunder Bay (Fig. 1). Each study area consists of one clearcut - alternate strip cut pair based on similarities in soil, area of harvest, year of harvest, original timber type, and size of regeneration. All alternate strip cut areas were located within 1 km of the paired clearcut. We assumed that moose had equal opportunities of using either type of cut. The alternate strip cuts had only the first coupe removed. All study sites were open to hunting from early October to mid-December 1983.

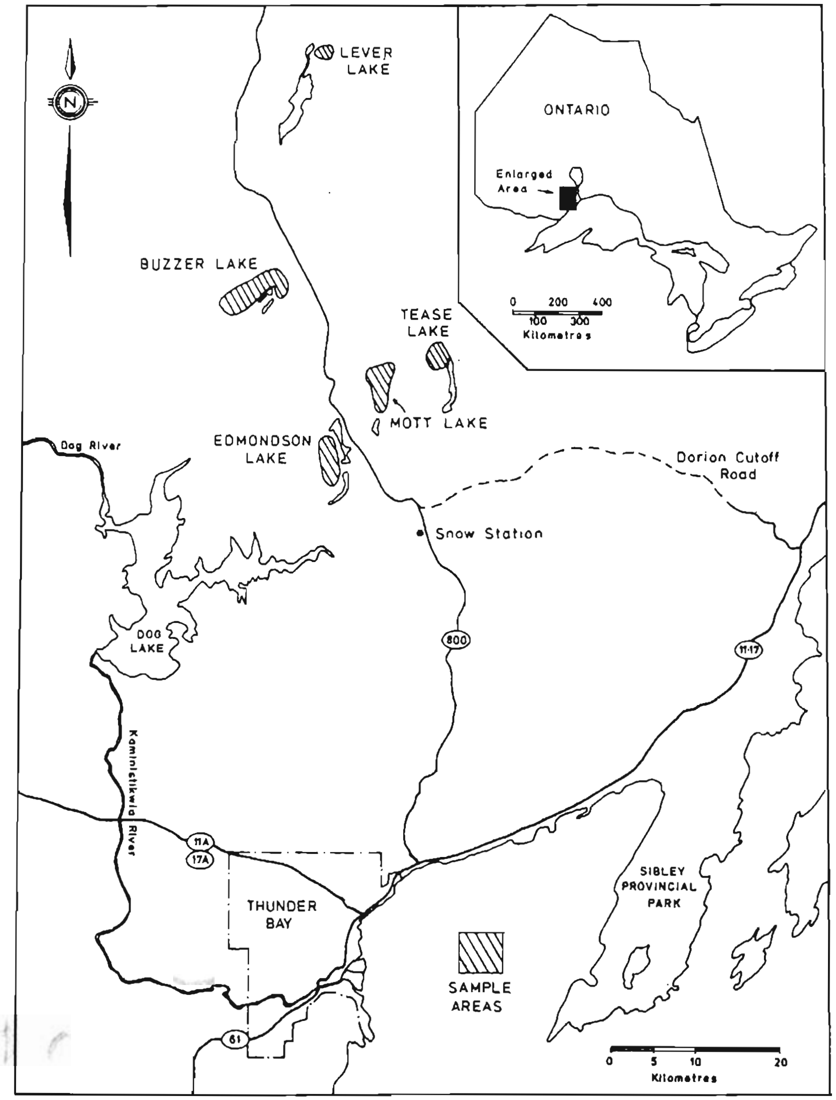

FIGURE 1: Study sites located north of Thunder Bay, Ontario.

The major site characteristics of the five study areas are summarized in Table 1. The study areas were harvested 7 to 14 years previously and ranged in size from 135 to 530 ha. The harvest area for the pairs was not always similar due to the selection constraints imposed by keeping the pairs within 1 km of each other and pairing areas of similar harvest age. 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 blocks.

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 project. All winter moose and track aggregate observations were excluded from subsequent analysis of the 1983-84 winter data. Another clearcut which met all of the selection criteria was picked for the spring browse and pellet group surveys, and 1984-85 winter observation data collection.

Table 1. Site characteristics of the 5 paired alternate strip cut-clearcut study areas north of Thunder Bay, Ontario.

Study Area	Year Harvested	Timber Type[1]	Area (ha) Strip Cut	Area (ha) Clear-Cut	Soils
Edmondson Lake	1972	Sb, Pj, Bw	350	530	Shallow-deep sand till, rock outcrops
Mott Lake	1974	Sb, Pj	503	400	Shallow-deep sand till, rock outcrops
Tease Lake	1974	Sb, Pj, Bf	215	299	Deep sand till, no rock outcrops
Buzzer Lake	1970	Sb, Pj	391	192	Shallow-deep sand till, rock outcrops, and some swamp
Lever Lake	1977	Pj, Sb	135	145	Thin sand till, rock outcrops common in strip cuts

[1]Sb = Black Spruce Bw = White Birch
Pj = Jack Pine Bf = Balsam Fir

METHODS

Weekly reconnaissance flights were made over all study locations from early January to the end of March 1984, in either a Piper Supercub or a Cessna 172 fixed wing aircraft. Flights were restricted to sunny days at a height of 250 m above ground level, and at an air speed of approximately 120 km/h. All flights were made between 1000 and 1500 in order to minimize the obscuring effects of long shadows cast by standing timber. Each study area was circled until all moose and track aggregates were believed to have been sighted and recorded. The location of all sightings of moose, track aggregates, and single tracks were recorded with alcohol-based pens on acetate overlays placed on 1:15840 scale photomosaics of each study area. To avoid duplicating the same track aggregates on subsequent flights, the overlays were retained until a major snowfall 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.

Snow depth, hardness and density measurements were made once in mid-winter and once in late winter in a similar alternate strip area, 50 km north of Thunder Bay. The 40 m wide coniferous strips were orientated east-west and within 60 km of the furthest study area. Snow depth was measured every 4 m across three harvested and three leave strips. Snow density and hardness was measured in the center of the second harvested and leave strips sampled. No snow measurements were made in any of the clearcuts due to mechanical difficulties encountered at the time when they were made.

All paired study areas except Tease Lake were sampled for browse utilization and pellet groups in the spring of 1984. Browse utilizaton plots (1 x 20 m) were nested within the pellet group count plots (2 x 20 m). Plots were systematically spaced at 100 m intervals along randomly selected cruise lines. In the strip cuts, cruise lines were perpendicular to the strip orientation.

Browsed stems (any stem which had browsed twigs on it) and unbrowsed stems were counted in the 1 x 20 m rectangular plots. A total count of all browsed and unbrowsed twigs (minimum length 2.5 cm) per stem was done in every fifth plot. Pellet groups deposited since leaf fall were counted in the 2 x 20 m plots.

The basal area of standing residual timber was measured at both ends of the plot using a 2 m^2 basal area factor (B.A.F.) prism.

In the field, plot locations were classified similar to McNicol (1976) into one of 6 strata:

1. Dense Conifer
2. Open Natural
3. Open Planted
4. Scattered Residual
5. 30 metre influence zone around dense conifer residual (clear-cut only)
6. Unclassified - i) Swamp
   ii) Hardwood
   iii) Blowdown

A 30 m influence zone was established around all dense conifer residual stands and parallel to edges of the clearcut in order to compare the same influence as the harvested strips. Any plot in a clearcut with it's centre within 20 m of dense conifer timber was placed in the 30 m influence zone.

For each study area all strata were delineated on a 1:15840 scale base map and marked in different colours. The area of each strata was calculated using an electronic planimeter. The acetate overlays of moose observations and track aggregates were placed over the stratified base map of the corresponding study area. The number of moose sightings and track aggregates was recorded in each strata by flight date.

Browse utilization data were analyzed using the method described by Passmore and Hepburn (1955). Preference ratings were calculated using Petride's (1975) formulae. The number of pellet groups/ha for each study area were calculated using Overton's (1971) formula, and used to compare relative moose densities between areas. The estimated population of moose in each study area was not derived from this data due to the inherant problems with this method (Timmermann 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 (Neu et al. 1974). Snow depth data were analyzed using a paired t test.

RESULTS

Snowfall in Thunder Bay from December 1983 to March 1984 was not significantly different ($P < 0.01$) than the 30 year average snowfall for these months (Environment Canada, 1981). In the sampled area, mean snow depths were significantly greater ($P < 0.01$) in the harvested strips than in the adjacent uncut strips, both in the mid and late winter measurements. Mid-winter snows in the harvested strips tended to be shallowest against the edges of the standing timber and deepest in the center of the strips (Fig. 2). Also for this period, snow depths were generally similar across the uncut 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 the longer

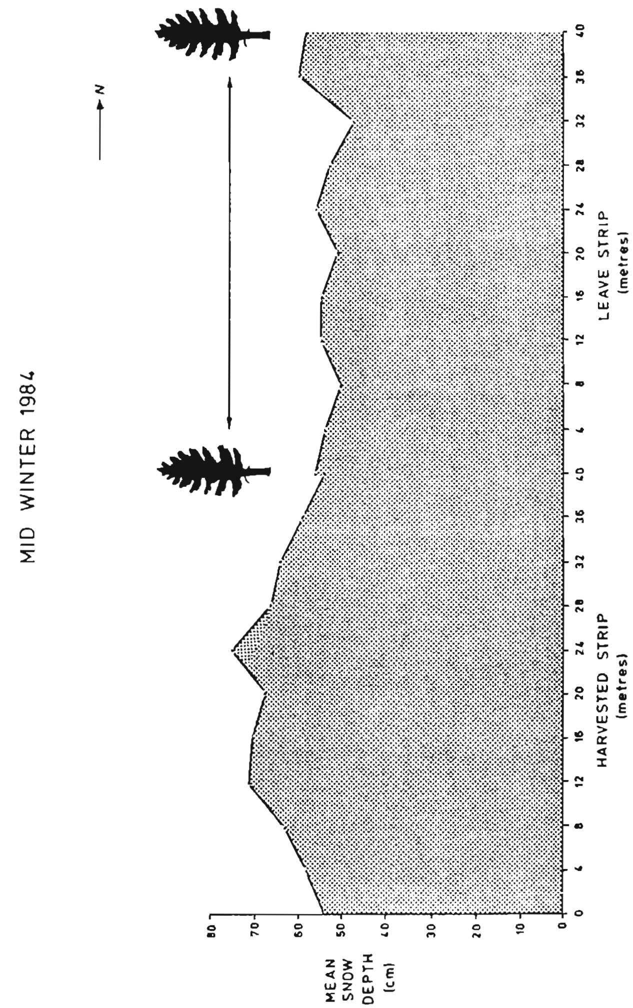

FIGURE 2: Mean mid winter snow depths in east - west oriented harvested and leave strips.

daylength (Fig. 3). Snow was deepest on the south sides of the harvested strips where it was in the shade of the standing timber. Snow depths decreased across the harvested strips until within 8 m of the standing timber where snow depths started to increase again. Snow depths in the uncut strips showed a similar, although reverse pattern: shallowest snow depths were in the south side of the uncut strip, and greatest on the north side.

Ontario Ministry of Natural Resources snow stations in nearby Thunder Bay, Dorion, Nipigon and Armstrong all reported heavy crusting conditions between February 13-20. Mild temperatures, fog and 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 the snow in the uncut strips, although not significantly ($P < 0.05$). A 9 cm ice crust was found on the snow in the harvested strips in late winter, but not on the snow in the uncut strips.

Moose and Track Aggregate Observations

Nine flights were made during the period of January 9 to March 31, 1984 and 26 moose were observed (Table 2). The number of moose observed in the clearcuts (23) was significantly greater ($P < 0.05$) than the number of moose observed in the strip cuts (3). No moose were observed in any of the study areas after February 6. All moose observed in the strip cuts were located in the harvested strips. Of the 23 moose observed in the clearcuts, 14 (60%) were located in the 30 m influence zone strata, 6 (26%) in the scattered residual and only 3 (14%) were observed in the open natural stratum.

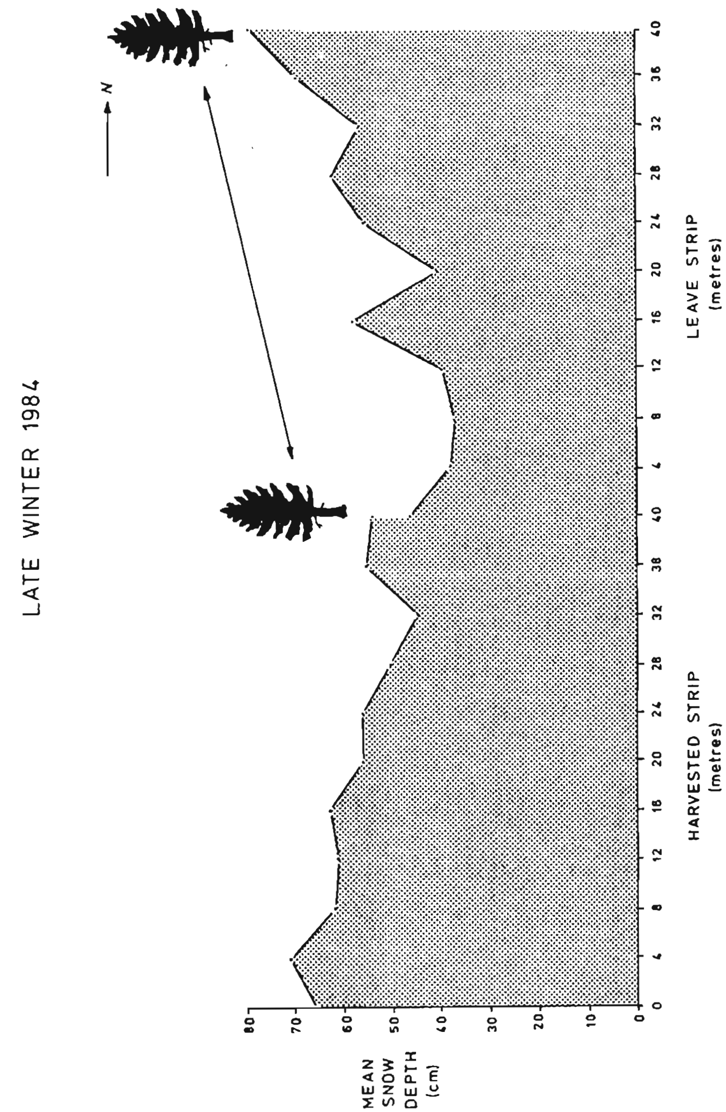

FIGURE 3. Mean late winter snow depths in east - west oriented harvested and leave strips.

Table 2. Winter 1984 moose observations in alternate strip cuts and clearcuts.

	Number of Moose Observed	
Date	Strip Cut	Clearcut
Jan. 11	1	0
Jan. 15	0	11
Jan. 27	0	2
Feb. 6	2	10
Feb. 21	0	0
Feb. 29	0	0
Mar. 6	0	0
Mar. 23	0	0
Mar. 31	0	0

The observed number of track aggregates was significantly greater ($P < 0.05$) in the clearcuts than in the strip cuts. The number of track aggregates in both harvest types rapidly increased to a peak at the end of January, and gradually declined over the rest of the winter (Fig. 4). One minor exception to this pattern isthe decrease in the number of track aggregates observed on February 21, when crusting conditions were being formed.

Browse Utilization and Pellet Group Observations

The numbers of available and browsed stems were significantly greater ($P < 0.05$) in the clearcuts than in the strip cuts. The 2 most northern study sites had significantly more available browse ($P < 0.05$) than the 2 southern study areas in both types of timber harvest.

The 10 most utilized browse species were determined from all of the collected data (Table 3). Over 80 percent of the browse consumed in both harvest methods was made up of four different browse species.

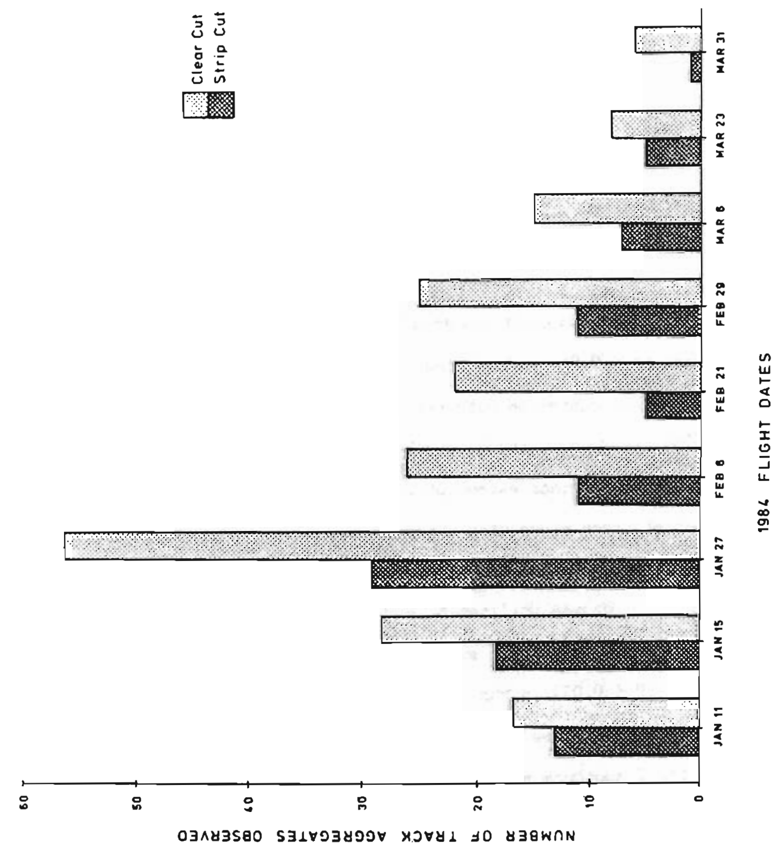

FIGURE 4. Total number of track aggregates observed in all alternate strip cut and clearcut study sites.

In the strip cuts, red osier dogwood (Cornus stolinifera), white birch, trembling aspen and mountain ash (Sorbus americana) were the four most heavily browsed species. In the clear cuts, white birch, mountain ash, pin cherry (Prunus pennsylvanica) and mountain maple (Acer spicatum) were the most frequently browsed species. Red osier dogwood and mountain ash were the only preferred (i.e. preference rating > 1.0) forage species in the strip cut areas compared to mountain ash, mountain maple, pin cherry, white birch, and red osier dogwood in the clearcuts.

Table 3. Density of available and browsed stems and preference ratings of the ten browse species most selected by moose on sampled alternate strip cuts and clearcuts in northwestern Ontario, Winter 1983-1984.

Browse Species	Avail. Stems/ha Strip Cut	Avail. Stems/ha Clear-Cut	Browsed Stems/ha Strip Cut	Browsed Stems/ha Clear-Cut	Preference Rating Strip Cut	Preference Rating Clear-Cut
White Birch	3118	1887	55	101	0.69	1.20
Trembling Aspen	938	1211	18	23	0.74	0.42
Pin Cherry	893	1197	14	75	0.62	1.57
Mountain Ash	136	378	18	77	5.11	4.54
Beaked Hazel	209	493	5	2	0.99	0.07
Green Alder	607	707	7	7	0.46	0.22
Willow spp.	505	502	5	19	0.41	0.85
Red Osier Dogwood	428	334	60	16	5.51	1.05
Mountain Maple	64	850	0	61	----	1.60
Balsam Fir	248	1007	0	2	----	0.08

There was no significant difference ($P < 0.05$) between the number of pellet groups/ha observed in alternate strip cuts and the clearcuts. We observed 22 pellet groups/ha in the clearcuts and 13 pellet groups/ha in the strip cuts.

Habitat Selection

The observed number of moose, track aggregates and browsed stems per hectare were all significantly greater ($P < 0.05$) in the clearcuts than in the strip cuts (Table 4). Only the observed density of pellet groups was within the expected proportion of selection for both timber harvest methods. Thus clearcuts appeared to be used more heavily than strip cuts.

Table 4. Selection of alternate strip cuts and clearcuts by moose based on observations of moose sightings, tract aggregates, browsed stems and pellet groups densities.

Observed Variable	Strip cut*	Clearcut*
Number of moose	-	+
Number of track aggregates	-	+
Browsed stems/ha	-	+
Pellet groups/ha	0	0

*Selection: (+) observed variable higher than expected level
(-) observed variable lower than expected level
(0) observed variable proportional to expected level

There was poor utilization of all available timber when the clearcut study sites were harvested. Except for Lever Lake, the clearcuts contain many pockets of dense coniferous timber or expanses of scattered hardwood species, from which all merchantable coniferous stems were removed. The proportions of the study areas comprised of cover associated habitat strata (dense conifer, scattered residual, hardwood and swamp) ranged from 31% in the Lever Lake clearcut to 74%

on the Edmondson Lake clearcut (Table 5). The number of moose observed in the clearcuts was not well correlated with the percentage of the area which was comprised of cover associated strata (r = 0.14), nor were the number of track aggregates (r = 0.03). The number of moose observed in the clearcuts was well correlated with the percentage of area covered by the 30 m influence zone (r = 0.81), and the number of track aggregates was moderately correlated (r = 0.72).

Table 5. Habitat availability, moose and track aggregate observances in clearcut study areas.

Study Area	Clearcut Habitat Area (ha) Open	Influence Zone	Cover Associated	No. of Moose Observed	No. of Tracks Aggregates Observed
Edmondson Lake	68.8	62.6	379.0	4	30
Mott Lake	116.3	78.0	166.5	14	133
Tease Lake	195.3	23.9	79.8	5	55
Lever Lake	92.5	19.1	50.5	0	0

Clearcuts were further classified into open habitat types (open natural and open planted), the 30 m influence zone, and cover associated habitat types (Table 6). This was done in order to determine what effect the 30 m influence zone exerted on moose utilization compared to the other clearcut strata. Only moose observations, track aggregates, and the number of browsed stems/ha observed were tested. There was no significant difference ($P < 0.05$) in the observed density ofpellet groups among the 3 major clearcut habitat strata.

Table 6. Selection by moose of clearcut habitat strata within clearcuts.

Habitat Strata	Moose Observed*	Track* Aggregates Observed	Browsed* Stems per Hectare
Open types	-	-	+
Influence zone	+	+	+
Cover associated types	-	-	-

*Selection: (+) observed variable higher than expected level
(-) observed variable lower than expected level
(0) observed variable proportional to expected level

The 30 m influence zone around dense conifer cover was preferred by moose based on all 3 indicators of use. The other open habitat types which have no appreciable cover were avoided according to moose and track aggregation observations, yet were preferred according to browsing. The cover associated habitat types were avoided, based on all 3 tested categories.

Ranta et al. (1982) used browsing "as a measure of activity and pellet group distribution as a measure of time spent in a habitat". In the harvested strips with pockets of scattered residual timber 3.8% of all available stems browsed, compared to harvested strips with no residual which had 3.6% of all available stems were browsed. The strips with pockets of residual hardwoods also had the highest densities of trembling aspen and white birch stems. Thus, the heavy use of the available browse in these strips is probably related to the high stem densities, and not to the presence of residual cover. Highest browse utilization of available stems in the clearcuts was observed in the hardwood (8.6%), open planted (6.7%) and open natural (6.3%) strata, indicating more moose activity in these strata than in areas associated with conifers and residual cover. The highest pellet group densities were observed in the scattered residual and open natural strata in the strip cuts and in the hardwood, open natural and influence zone strata in the clearcuts. The hardwood stratum in the clearcuts showed a significantly greater ($P < 0.05$) number of browsed stems and pellet groups densities, but had significantly fewer ($P < 0.05$) track aggregates and moose observations.

DISCUSSION

Our data suggested that moose utilization was greater in clearcuts than in strip cuts. It appeared that much of the winter activity in the clearcuts was dictated by the amount of residual cover left from unmerchantable timber or inoperable terrain. However, we found a poor correlation between the amount of residual timber left in the clearcuts and the number of moose observations and track aggregations. We suggest that winter utilization of clearcuts in 1984 is best explained by the amount of area within 30 m of coniferous cover, and not the amount of residual cover associated habitat types left on the clearcuts.

The heavy use of white birch, mountain ash, pin cherry, and trembling aspen are similar to that found by McNicol and Gilbert (1980). Willow (Salix spp.) was not a heavily browsed species, although it made up about 6 % of the available browse on both types of cut. Utilization levels of pin cherry in the clearcuts sampled was double that observed by McNicol and Gilbert (1980). Mountain maple was heavily browsed in the clearcuts sampled and constituted 16% of the browsed

stems in the clearcuts.

Clearcuts had a significantly greater number of browsed stems/ha in the open habitat and influence zone strata. White birch and pin cherry were major constituents of the moose diet in the open strata, and mountain ash and pin cherry were the major food species in the influence zone. Mountain maple was utilized only in the scattered residual and hardwood strata. This is unusual as we expected that mountain maple would be browsed most often in the dense conifer strata. Generally, mountain maple is considered an important browse species when moose have to utilize dense conifer areas due to deep snow conditions. Peek (1976) considered mountain maple a less palatable species and observed higher utilization of this species during a severe winter.

Heavy use of red osier dogwood (30% of the total browse consumed) in the alternate strip cuts may indicate an early winter utilization of this timber harvest method. Peek (1976) observed that red osier dogwood was utilized most heavily in the early winter before snow depths made it unavailable. One metre snow depths buried many red osier dogwood stems and limited the availability of this species for browsing (Peek 1974). Florkiewicz (1984) found high utilization of red osier dogwood in forest reserves and cutovers and suggested that these areas were utilized in the early winter months.

The low densities of pellet groups (about 17/ha) observed in all study sites reflects the low moose densities ($< .13$ moose/km^2) found in the study area (McNicol, pers. comm.). McNicol (1976) observed 36 pellet groups per hectare on 16 mixedwood cutovers in the same vicinity with moose densities of 0.31 moose/km^2. Similar to our study, Armstrong

(1983) found highest pellet group densities in hardwood stands and lowest in spruce stands.

The number of track aggregates observed in the hardwood strata increased and peaked at the end of January, and steadily decreased in February and March. Utilization of the hardwood habitat types likely occurred prior to January and would explain utilization discrepancies between the spring collected data and the winter flight observations. The number of moose tracks observed in the scattered residual portions of the harvested strips was proportional to the expected level based on the area occupied by this habitat type. The spring data and winter observations appear to substantiate each other.

It is not unusual that moose were observed in either the alternate strip cuts or the clearcuts after February 6, 1984. The lack of moose observations from mid to late winter is well documented. Phillips et al. (1973) found moose showed a preference for tall, mature hardwood cover during the winter rather than open areas. Addison et al. (1980) observed movement to coniferous cover in early to mid-winter as snow depths increased. Thompson et al. (1981) found decreasing moose observations from January through to the lowest number of observations in February. Welsh et al. (1980) observed movement from harvested areas to uncut timber as winter progressed. Crete and Jordan (1982) found that moose movements decreased in mid March due to thicker and harder snow. A heavy snow crusting caused by the mid-February rainfall was probably the most plausable explanation for the absence of moose in the open areas for the last half of the winter.

The importance of the conifer "edge" area in relation to

winter utilization of habitat by moose has been well documented. Neu et al. (1974) observed that moose preferred for a 400 m periphery in and around a burned area in northeastern Minnesota. Hamilton and Drysdale (1975) found a decrease in browse utilization with increasing distance from cover in 5 to 6 year old cutovers. Significant decreases in utilization were observed beyond 40 m from cover, with no utilization observed past 100 m from cover. Stone (1977) observed mixed results concerning utilization of browse next to the edge of clearcuts in Maine, mainly due to utilization of skid trails throughout the clearcuts. McNicol and Gilbert (1980) found that the edge around conifer residual in a cutover was utilized significantly more than the edge around the periphery of the cutover. Hamilton et al. (1980) observed utilization of cutover edges until late February and suggest this could be to avoid wind chill and predators.

If alternate strip cuts provide similar conditions to the 30 m influence zone around conifer cover in clearcuts, why were they utilized less? Although the alternate strip cuts had less available browse than the clearcuts, we believe that this can best be explained by snow conditions in the strip cuts. 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. Hoover and Leaf (1967) observed higher snow levels in harvested strips and less snow in leave strips than there was before their study area had been strip cut. Although total snowfall for the entire area remained unchanged, distribution patterns had been changed due to the increased snow trapping effectiveness caused by the openings created. Hoover (1971) stated that snow trapping in forest openings was most effective where turbulence occurs near the top of clearings which have relatively calm air at the bottom. Increased wind turbulence against the uncut strips results in deposition of snow lodged in the forest canopy into the adjacent harvested strips.

Costin et al. (1961, cited by Hoover, 1971) observed shallowest snow depths in open areas, increased depths under trees and deepest snows in small forest openings. Deeper snows in harvested strips than in uncut strips have been observed by Bay (1955), Hoover and Leaf (1967) and Clausen and Mace (1972). Clausen and Mace (1972) found significantly deeper snows in north-south orientated strips than in east-west orientated strips. The literature shows that moose move from open areas to heavy cover when snow depths exceed 50 cm (Berg 1971, Peek 1971 and Phillips et al. 1973). As alternate strip cuts provide the micro climatic conditions which effectively trap snow, it is conceivable that the increased snow depths in a heavy snow year could cause moose to avoid utilizing them.

This study is continuing over the winter of 1985 as part of a M.Sc. Forestry thesis. Flight data are being collected from December 1984 to April 1985 to provide additional information on the utilization of alternate strip cuts and clearcuts by moose.

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