THE INFLUENCE OF ACCESSIBILITY ON MOOSE HUNTING IN NORTHWESTERN QUÉBEC

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ABSTRACT: Moose (*Alces alces*) density, hunting pressure (days / km^2), sport harvest, and harvest rate (% of the population killed) were monitored in study blocks supporting different types and sizes of clear cuts in order to identify the impact of road access on moose hunting. The block with the lowest moose density (0.11 moose / km^2) was the Control Block which was dominated by virtually unexploited mature coniferous stands. Densities were moderate to high in the cut blocks (0.22-0.58 moose / km^2). We measured a 3 - 6% non-significant ($P > 0.05$) increase in harvest rate by sport hunting in 2 blocks surveyed before and after cutting. After cutting, harvest rate was moderate in the first (15.4%) and high in the second block (23.7%). In the blocks surveyed exclusively after cutting operations, harvest rates were high (23-29%). Overall, among all blocks and years, harvest rate was 19.6% before cutting and 23.5% after. Hunting pressure increased in recently cut blocks but moose density and proximity from urban areas were as important as road access in influencing hunting pressure. Camp-hunters, who yielded the majority of harvested moose, did not rely exclusively on forest roads for access to their hunting sites. The majority of them (70%) hunted in 2 km^2 or less, and consequently their hunting sites were not adequately protected by existing forest harvesting guidelines.

Key words: harvest, harvest rate, hunter characteristics, hunters, hunting pressure, moose density

RÉSUMÉ: La densité de l'orignal, la pression de chasse (jours de chasse / km^2), la récolte sportive et le taux d'exploitation (% de la population récoltée) de l'orignal ont été évalués dans des blocs d'étude où l'on retrouvait divers type de coupes de superficie variable. La plus faible densité (0,11 orignal / km^2) a été retrouvée dans le bloc témoin qui était couvert de peuplements résineux matures pratiquement sans coupe forestière. Les densités étaient de moyennes à fortes dans les blocs coupés (0,22-0,58 orignal / km^2). Après coupe, le taux d'exploitation a augmenté de 3 à 6% pour atteindre 15,4 et 23,7% dans les deux blocs qui furent suivis avant et après coupe. Ces changements n'étaient pas significatifs ($P > 0{,}05$). Dans les blocs inventoriés exclusivement après coupe, les taux d'exploitation étaient élevés (23-29%). Au total pour l'ensemble des inventaires, le taux d'exploitation était de 19,6% avant coupe et de 23,5% après. La pression de chasse a augmenté dans les blocs récemment coupés, mais la densité de l'orignal et la proximité des centres urbains sont des variables tout aussi importantes pour expliquer l'ampleur de la pression de chasse. Les chasseurs en camp, qui rapportent la majeure partie des orignaux récoltés, ne dépendent pas exclusivement des routes forestières pour accéder à leurs sites de chasse. Environ 70% d'entre eux chassent dans de petits territoires de 2 km^2 ou moins, lesquels ne sont pas adéquatement protégés par les normes d'exploitation forestière actuelles.

Mot-clés: chasseur, densité, portrait, pression de chasse, récolte, taux d'exploitation

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It is widely accepted that any kind of disturbance that rejuvenates the forest is beneficial to moose (Krefting 1974, Crête 1988, Timmermann and McNicol 1988, Loranger *et al.* 1991). This includes forest cutting which is actually the main disturbance agent of northern forests, due to the protection of forests against wild fires (Crête 1988). In the long term, this activity, like other disturbance agents, increases browse production and consequently improves the quality of moose habitat (Vallée *et al.* 1976, Joyal 1987). However, increasing habitat quality does not always have a favourable impact on moose population dynamics. Clear cutting, which is the usual forest harvesting technique in northern forests, creates large openings and new roads that facilitate access for hunters, leading to higher harvest rates and population declines (Eason *et al.* 1981, Girard and Joyal 1984, Eason 1989, McMillan *et al.* 1995, Rempel *et al.* 1997). While clear cuts have the potential to facilitate hunting, moose hunters generally dislike them because they disrupt the natural aspect of the landscape and because they may increase competition among hunters who are looking for exclusive hunting sites (Bugnet *et al.* 1998).

As part of a 5-year project to study the impact of forest cutting on several species (Potvin and Courtois 1998), we also investigated the impact of accessibility on moose harvest and on the reactions of moose hunters. Moose density, moose harvest, and the distribution of hunters were monitored in a control site, in cut areas, and in sites where cutting operations were planned in order to estimate the impact of road access on harvest rate (% of the moose population killed) and hunting pressure (number of hunting days / km^2).

STUDY SITE

The study was conducted in a 2,183 km^2 study area located in northwestern Québec (Fig. 1). This large area was divided into 25 blocks ranging from 21 - 180 km^2 ($\bar{x}$=87.3, SE = 8.4 km^2) based on easily identifiable landmarks (streams, roads, etc.). The dominant tree species of the area were black spruce (*Picea mariana*), jackpine (*Pinus banksiana*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*). The terrain is mostly flat or gently rolling with hills rarely exceeding 350 m above sea level. Lakes and streams occupy between 8 and 17% of the area depending on the study block. Two main types of cutting methods were employed: large clear cuts without protected regeneration (CT) that were 7-11 years old at the time of the study, and recent cuttings with protected regeneration (CPR) that were mostly made between 1992 and 1994. Characteristics of these 2 types of cuts have been previously described (Courtois *et al.* 1998b). Cut areas occupied between 4 and 68% of the study blocks. Studies were more intensive in 7 of these blocks, with both moose and moose hunter surveys being conducted. Block 5, cut over only 4% of its area, acted as a Control Block. Blocks 16 (50% cut) and 19 (68%) supported 7-11 year-old CTs whereas Blocks 3 (29%), 11 (46%), 13 (44%), and 20 (43%) were covered with 2-3 year-old CPRs.

METHODS

Moose densities were estimated in January or February in 7 of the study blocks, these blocks being covered 2 - 5 times between 1990 and 1994, depending on available budget. The blocks were completely covered using transects spaced 500 m apart with helicopters (Hughes 500 C or D) flying at 160 km / h and at an altitude of 100 m above the ground in order to locate the track networks. Identified track networks were flown again at reduced speed and low altitude to count moose. Densities were corrected using a 0.82 visibility rate estimated from collared animals (Paré 1996). The sport harvest (1989 - 1994) was quantified in the 25 study blocks using the big game mandatory registration program of the Ministry. Harvest rate by sport hunting was estimated [harvest / (population in winter +

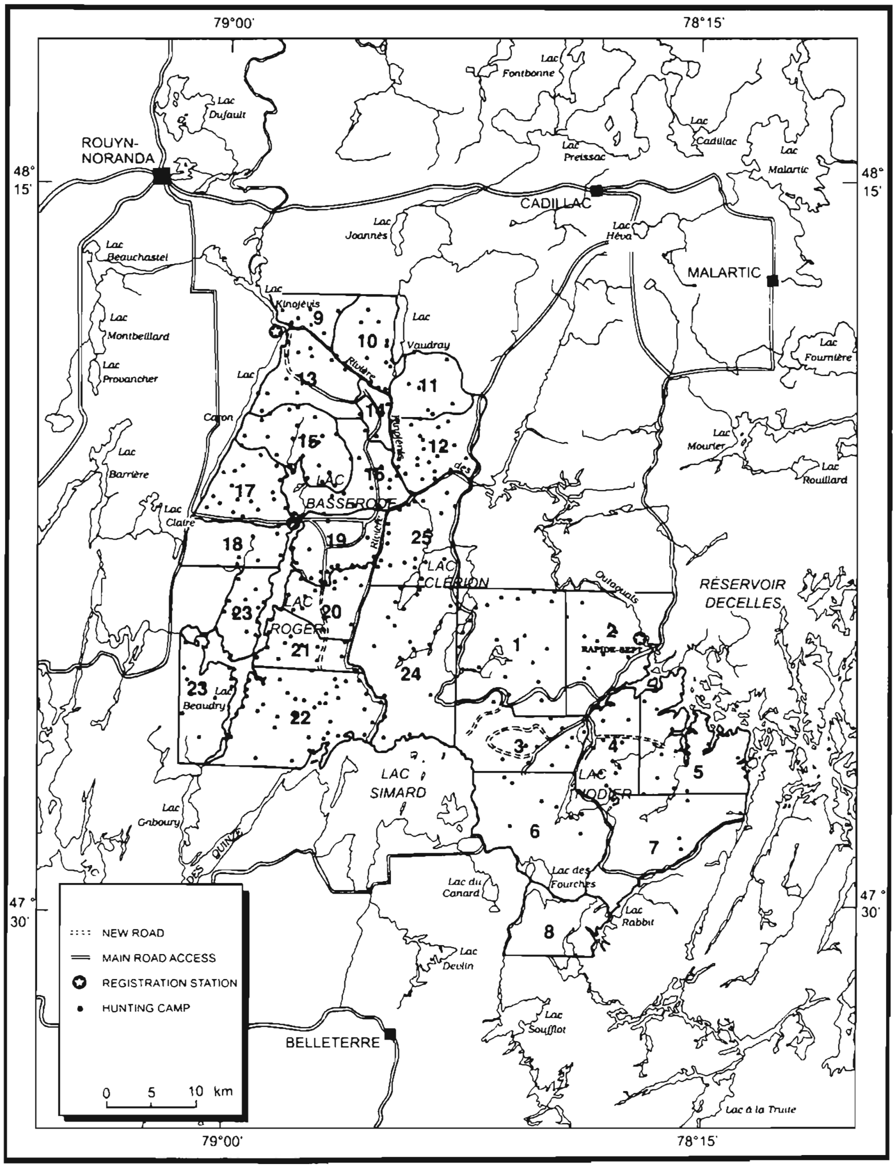

Fig. 1. Blocks used to study the impact of forest cutting on moose and moose hunters in northwestern Québec (~ 78° 40' W, 47° 50' N). Most data were collected in Blocks 5 (Control), 3, 11, 13, 16, 19, and 20. ═══ forest roads available at the beginning of the study; ==== = forest roads constructed during the study.

harvest)] in the 7 blocks where winter density was known, assuming no natural mortality between fall and winter.

Five accessibility indices (number of hunting camps, length of forest roads, trails, rivers, and area of lakes) were evaluated in all blocks using 1:50,000 topographic maps and data available in files. Hunting camps were defined as permanent camps constructed in the forest and registered in the files of the Ministry of Natural Resources. These camps are used for moose hunting but some can also be employed for fishing or trapping. Registration stations were operated during the firearm hunting season in order to estimate the number of hunting days by moose hunters in each study block. One station was operated in 1990, 2 were operated in 1991, and 3 were operated between 1992 and 1994. The registration stations were located on the main access roads to the study sites (Fig. 1). An unknown number of hunters accessed the study site from the southern boundary. The location of the registration stations allowed the registration of almost all hunters frequenting Blocks 2 - 5 (since 1990) and 13, 14, 16, 19, and 20 (between 1992 and 1994). In the fall of 1990, the number of hunting days was estimated by distributing a questionnaire at the beginning of the hunting season when hunters arrived at the study site and by asking them to return it by mail. From 1991 - 1994, the registration stations were operated during the entire hunting season. This allowed hunters to be interviewed at the end of their hunting trip which provided an exact record of hunting days within each block. We used the Pearson correlation coefficient to assess the relationship between mean harvest and the 5 accessibility indices. As the normality of the data was not rejected ($P > 0.05$), *t*-tests were used to compare density, harvest rate, and hunting pressure before and after cutting.

RESULTS

Variables Influencing Moose Harvest

Moose density was low ($\bar{x} \pm SE = 0.11 \pm 0.02$ / km^2, $n = 4$) in the Control Block. Before cutting, densities were moderate (0.22 - 0.25 / km^2) in Block 3 and high (0.70 / km^2) in Block 20. In Block 3, density decreased to 0.18 immediately after cutting but re-established itself afterward (0.24 ± 0.05 / km^2, $n = 2$). In Block 20, density fell by approximately 30% after cutting and remained stable thereafter (0.53 ± 0.17, $n = 3$). In the blocks surveyed exclusively after cutting, densities were moderate and variable from year to year (Block 11: 0.18 ± 0.05, $n = 4$; Block 13: 0.24 ± 0.05, $n = 3$; Block 16: 0.34 ± 0.17, $n = 2$; Block 19: 0.22 ± 0.03, $n = 3$).

Harvest rate varied between 8 and 33% in the Control Block ($\bar{x} \pm SE = 22.5 \pm 5.8\%$). In the 2 blocks surveyed before and after cutting, we observed a 3 - 6% increase in harvest rate after cutting. In Block 3, harvest rate was $9.3 \pm 1.4\%$ before cutting and $15.4 \pm 1.7\%$ after. In Block 20 harvest rate was $19.8 \pm 0.3\%$ before cutting and $23.7 \pm 4.9\%$ after. Differences were not significant due to the very small sample sizes ($t < 1.7$, $P > 0.05$). In Blocks 11, 13, 16, and 19, harvest rates were high (23-29%). Overall, in all blocks and years, the harvest rate was $19.6 \pm 3.2\%$ ($n = 9$) before and $23.5 \pm 3.0\%$ ($n = 16$) after cutting ($t = 0.886$, $P > 0.05$).

Correlation between sport harvest and accessibility indices for the 25 blocks of the entire study area showed that mean annual harvest was highly correlated ($P < 0.01$) with the number of hunting camps ($r = 0.8$), the length of large rivers ($r = 0.6$), and the area of lakes ($r = 0.5$). The length of forest roads ($r = -0.2$), the length of trails ($r = 0.3$), or the area cut ($r = 0.4$) were not correlated with the mean harvest. Harvest pressure (harvest / km^2), which compensates for the differences in the area of the blocks, was also correlated to the density of hunting camps ($r = 0.7$, $P < 0.01$), lakes ($r = 0.4$, $P = 0.05$), and large rivers ($r = 0.4$, $P = 0.02$). The length / km^2 of forest roads ($r = -0.2$) and trails ($r = 0.2$), as well as the cut area / km^2 ($r = 0.2$) were not significantly correlated with harvest density.

Hunting pressure (hunting days / km^2) appeared to be equally influenced by the proximity of urban areas, road access, and particularly moose density (Fig. 2). In the

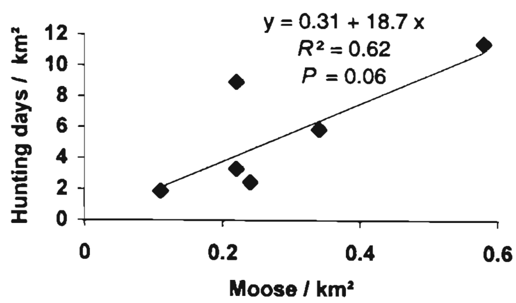

Fig. 2. Regression between hunting pressure and moose density in the study blocks of northwestern Québec where moose hunter census was complete.

eastern part of the study site, hunting pressure was twice as high in Block 3 which was accessible by road, as in Block 5 which was not (Table 1). In Block 3, hunting pressure increased from 2.8 ± 0.4 hunting days / km^2 (n = 2 years) before the construction of new forest roads, to 3.7 ± 3.1 (n = 3) after forest cutting (Fig. 3). The hunting pressure was much higher in the western part of the study site, located closer to the main urban area of northwestern Québec, reaching 12-16 hunting days / km^2 in Block 20. New roads were constructed in Block 20 in 1992 and in Block 21 in 1993. During that period, hunting pressure decreased in Block 19 but, thereafter, increased in Block 20 and 21 following road creation. Considering Blocks 20 and 21 together, hunting pressure increased from 9.5 / km^2 to 12.1 ± 0.8 (n = 2) following cutting. Nevertheless, hunting pressure was much lower in Block 13, which was not easily accessible by road, than it was in Blocks 16 and 19, which were. Moose density had a clear influence on hunting pressure (Fig. 2 and 3). The highest hunting pressure was observed in Block 20 where moose density was the highest. Hunting pressure was not related to the proportion of the block cut ($P > 0.05$). For example, Blocks 16 and 19, which were the most intensively deforested, did not support the highest hunting pressure.

Moose Hunters

The first investigation, in 1990, allowed us to determine the general characteristics of hunters. This census showed that hunters seemed loyal to their hunting territory (the area they frequent when they hunt moose) as the 472 individuals questioned had hunted in the same study block for an average of 7.8 years. These hunters declared a total harvest of 586 moose in previous years, which is a mean annual harvest of 0.38 moose per hunting group. The majority of groups consisted of 2 (59%),

Table 1. Hunting pressure, road access, and moose density in the study blocks of northwestern Québec where moose hunter census was complete. $\bar{x}$± SE, n = number of censuses.

Block	Hunting days / km^2			km roads	Density	
	Camp	Vehicle	n	/ km^2	Moose / km^2	n
Eastern part of the study site						
3	2.87±0.24	0.44±0.09	5	0.077	0.22±0.02	5
5	1.84±0.23	0.04±0.03	5	0.002	0.11±0.02	4
Western part of the study site						
13	2.43±0.15	0.02±0.01	3	0.007	0.24±0.05	3
16	4.56±0.86	1.29±0.37	3	0.020	0.34±0.17	2
19	7.27±1.74	1.68±0.13	3	0.038	0.22±0.03	3
20	9.81±0.50	1.61±0.52	3	0.008	0.58±0.04	4

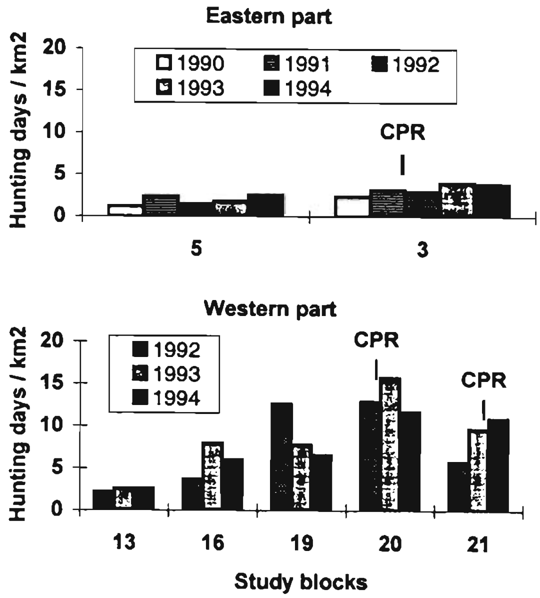

Fig. 3. Number of hunting days / km² spent by moose hunters in the study blocks of northwestern Québec surveyed before and after cutting. Blocks 3, 20, and 21 were cut with the protected regeneration (CPR) technique before the hunting seasons of 1992, 1993, and 1994 respectively.

3 (19%), or 4 (12%) people. Two categories of hunters were identified from interviews held between 1991 and 1994: vehicle-hunters who use trucks or cars to patrol the hunting grounds and who hunt on a daily basis ($\bar{x} \pm$SE= 1.2 ± 0.03 days, *n* = 1,201); and camp-hunters who conduct their sport from a "pied-à-terre" (camp, tent, or trailer) in the forest, hunt for a period of nearly 1 week (5.5 ± 0.1 days, *n* = 1,127), and spend 8.1 ± 0.8 days (*n* = 145) preparing their hunting trip. Camp-hunters usually had small territories of a few km² ($\bar{x} \pm$SE=3.4 ± 0.5 km², *n* = 161) and 70% of them hunted in territories ≤ 2 km². Legally speaking, hunting territories are not exclusive but most camp-hunters place signs to identify their territory and other hunters usually comply with them. Vehicle-hunters covered several blocks, driving all day, often more than a hundred kilometres, and invested much less time in preparation (2.9 ± 0.8 days, *n* = 43). They harvested ruffed grouse (*Bonasa umbellus*, 9.3 / 100 hunting days) and spruce grouse (*Dendrapagus canadensis*, 4.3 / 100 hunting days) as well as moose (0.4 / 100 hunting days). Camp-hunters concentrated on moose hunting (1.8 / 100 hunting days) and harvested less game birds (5.7 ruffed and 1.5 spruce grouse / 100 hunting days) even though the 2 categories of hunters had comparable opportunities to harvest small game (vehicle: 17.5 ruffed grouse, 5.2 spruce grouse, and 2.2 moose seen / 100 hunting days; camps: 24.3, 6.1, and 3.4 respectively). During our 5-year study the number of hunters in both categories was similar (2,332 in vehicle vs. 2,706 in camps) but vehicle-hunters hunted 5.5 times fewer days compared to camp-hunters (2,750 vs. 15,179) and harvested very few moose (15 vs. 193).

DISCUSSION

As in other studies, we observed an increase in harvest rate after the occurrence of cutting. However, in this study changes were not significant, this probably being due to small sample sizes (2 - 3 years before and after cutting). Our results in 7-11 year-old CTs suggest that harvest rates remained high (23 - 29%) for at least a decade in cut areas. Nevertheless, harvest rates were not high enough to induce a 75% density decline as reported by Eason *et al.* (1981) in a 150 km² study block in Ontario. In the blocks we surveyed before and after cutting, the number of hunters increased substantially (109 and 77 hunters per year in Block 3 and 20 respectively) but the increase in harvest involved only 1 or 2 moose. Consequently, moose density declined only slightly after cutting and re-established itself 1 - 2 years later. The study period was too short to correctly depict temporal trends in the blocks that were recently cut. However, the high harvest rate noted after cutting seemed sustainable since moose were still present in moderate densities (0.2 – 0.3 moose / km^2) in Blocks 16 and 19 which had been heavily cut (50 – 68% of their area) 7 - 11 years before the study. Such a situation could be partly explained by the relatively high productivity of this population (overall mean = 47 calves / 100 cows in winter; 26.1% of the population).

While attracted by new road access, most hunters in our study site remained faithful to their hunting territory. This reaction may be explained by the difficulties in preparing a new hunting territory (finding a suitable site, building a camp, preparing tree stands, trails, etc.). Moreover, most hunting sites were already occupied by other groups of hunters, at least near urban areas. For example, in the western part of our study site, there were 0.21 hunting camps / km^2 (SE = 0.02, n = 25) and the hunting pressure reached 12 - 16 hunting days / km^2 in Block 20. Such a high hunting pressure was about 5 times that noted in Block 3, more distant from urban areas, and higher than usually observed in western Québec (Hunting Zone 13) and in most North American jurisdictions (Crête 1987, Nedelca 1990). Considering that hunters try to maintain exclusive territories, it was not surprising that the creation of new access during forest harvesting resulted in competition among hunters (Bugnet *et al.* 1998). This may explain the small increase in moose harvest and harvest rate in spite of changes in hunting pressure.

The number of hunting camps, the length of large rivers, and the area of lakes were the most important variables influencing moose harvest in the study area. These variables appeared more important than the density of access roads. Paré and Courtois (1990) also stressed the importance of hunting camps on a larger scale in northwestern Québec (Hunting Zones 12 and 13). Moreover, they found that moose density was inversely correlated with the number of hunting camps and the length of usable roads. North of our study site (Hunting Zone 16), where land access was limited, Paré (1991) did not find any relationship between moose density and the length of forest roads. However, the number of hunting camps was positively correlated with the area of track networks, an index of moose abundance. These results were consistent with this study and suggest that hunters look for high moose density and locate their hunting camps in these areas with little concern for road access. Hunters will use roads whenever possible, but can easily use boats or planes to access their hunting territory. When camp density is high, hunting pressure may increase sufficiently to reduce moose density. This was observed on the North Shore of the St. Lawrence River in Zone 19, a large northern zone where accessibility is very low (Gingras *et al.* 1989).

Managers should be aware that they need to evaluate other parameters besides road density when assessing the impact of accessibility on moose hunting because the influence of new access roads and the characteristics of hunters can vary regionally. In this study, the creation of new roads only resulted in a small increase in harvest rate because the camp-hunters were already established in the study areas before the creation of new access and the vehicle-hunters who used these new roads were less active and less efficient than camp-hunters. However, the impact of new roads may be more dramatic in northern areas that were completely inaccessible before cutting. About 150 km north of our study site, Colin and Walsh (1991) reported a 4-fold harvest increase in 100-km^2 study blocks where $\geq$ 25 - 30% of the block was cut (0.028 moose harvested / km^2) compared to blocks where $\leq$ 5% was cut (0.006 moose / km^2). They also reported that the harvest declined slightly when > 35% of the block was cut (falling to 0.020 moose harvested/km^2 where ≥ 90% of the block was cut), suggesting a density decline due to unsuitable habitat or over-harvest.

While CPRs produce good moose habitat 10 - 15 years following cutting, moose do not use them sufficiently after cutting for these sites to be considered as good hunting grounds (Courtois *et al.* 1998a). The negative attitude of hunters towards forest harvesting (Bugnet *et al.* 1998) is easy to understand considering that the most active hunters stay in camps, hunt in small territories of about 1-2 km^2, and remain faithful to their hunting territory for 5 - 10 years. Any important habitat modification has a major impact on them. For example, forest management guidelines in use during our study limited cutover size to 2.5 km^2 (MER 1989). Consequently, a single cutover was sufficient to completely cover a hunting territory. The 1995 revised guidelines limit the cutover size to 50 - 100 ha, but cutovers can be juxtaposed by keeping a 60 - 100 m strip between 2 adjacent cutovers. Managers must consider the possibility of dispersing the cutovers over the entire landscape in order to satisfy the needs of moose hunters.

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