RELATION OF MOOSE TRACK COUNTS

TO COVER TYPES IN NORTH-CENTRAL ONTARIO

By

H. G. Cumming[1]

ABSTRACT: Counts of moose tracks during 1394 km of transect flights over the coniferous forests and clear-cuts of north-central Ontario showed that moose frequented spruce stands more than jackpine stands, but probably preferred stands with a hardwood component. Tracks in partially cut areas were 3X as numerous as in uncut spruce and 13x as numerous as in jackpine; however, entirely cut and lightly cut areas did not show significantly more tracks than uncut spruce. Possible ecotone effects were suggested by increased tracking near lakes, streams and roads in uncut forests and by some high counts in spruce adjacent to cut areas.

MOOSE TRACK COUNTS RELATED TO COVER TYPES

IN NORTHERN ONTARIO

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H. G. Cumming[1]

Moose (*Alces alces*) habitat requirements have attracted increasing attention in recent years (e.g. Chamberlin 1972, Hamilton and Drysdale 1975, MacLennan 1975, Peek, Urich and Mackie 1976, Vallée and Couture 1976,

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Hunt 1976, Usher 1977, Nowlin 1978, McNicol and Gilbert 1980); but much remains to be learned before moose managers can confidently request costly alterations in forest management practices knowing that they are supported by solid facts. All too often they must fall back on generalizations such as "moose prefer early successional stages and thus benefit from cutting operations" and "ecotones increase wildlife densities". Are these statements always, or even generally, true? What increase in moose densities can we expect when an area is cut? Do moose really respond to ecotones the way some smaller animals do? Specific questions like these remain difficult to answer. An opportunity to find some evidence concerning the effects of cover types on moose dispersion occurred during the winter of 1977-8 when, as part of a woodland caribou (*Rangifer tarandus caribou*) research program, I flew over coniferous forests east of Lake Nipigon, Ontario, Canada. Since the area was inhabited by moose, I recorded the locations of moose tracks and cover types to answer the question, "Are moose densities related to forest types, cut-over areas or ecotones?"

STUDY AREA

The study area of 6,000 km^2 extended from 16 km north of Highway 17 northward to the transcontinental line of the Canadian National Railway and from 22 km east of Onamon Lake westward to Lake Nipigon (i.e. 49^0 50' N to 50^0 15' N and 87^0 to 88^0 W). The country is relatively flat with two large lakes (Fig. 1), Nipigon (3,000 Km^2) and Onamon (70 km^2), as well as a multitude of small lakes and streams. Temperatures are cold, often to -40^{0}C in winter, and precipitation is moderate at about 70 cm of water per year.

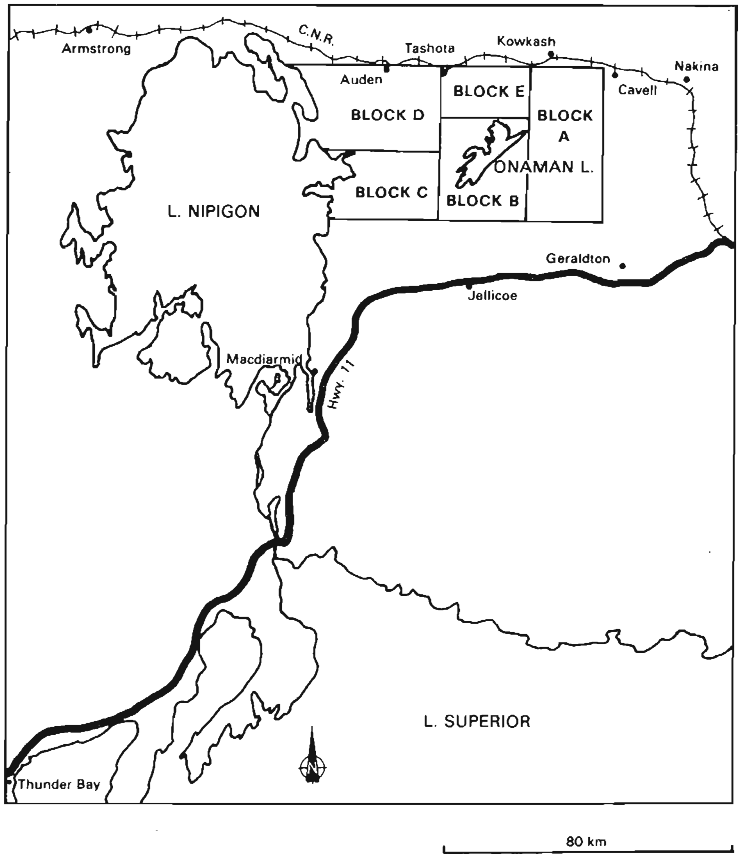

Fig 1. Location of study area showing blocks that were surveyed separately.

Snow depths exceed 1 m only during exceptional winters. During the winter of 1977-78 little snow fell after one storm in early January, and depths never exceeded 50 cm. Snow-mobile tracks made in mid-December were visible all winter.

The area was mostly covered with virgin boreal forest. Only a few stands followed early logging. Spruce (mainly *Picea mariana* but with some *P. glauca*) occupied 60% of the land area; jackpine (*Pinus banksiana*) covered another 15%; mixed conifer-hardwoods occupied only 10% (Appendix 1). A few stands of aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*) and eastern white cedar (*Thuja occidentalis*) were also recorded but too few to contribute to over-all percentages.

Disturbances included cutting, blowing down and burning. In most recognizable cut areas, operations had been so recent that regeneration had not passed the shrub stage (0-20 years depending on soils and local climate). All but one were clear-cuts and together they occupied 12% of the area. A few cut-overs were old enough to support half grown trees but they amounted to only 0.1% of the area. Places where trees had blown down constituted nearly 2% of the area, whereas recognizable burned portions amounted to less than 0.1%. Topographic maps showed bogs over nearly half the area. Only three major roads were plowed during winter.

Human settlements included some tiny villages (inhabited mainly by native people) along the railway at the northern boundary, and a pulp cutting camp on the Onamon River near Lake Nipigon. A few summer cottages and outpost cabins were scattered through southern portions of the study area. Logging, commercial fishing, trapping and some mineral exploration constitued the major human activities.

Hunting for moose also took place from mid-October to mid-December. Hunting pressure was significant near haul roads and the northern villages but relatively light elsewhere.

METHODS

I divided the study area into 5 blocks of suitable size for surveying from the air in one day. Within each block I drew transect lines on 1:126,720 maps. The first two blocks (A and B, Fig. 1) were flown in transects at 1.5 km spacing. However, the spacing proved unnecessarily close for the caribou study and the remaining blocks were laid out at 3 km spacing. Since I was not attempting to observe all the area between transect lines, the change in transect configuration did not affect the moose study. Three blocks (A, B and D) were laid out in north-south transects and two (C, E) in east-west transects for optimum use of aircraft time, but changes in direction did not affect my ability to see tracks.

We flew one block on Jan. 19, 21, Feb. 21 and two blocks on Mar. 16. Since I had decided to count tracks, rather than moose, I insisted on searching only from 1000-1400 hrs. on clear sunny days; these conditions provided sufficient shadows for delineating tracks without tree shadows being dense enough to hide them. We maintained heights of about 200 m in a Cessna 185 aircraft. Although other observers were in the aircraft, I alone recorded observations related to this study. Rather than attempting to cover some specified transect width or the entire area between transects, as MacLennan (1975) and Hunt (1976) did, I found a comfortable viewing angle and allowed my line of sight to determine an imaginary transect on the ground. I then recorded on the maps (1) all cover types intersected by my imaginary line and (2) each set of moose tracks that crossed this line.

My classification of cover types included (1) spruce (2) jackpine (3) mixed conifer-hardwood (4) cut-over (5) blowdown and (6) burned area. Spruce and jackpine were easily differentiated by their crown forms and colours. Blowdown areas were apparent from the large number of trees lying parallel on the ground. Burns were identified by blackened standing trees. I also recorded some additional tree species and old cut-overs but these were too few to contribute to my analysis (Appendix 1).

To analyse results, I divided the map transects into contiguous 5 km segments. I then estimated by eye the proportion of each segment marked on the map as some particular type of cover and recorded these in tenths. Thus spruce_{10} would indicate a segment entirely covered by spruce. Spruce_7 jackpine_3 would indicate 70% of the segment marked as spruce and 30% as jackpine.

To avoid unmanageable combinations of cover types in further calculations, I then classified the segments as being pure stands, 7-9 tenths of one type, or segments with no single species occupying more than 6 tenths which were designated in the tables as "other". The only exception to this rule was in cut-overs for which I recognized a category of 1-6 tenths.

RESULTS

In 1394 km of transect flights, the average numbers of moose tracks per transect segment varied significantly among cover types (χ^2= 6.76, $P < 0.05$). Highest track frequencies occurred on partially cut plots and on the few segments classified as mixed conifer-hardwood forest (Table 1). Lowest frequencies occurred on segments mainly or completely forested with jackpine.

Table 1. Average number of moose tracks per transect segment by cover type.

	COVER TYPES										
	S_{10}*	S_{7-9}	Pj_{10}	Pj_{7-9}	Mx_{10}	Mx_{7-9}	Co_{10}	Co_{7-9}	Co_{1-6}	Bl	Other
Number of segments	38	80	4	9	2	4	6	13	37	1	43
Number of moose tracks per segment	1.18	1.06	0.25	0.44	3.00	2.00	1.33	3.23	1.67	1.14	

Note: Throughout this report the following symbols are used:

S - *Picea* spp.
Pj - *Pinus banksiana*
Mx - Conifer - hardwood mixture
Co - Cut-over
Bl - Blowdown
Other - Mixtures too great to classify
* Numbers indicate tenths of plot covered by timber type.

Table 2. Counts of moose tracks on cut and uncut areas during different periods of winter.

	Jan. 19 (Block A)	Jan. 21 (Block B)	Feb. 21 (Block C)	Mar. 16 (Block D, E)	
No. uncut segments	37	108	51	63	40
Tracks/uncut segment	0.68	1.48	0.98	2.10	1.60
No. cut segments	20	28	6	6	0
Tracks/cut segment	1.15	2.14	1.83	3.50	0

Since survey dates ranged from January to March, changes in use of cut areas seemed likely (Cf Welsh et al., in press); however, track frequencies remained higher on cut than on uncut segments even during March (Table 2) and a comparison of the five counts showed no significant difference among blocks surveyed on different dates (χ^2= 4.84, 0.10 > P > 0.25). Furthermore a comparison of the March counts with the total for all earlier counts again showed no significant difference (χ^2= 0.436, 0.50 > P > 0.25). Therefore I combined the data from all counts for further analysis.

On undisturbed segments, the numbers of tracks differed significantly among the spruce, jackpine and mixed timber types (χ^2 = 6.76, 0.05 > P > 0.025). Since spruce covered most of the area, I used it as a standard. One quarter as many moose tracks were found on jackpine segments as on the spruce segments (χ^2 = 3.89, 0.05 > P > 0.025). Two or three times as many tracks were recorded on mixed segments as on spruce segments but the differences were not significant (χ^2 = 2.26, 0.1 < P > 0.25). Thus the low counts in jackpine contributed most to the significant differences found among frequencies of moose tracks on undisturbed plots.

All segments disturbed by cutting showed higher track frequencies than segments forested primarily in spruce (Table 1). When the segments cut 10, 7-9, and 1-6 tenths were compared with segments supporting spruce, the differences were not significant (χ^2 = 7.12, 0.01 > P > 0.05), but when all cut segments were combined and compared with spruce the difference was highly significant (χ^2 = 8.27, P < 0.005). Individual comparisons showed that the segments cut 7-9 tenths contributed the major increase in track densitites compared with spruce (χ^2 = 6.85; P > 0.01).

In fact they contained 3x as many tracks as uncut spruce and 13x as many as uncut jackpine. The entirely cut segments (χ^2 = 0.04, P > 0.09) and the segments cut 1-6 tenths (χ^2 = 1.27, 0.50 > P > 0.25) did not differ significantly from the spruce segments. Neither of the other two types of disturbance, fire and wind, affected enough area to allow meaningful analysis of the results, but the lack of tracks indicated that blowdowns were almost completely avoided (Appendix 2).

The number of moose tracks on any one plot varied from 0-9 (Table 3). Only on spruce and cut-over areas was the count 5 or more. Inspection of field maps showed that half of the high counts in spruce occurred adjacent to segments with some cut sections. Therefore the very high track counts were mainly associated with cut areas. Counts of 4 moose or more (Appendix 2) occurred on segments accounting for 23% of the recorded cut-over tenths, 11% of the mixed tenths, 9% of the spruce tenths but only 2% of the jackpine tenths; these variations in cover type use were highly significant (χ^2 = 60.49, P < 0.005). Similarly segments with 2-3 tracks made up 38% of the mixed tenths, 28% of the blowdown (but numbers were very small), 24% of the cut-over; 23% of the spruce and 14% of the jackpine; again these variations in cover type use were highly significant (χ^2 = 28.09, P < 0.005). However the number of segments with only one moose did not vary significantly among cover types (χ^2 = 6.80, .10 > P > 0.05), nor did the number of segments without any tracks (χ^2 = 6.93, 0.75 > P > 0.50). Therefore the use of spruce and cut-overs was more pronounced among segments showing higher frequencies of tracks.

Major ecotones in uncut forests might be expected to occur along streams, lakes and roads which provide brushy edges.

Table 3. Numbers of moose tracks on each segment by cover types

Number of moose tracks on the segment	S_{10}	S_{7-9}	Pj_{10}	Pj_{7-9}	Mx_{10}	Mx_{7-9}	Co_{10}	Co_{7-9}	Co_{1-6}	Bl_{7-10}	Other
0	18	39	3	6		1	3	1	12	1	17
1	11	17	1	2			1	3	7		11
2	4	12		1	1	1	1	3	7		11
3	2	4				2		2	7		4
4	1	2			1				1		1
5	2	3					1	2	2		
6	1								1		
7									1		
8								1			
9								1			

On transect segments covered entirely with spruce, 64% of the moose tracks occurred within 1 km of such features (Table 4). Segments covered 7-9 tenths with spruce showed 48% of the moose tracks near presumed ecotones. Other undisturbed segments provided too few counts for individual analysis, but, when combined, 57% of the moose tracks were near lakes, streams or roads. In contrast, on segments where cutting had taken place only 18% of the tracks were near such features and the overall difference from uncut areas was highly significant ($\chi^2 = 44.33$, $P < .005$). Thus moose appeared to relate to these features in uncut forests but not in cut-overs.

DISCUSSION

Tracks observed during this study represented the Jan-Mar distribution of moose in a simple ecosystem during a winter with little snow. The lack of any pronounced movement from cut-over to conifer areas in March does not bear out the suggestion of Welsh et al. (in press) that seasonal movements may be general throughout Ontario, but this difference may be explained by the unusually low snow levels and absence of any major snowfalls during the winter. The small number of forest types and mainly recent age of cut-overs simplified the problem of classification and facilitated aerial identification of cover types. It is impressive that even under these unusual conditions moose occupied the different cover types to significantly different extents.

Spruce stands have seldom been reported more attractive to moose than jackpine stands, but Nowlin (1978) quoted an unpublished report by Haig and Keith recording 2-3 x greater densities of moose in black spruce and black spruce-tamarack (*Larix laricina*) than in jackpine in

Table 4. Moose tracks classified in relation to presumed major ecotones by cover type

Ecotone	Cover Type: S_{10}	S_{7-9}	Pj_{10}	Pj_{7-9}	Mx_{10}	Mx_{7-9}	Co_{10}	Co_{7-9}	Co_{1-6}	Bl	Other
Moose tracks near streams	11	18		1	2	1	1		10		18
Moose tracks near lakes	7	13	1	2		2		1	8		10
Moose tracks near roads	11	15			2						
Moose tracks unrelated to major ecotones	16	49		1	2	5	7	41	44		21
	45	95	1	4	6	8	8	42	62		49

northeastern Alberta, a difference not far from the 4 x difference found here. Peek et al. (1976), found substantial use of jackpine in plantations, but not in natural stands in northeastern Minnesota. Welsh et. al. (in press) found jackpine selected against in northeastern Ontario. What amounts to an avoidance of jackpine by moose could have important implications for relationships between moose and woodland caribou since work in progress suggests that caribou use jackpine stands extensively.

Since mixed stands showed higher track frequencies than either spruce or jackpine, approaching those of cut-over areas, significant differences between mixed stands and spruce stands, although not demonstrated in this study, would probably be established by additional samples in mixed stands. Preference for mixed stands has been reported by Chamberlain (1972) and Welsh et. al. (in press) in north-eastern Ontario, and by Nowlin (1978) in Alberta. Peek et al. (1976) found that moose in Minnesota preferred aspen stands when winter conditions were moderate, as they were in this study.

Although partially cut segments (7-9/10) produced the highest track counts of any cover type, and differed significantly from uncut spruce and jackpine, they were only marginally higher than segments classified as mixed. These results might lead one to wonder whether any real increase in moose densities would result from cutting a forest with a high hardwood component. However, MacLennan (1975) found 2.4 x more and Hunt (1976) 56% more moose in cut aspen stands than in uncut aspen in Saskatchewan. Thus cutting seems to bring increased moose numbers in most timber types.

The substantially lower track counts on completely cut transect segments suggest that large cut areas are not as attractive to moose as smaller ones.

Thus large clear cuts would probably not be as beneficial. The best cutting policy for moose, judging from these results, might be to leave part of each 5-km block standing. However, if small cuts are best for moose, the low counts on segments cut 1-6 tenths are difficult to explain. Further work is needed to substantiate the widely held belief that there is value in keeping clear-cuts small.

The high counts of tracks on some partially cut areas suggest that these are particularly attractive to moose; thus moose aggregations, similar to those reported by Peek et al (1976), occur there during winter. The observation that half the high counts in spruce occurred on segments adjacent to clear-cuts suggests that the high numbers there may be part of the same attraction to cut areas through the operation of an edge effect. Moose tracks were more numerous near the ecotones resulting from creeks, lakes and roads in uncut forest so the moose may have reacted the same way along the ecotones between cut and un-cut areas. An ecotone effect on the cut side of cut-uncut boundaries has been reported by several authors. Berg and Phillips (1975) found moose using a strip 0.4 km inside cut areas. Hamilton and Drysdale (1975) found that moose browsed only about 100 m out from cover. MacLennan (1975) found they averaged 97 m from cover but ranged out to 352 m. On the other hand relatively few authors have reported an edge effect also within the standing timber. MacLennan (1975) could not document any such effect in Saskatchewan but Hunt (1976), also in Saskatchewan, found cases where moose densities gradually declined from the cut edge to about 1.6 km into standing timber, with highest numbers no more than 0.4 km from the edge. Such an edge effect would explain many of my high track counts in uncut spruce.

Apparently disturbance is not universally valuable for improving moose habitat since blowdown areas showed few tracks. This seems surprising in view of the observed preference for cut areas. Also previous work indicated high use of sites affected by spruce budworm, (*Choristoneura fumiferana*) where blowdown was common (Cumming 1956). Perhaps the fallen timber in these relatively large blowdowns presented too many obstructions to the moose.

The low number of burned areas may have been in error because they could not be distinguished from cut-over areas. On the other hand, the rain shadow of Lake Nipigon, might have aided efficient local fire suppression crews (at Geraldton and MacDiarmid) in preventing large fires in recent years. Earlier fires would have been classified as a timber type. Hunting might also have biased the results. During 3 days of driving haul roads in November, 1978, I saw no moose tracks in any cut-over areas. Thus my track counts in clear-cuts must have resulted from moose moving into these areas after the hunting season ended in mid-December. Probably the tracks were fewer than they otherwise might have been because of the high vulnerability of moose on these easily hunted areas. This possibility makes the observed high track counts on cut-overs all the more striking.

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Appendix 1. Cover types and moose counts by block.

STATISTIC	A Jan. 19 (NS)	B Jan. 21 (EW)	C Feb. 21 (NS)	D Mar. 16 (NS)	E Mar. 16 (EW)	Total Area
Length of transect (Km)	381	363	346	182	122	1394
No. of segments	54*	74	52	30	25	235
Segment tenths classified in each cover type						Calc
S	290 (54.1)**	408 (55.7)	349 (67.6)	165 (56.7)	167 (69.6)	1379 (60.0)
Pj	118 (22.0)	98 (13.4)	89 (17.2)	32 (11.0)	15 (6.2)	352 (15.2)
Mx	8 (1.5)	89 (12.2)	36 (7.0)	56 (19.2)	51 (21.2)	240 (10.4)
Ce			1 (0.2)			1 Tr
Po					4 (1.7)	4 Tr
Co	116 (21.6)	118 (16.1)	22 (4.3)	20 (6.9)		276 (11.9)
Old Co		18 (2.5)				18 (0.1)
Bl	4 (0.7)	1 (0.1)	19 (3.7)	18 (6.2)		42 (1.8)
Burn					3 (1.3)	4 Tr
						2315 (99.4)
TOTAL moose Tracks seen	36 (+3 moose seen)	108 (7 seen)	50	61	40	295 (10 seen)
Moose tracks per 100 Km	9.4	29.8	14.5	33.5	22.8	21.2

* No. of segments per Km varies due to presence of large lakes which were excluded.

** Figures in brackets are percentages.

Appendex 2. Comparison of over-all cover types on each block with cover types on the transect segments showing moose tracks.

A (January 19)

	Block Totals	Number of Moose Tracks on Segment 1	2-3	4+
Total No. of Segment Tenths	536	100	81	10
Cover Types		Percentages		
S*	54.1	51.0	33.0	100
Pj	22.0	24.0	11.1	
Mx	1.5			
Co	21.6	24.0	55.6	
Bl	0.7	1.0		

B (January 21)

	Block Totals	Number of Moose Tracks on Segment 1	2-3	4+
Total No. of Segment Tenths	732	138	196	90
Cover Types		Percentages		
S	55.7	47.1	61.2	50.0
Pj	13.4	29.0	6.1	
Mx	12.2	10.1	16.3	5.6
Co	16.1	13.8	16.3	44.4
Old Co	2.5			

C (February 21)

	Block Totals	Number of Moose Tracks on Segment 1	2-3	4+
Total No. of Segment Tenths	516	140	127	20
Cover Types		Percentages		
S	67.6	75.0	67.7	40
Pj	17.2	17.9	16.5	
Mx	7.0	10.7	8.7	10
Co	4.3	4.3	7.1	50
Bl	3.7	1.4		
Ce	0.2	0.7		

Appendix 2. Continued

D (March 16 N-S)

	Block Totals	Number of Moose Tracks on Segment 1	2-3	4+
Total No. Plots	291	97	110	60
Cover Types		Percentages		
S	26.7	68.0	47.3	53.3
Pj	11.0	9.3	4.5	13.3
Mx	19.2	15.5	29.1	11.7
Co	6.9	2.1	9.1	21.7
Bl	6.2	5.1	10.0	

E (March 16 E-W)

	Block Totals	Number of Moose Tracks on Segment 1	2-3	4+
Total No. Plots	240	77	64	40
Cover Types				
S	69.6	84.4	59.4	67.5
Pj	6.2	6.5	7.8	
Mx	21.2	9.0	26.0	32.5
Po	1.7		6.2	
Burn	1.3			

* S - *Picea* spp.
Pj - *Pinus banksiana*
Mx - Conifer - hardwood mixture
Co - Cut-over
Bl - Blowdown
Ce - *Thuja occidentalis*
Po - *Populus* spp.