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AERIAL SURVEY OF MOOSE, MACKENZIE DISTRICT, N.W.T., MARCH 1956, WITH COMPARISONS TO SURVEYS IN JANUARY AND DECEMBER 1953, MARCH 1954, AND FEBRUARY 1955

by

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INTRODUCTION

Moose are very important in the economy of the Indians and non-Indian trappers of the Mackenzie River valley as a source of fresh meat and hides.

An aerial census was made in January 1953 in a roughly triangular area of approximately 3,300 square miles, bounded by the Mackenzie River, Liard River and Nahanni Range, (Flook, 1963). On the basis of that survey and on observations in other areas, it was recommended that the quota of moose allowed per licensed hunter be increased from one bull to two bulls per season in certain areas.

On December 3, 1953 the Advisory Board on Wildlife Protection passed a resolution recommending that the quota of moose per hunter be increased to two bulls in certain areas. It was also resolved that the Canadian Wildlife Service should take action to determine the effects on the moose population of the increased hunting operations.

An aerial census of moose was made in December 1953 in the Fort Liard, Fort Simpson and Fort Norman warden districts. No formal report on that survey was submitted.

In March 1954 an aerial survey of moose was carried out in the Northern Mackenzie District by E.H. McEwen (1954).

On July 14, 1954 the N.W.T. Game Ordinance was amended to permit a quota of two bull moose per hunter in the areas hunted by trappers from Fort Providence, Fort Liard, Fort Simpson, Wrigley, Fort Norman, Fort Franklin, and Fort Good Hope.

On January 27, 1955 the N.W.T. Game Ordinance was amended to permit licensed hunters to shoot any number of moose of either sex and of any age at any time of the year on unoccupied crown lands in the N.W.T.

E.H. McEwen (1956) carried out a second aerial survey of moose in the Northern Mackenzie District in February 1955.

The March 1956 survey was planned to attempt to determine the effects on the moose population of the liberalized hunting regulations.

Previous experience in the Fort Simpson District had indicated that moose are fairly readily observed in deciduous habitat in early winter when there is a heavy deposit of hoar-frost on the vegetation. However, in the northern district it had been found that the short periods of daylight and poor flying weather made it very difficult to complete a large scale operation in early winter. Moose surveys there had been made in February and March to take advantage of long daylight periods and good weather. Since it was planned that the current survey should cover the northern and southern areas in one operation, it was decided to carry it out in March.

PROCEDURE

A method of determining transect width and of estimating moose numbers per unit area was described by Flook (1953). It was applied in the December 1953 and the March 1956 surveys.

The Cessna 195 has no wing struts. In order to provide markers for angles of observation, monel metal wire was stretched between the ski strut and the wing on each side of the aircraft and small pieces of red ribbon were tied in the wire to show the angles (Fig. 1).

Fig. 1. Angle markers used on Cessna 195.

In 1953 a protractor was used to locate the markers at appropriate angles while the aircraft was on the ice.

In 1956 the ribbon markers were mounted while the plane was on the ice. The angle of each marker was then measured using an Abney level when the plane was in the air, as it was found that the angles were altered slightly by the plane's assuming flying position. The markers indicated angles from the vertical as follows: right side, 30°, 40°, 60° and 72°; left side, 42°, 56°, 71° and 77°.

The pilot for the 1956 survey was asked to keep the aircraft as closely as possible to 400 feet elevation above the ground. He succeeded admirably but as it was not possible to follow perfectly the rapidly changing ground levels, the height of the aircraft was estimated and recorded at each moose observation. The height estimates were used in calculating the distance from the flight line of each moose observed.

Since the 1953 survey of the Liard, Simpson and Norman districts was not reported previously, it will be included here.

All the transects flown in the December 1953 and March 1956 surveys are shown on the accompanying map. The 1956 transects are shown in red, the 1953 transects in green, and those flown on both surveys in black. For convenience in discussion, all transects are designated by appropriate numbers.

December 1953 survey

Transects 22 and 23 were flown on December 8 and 9 and transect 24 on December 13. The aircraft used was an Aklavik Flying Service Cessna 195 piloted by M. Zubko. D. Flook observed through the right forward window and W.H. Day through the left rear window.

On December 16 transects 26 and 25 were surveyed by J.P. Kelsall flying from Yellowknife to Fort Simpson with a Wardaire Husky piloted by R. Rutherford. The Husky was used for the remainder of this operation. Flook observed from the right forward seat and Kelsall from the left rear, on transects flown as follows: December 17, transects 18 and 17; December 18, transects 16, 15, and 14; December 19, transects 12, 13, and 16; December 20, transect 19. Kelsall surveyed transect 27 with Rutherford on the return trip to Yellowknife on December 22.

March 1956 survey

For the entire operation an Aklavik Flying Service Cessna 195 was used, piloted by D. Violette.

On March 23 transects 1, 2, 3, 4 and 5 were flown, and on March 26 transects 6, 7, 8, 9, 10 and 11. Bryant observed from the right front seat, Flook from the left rear.

From March 27 to 31 Flook occupied the front right position and Bryant the left rear. Transects were flown as follows: March 27, transects 12, 13, 14, 15 and 16; March 28, transects 17 and 18; March 29, transects 24 and part of 21; March 31, transect 20, remainder of 21 and transect 25.

On the return trip to Aklavik, Bryant surveyed transect 28 and 29 as far as Trout River on April 1 and the remainder of 29, and 30, 31 and 32 on April 2.

PRESENTATION OF DATA AND DISCUSSION

Population estimates, northern district, 1956 survey.

The data from transects 1 to 11, 31 and 32 will be considered.

In Table 1 the moose observations for those transects are grouped according to their calculated distances from the flight line.

TABLE 1

Observations of moose, northern district, grouped according to distance from flight line

Interval (feet)	Transects 1 to 11		Transects 31 and 32
	Left Observer	Right Observer	Right Observer
0-300	2	1	0
301-600	2	3	5
601-900	4	10	4
901-1200	5	1	0
1201-1500	0	9	4
1501-1800	1	5	0
1801-2100	0	0	0
2101-2400	1	0	0
Totals	15	29	14

From inspection of Table 1 it appears that the observing effeciency of Flook, observing from the rear left window was appreciably lower than that of Bryant in the front right position.

(Chi-square = 3.8 (with Yates' correction)). For that reason only the data collected by the right observer will be used in population estimates for the northern district although data collected by both observers will be used in determining age ratios.

As is indicated by the dotted lines in Table 1, observations by the left observed were fairly evenly distributed within the 0 to 1200 feet interval, the right observer's effective transect width was between 301 and 1800 feet from the flight line on transects 1 to 11 and between 301 and 1500 feet on transects 31 and 32. For purposes of population estimates only the right observer's records falling within the dotted lines in Table 1 will be used.

Table 2 summarizes the moose population density estimates for the northern district.

TABLE 2

Moose population density estimates, northern Mackenzie district, March 1956.

Transect Number	Length (miles)	Strip area (Sq. miles)	Total moose seen	Moose Within Strip	Sq. miles per moose
1	44	12.5	0	0	--
2	68	19.3	0	0	--
3	92	26.1	2	0	--
4	77	21.9	3	1	21.9
5	104	29.5	3	1	29.5
6	52	14.8	0	0	--
7	130	36.9	6	4	9.2
8	156	44.3	22	15	3.0
9	58	16.5	0	0	--
10	65	18.5	0	0	--
11	175	49.7	9	7	7.1
31	88	20.0	9	8	2.5
32	175	39.7	6	6	6.6
Totals	1284	349.7	60	42	8.3

Although neither Bryant nor Flook had made moose surveys in the northern district previous to that of March 1956, it was the feeling of both observers in surveying this area that many moose present on the transects were not seen. Frequently fresh tracks were seen, indicating that a moose was nearby, but it could not be found. In many instances when moose were seen, the observer felt that he had almost missed them. Sometimes such moose were bedded down, screened by brush, and were not seen until they stood up or turned their heads as the plane passed over them. More reliable evidence of the low observability of moose at this time of year was found on transect 25, and will be discussed later in the report. It can be stated here, however, that the population densities given in Table 2 are considered to be lower than actually occurred, probably much lower.

Comparison with previous surveys, northern district

In Table 3 the results of the 1956 survey are compared with those made by McEwen in 1954 and 1955.

TABLE 3

Comparison of moose surveys, northern Mackenzie district, 1954, 1955 and 1956

	Transect length (miles)	Transect width (miles)	Transect area (sq. miles)	Moose within strip	Sq. miles per moose
McEwen, 1954	460	0.5	230	18	12.8
McEwen, 1955	520	0.5	260	11	23.6
Present survey *	739	611 X .284 128 X .227	203	21	9.7

* Includes only transects 3 to 8 and transect 32.

McEwen (1955) described his survey height as about 500 feet, and said that most of the moose were observed between the angles of 20° and 40°. His assumed transect width of 0.5 mile was therefore probably much wider than the strip in which most of his observations occurred.

Consequently, his population estimates were probably lower than they would have been had he used the technique which was used in the 1956 survey.

The 1954 survey was carried out from March 12 to 14 and the 1955 survey on February 25. All three surveys were therefore subject to some error due to the difficulty of seeing moose in the spring of the year. In each instance this difficulty would tend to make the estimates conservative. However it cannot be known whether this error was the same in the three surveys. It probably was not.

The divergence of the population estimates from the actual population due to the above factors may be termed experimental error.

There is also present in any estimate based on a sample count an error termed sampling error. This error is due to chance. When only a small number of transects is surveyed it may happen that those sampled are on especially choice moose range, resulting in a population estimate which is too high. Conversely the transects selected may happen to be on range which is poorer than average, resulting in a population estimate which is too low.

For these reasons nothing can be concluded from Table 3 concerning trends in moose numbers in the northern district. The differences in estimates of population densities could be accounted for entirely by experimental error and sampling error.

Age ratios, northern district

Moose were classed as "calves", "older", or "unknown". Using all observations, there were 6 calves, 28 "older", and 26 of unknown age. The age ratio was 21 calves: 100 "older".

Assuming that the "older" class was composed of adults with a sex ratio of 1:1, these figures indicate a calf: cow ratio of 43:100. It seems probable that at least some of the "older" class would be non-breeding yearlings, so that the calf: cow ratio may actually approach 50:100. The population thus appears to be reproducing quite favorably. Observations of both observers were in agreement on age ratios.

Moose harvest, northern district

If one takes as the area sampled a polygon described by joining the extreme eastern, western, northern and southern points of the transects, the included area is approximately 30,000 square miles. Parts of this area are apparently rarely if ever hunted - e.g. the Mackenzie Mountains area west of Norman Wells and the upper reaches of the Arctic Red River. There are other areas, lying outside the sample, which are hunted, so that the portion of the northern Mackenzie district which receives some moose hunting pressure at the present time may be set at approximately 40,000 square miles. The kill by residents of Tuktoyaktuk, Aklavik, Fort McPherson, Arctic Red River and Fort Good Hope in 1954-55 was 322 (expanded figure based on 63% return of licenses). If this number is considered to be drawn from a population of 4,800 moose, a kill of 6.7% of the population was effected. Since the calf crop in March was indicated to be 18% of the total population, and since the population estimates given here are probably conservative, there seems to be scope for increased hunting pressure. However the main weight of the Indians' hunting activities falls within a short radius of the settlements and along the Mackenzie River and it those areas it is probably as great as the moose population can stand at the present

time. Since there is no evidence of any areas of over population where greater hunting pressure would be necessary, it is suggested that the present regulations remain in effect and that a thorough testing of aerial moose censuses be made to determine whether changes in population densities can be followed by this means.

Population estimates, central district, December 1953

The data considered here are from transects 12 to 19 inclusive and 22 to 27 inclusive. In Table 4 the moose observations for those transects (less 25 and 26) are grouped according to their calculated distances from the flight line.

TABLE 4

Moose observations, central district, December 1953 survey, grouped according to distance from flight line.

Interval	Left Observer	Right Observer
Transects 22, 23 and 24, surveyed with Cessna 195		
0-300	20	21
301-600	18	20
601-900	1	14
901-1200	3	2
1201-1500	2	1
1501-1800	0	0
Totals	44	58
Transects 12-19 and 27 surveyed with de Havilland Husky *		
0-300	5	3
301-600	11	10
601-900	7	3
901-1200	11	14
1201-1500	8	5
1501-1800	0	0
1801-2100	0	0
2101-2400	1	1
Totals	33	36

* Transects 25 and 26 not included as no angle markers were used.

It is demonstrated in Table 4 that the frequency of moose observations in the 0 to 500 feet interval was as high generally as in the intervals farther out from the flight line. The left observer saw as many moose as the right observer, out to 600 feet from the Cessna 195 and to 1500 feet from the Husky. Probable explanations are: first, moose were, in general, most easily observed in December due to their behaviour and to the presence of hoarfrost on the vegetation at that time of year. It was possible for both the pilot and the right observer to see moose ahead of the aircraft, even including those on or close to the flight line. Second, they reflect a characteristic of the pilots. Both Zubko and Rutherford were constantly looking for moose, and whenever they sighted a moose ahead, they informed the left observer so that he could be ready. Violette did this occasionally, but concentrated more on following the pre-set course, and on keeping the aircraft at the desired height for surveying. Neither Zubko nor Rutherford succeeded as well as Violette in maintaining a constant height above the ground, and the survey height varied from 200 to 700 feet in the December 1953 survey.

On transects 22, 23 and 24, surveyed with the Cessna 195, the frequency of the left observer's observations dropped off beyond 600 feet and those of the right observer beyond 900 feet from the flight line. On transects 12 to 19, surveyed with the Husky, the frequency of moose observations did not drop off until 1500 feet from the flight line. The following expanation is suggested: transects 22, 23 and 24 were south of Fort Simpson in an area of high moose population. As moose observations were frequent, the observers, in order not to miss moose, had to concentrate on watching a relatively narrow strip. The area surveyed with the Husky was north of Fort Simpson and was generally poorer moose habitat and carried a lower density of moose.

Moose were therefore only occassionally observed, and the observers subconsciously searched the landscape over a wider strip, thus spotting moose which were farther from the flight line.

For estimating population densities in the survey, data collected by both observers will be used. In the case of transects 22, 23 and 24, the strip will be considered to be 1500 feet wide, 600 feet to the left and 900 feet to the right of the flight line. For transects 12 to 19 the strip will be considered to be 3000 feet wide and observations from 0 to 1500 feet on both sides of the flight line will be used. For transect 27, where observations were made only on the right side, the strip width will be considered to be 1500 feet.

Table 5 summarizes the moose population density estimates for the central district as calculated from the December 1953 survey.

TABLE 5

Moose population density estimates, central district, December 1953

Transect Number	Length (miles)	Strip area (sq. miles)	Total moose seen	Moose within strip	Sq. miles per moose
12	168	95	2	2	47.5
13	119	68	21	21	3.2
14	105	60	11	11	5.5
15	175	99	7	7	14.1
16	49	28	1	1	28.0
17	262	149	8	7	21.0
18	84	48	4	4	12.0
19	336	190	10	9	21.1
22a	178	51	27	22	2.3
22b	60	17	18	14	1.2
23	147	42	12	12	3.5
24	287	82	45	45	1.8
25	102	--	4	--	---
26	109	--	8	--	---
27	217	61	7	6	10.2
Totals	2398	990	185	161	6.1

Sex and age classes, December 1953 survey

Moose were recorded in the December 1953 survey in the following categories: 42 antlered adults; 76 antlerless adults and yearlings; 23 calves; 44 unclassified moose.

The ratio between adult bulls and cows couldn't be determined with accuracy from the numbers of antlered and antlerless animals counted, for two reasons. First, the bulls had begun to shed their antlers at the time of the survey (J.P. Kelsall observed a bull carrying one antler on December 16). Secondly, the number of yearlings in the antlerless group was not known.

The ratio of calves to older animals was 19.5:100.

Population estimates, central district, March 1956 survey

The data considered here are from transects 12 to 18, and 20, 21, 24, 25, 28, 29 and 30.

In Table 6 the moose observations for these transects are grouped according to their calculated distances from the flight line.

TABLE 6

Moose observations, central district, March 1956 survey, grouped according to distance from flight line

Interval (feet)	Transects 12, 13, 14, 15, 16, 17, 18, 20, 21, 24, 25		Transects 28, 29 and 30
	Left Observer	Right Observer	Right Observer
0-300	0	3	3
301-600	17	11	2
601-900	3	8	0
901-1200	7	4	15
1201-1500	3	7	5
1501-1800	1	0	0
1801-2100	2	1	0
2101-2400	1	1	0
Not recorded	6	0	7
Totals	40	35	32

The above data indicate that Bryant, who occupied the rear left position in the survey of the central district, was able to observe moose with equal efficiency to Flook, in the front right position. The relatively high number of moose in the 301 to 600 foot interval on the left side probably indicates that moose were flushed from the 0 to 300 foot interval and were not observed until they reached the area beyond 300 feet. The transect will therefore be taken to include a strip 1500 feet wide on each side of the aircraft.

Table 7 summarizes the moose population density estimates for the central district, as calculated from the March 1956 data.

TABLE 7

Moose population density estimates, central district, March 1956

Transect Number	Length (miles)	Strip area (sq. miles)	Total moose seen	Moose within strip	Sq. miles per moose
12	168	95	5	4	23.7
13	119	68	5	5	13.6
14	105	60	9	3	20.0
15	175	99	2	1	99.0
16	49	28	5	5	5.6
17	262	149	14	12	12.4
18	84	48	2	2	24.0
20	100	56	9	8	7.0
21	340	191	16	16	11.9
24	287	161	6	6	26.8
25	102	57	2	1	57.0
28	140	40	5	3	13.3
29	200	57	3	0	----
30	285	59	24	22	2.7
Totals	2416	1168	107	88	13.3

Age classes, central district, March 1956 survey

Moose were recorded in the March 1956 survey in the following catergories; 38 moose older than calves; 9 calves; 60 unclassified. No antlered moose were seen in this survey.

The ratio of calves to older moose was 23.7:100.

Population estimates, central district, January 1953 survey

In a report submitted June 3, 1953 the results of the January 1953 aerial moose survey were described. The route flown in that survey is indicated as transect 21 on the attached map. Following discussion and further consideration, the data from that survey have been re-analyzed, separating the observations of the two observers. The observations, grouped according to their calculated distances from the flight line are presented in Table 8.

TABLE 8

Moose observations, area south of Fort Simpson, January 1953 survey, grouped according to distance from flight line

Interval (feet)	Left Observer	Right Observer
0-300	0	4
301-600	0	5
601-900	5	5
901-1200	5	6
1201-1500	5	4
1501-1800	4	1
1801-2100	0	0
2101-2400	0	0
2401-2700	1	2
2701-3000	1	4
Beyond 3001	1	0
Totals	22	31

Inspection of Table 8 reveals that the left observer observed moose evenly distributed in the 1200 feet wide strip between 601 and 1800 feet from the flight line. The right observer observed moose evenly distributed in a strip within 1500 feet of the flight line. These respective strip widths will therefore be used in calculating moose population density for that survey. The total strip lengths were 344 miles for the right observer and 330 miles for the left observer. For the left observer the strip area was therefore 75 square miles and for the right observer 98 square miles. The moose population densities observed were therefore 3.9 square miles per moose for the left observer, 4.1 square miles per moose for the right observer, and 4.0 square miles per moose for both observers.

Comparison of periodic moose surveys, central district

Table 9 compares the moose population density estimates by transects for the three surveys which were conducted in the central district.

TABLE 9

Comparison of moose population density estimates for three surveys in the central district

Transect Number	Square miles per moose				
	January 1953	Apparent trend	December 1953	Apparent trend	March 1956
12			47.5	(+)	23.7
13			3.2	(-)	13.6
14			5.5	(-)	20.0
15			14.1	(-)	99.0
16			28.0	(+)	5.6
17			21.0	(+)	12.4
18			12.0	(-)	24.0
19			21.0		
20					7.0
21	4.0	(+)		(-)	11.9
22a			2.3		
22b			1.2		
23			3.5		
24			1.8	(-)	26.8
25					57.0
26					
27			10.2		
28					13.3
29					
30					2.7
Averages	4.0	(-)	6.1	(-)	13.5

From inspection of Table 9, it might appear that there was a general alarming decrease in the moose population between 1953 and 1956. However it is the opinion of Flook that the data actually reflect a lower observing efficiency in the 1956 survey. The decreased efficiency is believed to be due to two main factors: the nature of the snow and frost cover, and the behaviour of the moose.

In both the January 1953 and December 1953 surveys the ground was completely covered with snow and there was a heavy deposit of hoarfrost on the vegetation. There was thus a white background against which the moose showed up very well. Recent moose activity was evidenced by the frost's having been knocked from the vegetation.

A large proportion of the moose observed in January and December were feeding in willow, poplar, or birch and were thus readily observed. In March a larger percentage of the moose observed were bedded down, often in heavy cover. Both observers felt that there were probably many more moose on the transects, bedded down, which were not seen.

It would appear that in mid-winter moose are forced by the long periods of darkness to feed in the middle of the day, whereas in the spring they rest through the hours of bright sunlight and feed through the prolonged periods of dawn and dusk (See, for instance, Altmann, 1956). Temperature and light may both be involved in this pattern. Behaviour will be discussed further under "activity".

Corporal S. Buyer of the R.C.M.P. detachment at Fort Simpson kindly provided information which is indicative of the difference in observability of moose in spring as compared to winter. On January 23, 1956, Constable A. Trace flew by R.C.M.P. plane from Fort Simpson to Fort Providence.

This route roughly follows transect 25. Between the mouth of the Rabbitskin River and Mills Lake Constable Trace observed at least 12 moose. On March 31, in flying transect 25, the writers observed only 2 moose.

Transects 21 and 22a are in the same general area southwest of Fort Simpson. The population density observed on 22a in December 1953 was double that observed on 21, 11 months earlier. The difference could be only partly explained by population increase, so must be at least partly due to differences between the transects or to chance distribution of the moose.

Since the population data from the March 1956 survey are apparently affected by a lower observability of moose than was the December 1953 survey, no sound conclusion can be reached concerning trends in the moose populations.

Moose harvest, central district

The area hunted by the Indians of Fort Norman, Fort Franklin, Wrigley, Fort Simpson and Fort Liard, is roughly outlined on the accompanying map. It is approximately 49,900 square miles. That region represents approximately the area in which Flook has found some evidence of hunting activity during the past five years. Visits by hunters beyond the boundaries of the area outlined are infrequent. A 63% license return from hunters in the settlements mentioned, included 300 moose reported shot in 1954-55. If we assume the same success for hunters whose licenses were not returned, the estimate obtained for the total moose harvest of this area in 1954-55 is 476.

When there was a quota of one or two moose per hunter in the N.W.T., it was found that hunters were taking moose over their quota, when possible, but were not, of course, reporting

them on their license returns. From personal advice received from W.H. Day, formerly warden at Fort Simpson, and from G. Turner, trader at Nahanni Butte, it appears that even since removal of the restrictions, Indian hunters persist in reporting a moose kill lower than that actually made. At present no estimate is available of the kill in excess of that reported. It is to be hoped that this reluctance on the part of the Indians, to report their real kill, can be overcome by public relations work.

The ratio of calves to older moose observed in the survey of the central district in March 1956 was 23.7:100. Thus the estimate of the calf crop at that time was 19.1% of the population.

On the basis of the average population density estimates of the March survey in the central district, the moose population in the area outlined on the map was approximately 3,750. As was pointed out earlier, there is reason to believe that this estimate is low. The 1954-55 reported moose harvest (476) was thus 13% of the March 1956 population estimate. It would thus appear that the moose harvest in the central district, as in the northern district, is light, considering the entire hunted area. Because hunting is heaviest in most accessible areas near the settlements and major rivers, moose may be actually overharvested locally, while they are greatly underharvested in the outlying areas.

Moose activity

Through part of the December 1953 survey, Flook, observing from the forward right position, attempted to note the activity of each moose observed, classifying them in the categories; lying down; standing; or running. In the March 1956 survey both observers recorded the activity of as many moose as possible. The results of the observations from the two surveys are presented in Table 10.

TABLE 10

Activity of moose.

Survey	Observer	Position in Aircraft	Moose Observed					
			Lying down		Standing		Running	
			#	%	#	%	#	%
Dec. 1953	Flook	forward	12	23	34	65	6	12
Mar. 1956	Flook	forward	19	58	11	33	3	9
Mar. 1956	Flook	rear	4	29	1	7	9	64
Mar. 1956	Bryant	forward	13	50	6	23	7	27
Mar. 1956	Bryant	rear	13	41	12	38	7	22

It is evident from the data in Table 10 that either observer, when he took the rear seat of the aircraft, observed a lower percentage of moose bedded down, than did the observer in the front seat. That agrees with our observations, that a moose which was lying down when first observed ahead of the aircraft, from the forward position, often stood up as the aircraft passed over, and in some instances bolted away from the flight line. In many cases the rear observer would not be able to see the moose until after it had stood up. The difference brought about by changing from front to rear position was greater in the case of Flook who apparently did not pick up the observations as quickly as Bryant. It is probable that some of the moose which were running or standing when first seen by the front observer had actually been bedded down and stood up as the aircraft approached. The proportion of cases in which that occurred can probably be assumed to have been the same in both the 1953 and 1956 surveys.

In March 1956, the percentage of moose bedded down when first observed from the forward position was 58% by Flook and 50% by Bryant. It is considered significant that these figures

for percentage of moose bedded down, were much higher than the 28% observed by Flook in the December 1953 survey. That supports the idea presented earlier, that moose were less observable in the March survey than in the December survey due to different behaviour.

Cover types and moose habitat preference

During the March 1956 survey, notes were kept of the habitat type at the point of each observation of moose or tracks. In addition, notes were made at regular intervals (usually five-minutes) of the habitat occurring immediately beneath the aircraft. These data are shown in Table 11 which is broken into three parts representing the northern, central and southern portions of the survey. Table 12 summarizes all the habitat data collected during that survey. Figs. 3 and 4 are graphic representations of the data in Table 11.

In order to represent habitat preference by means of one arithmetic term, a "relative use" (r.u.) factor has been utilized. This factor is determined by dividing the percentage occurrence of moose or tracks in each habitat type by the percentage occurrence of that type. An r.u. value of 1 would occur if, say, 30% of the moose occurred in a habitat type which covered 30% of the area surveyed. Such a value would indicate neither preference for nor shunning of that particular type. An r.u. value greater than 1 would indicate preference for the type; of less than 1, avoidance of the type. Table 13 shows r.u. factors drawn from Table 11. Table 14 shows r.u. factors drawn from Table 12, i.e. from the summary of the whole survey.

Creek and river bottoms were, by far, the most preferred habitat type (r.u. for moose = 7.4). Coniferous forest was the least preferred (r.u. for moose = 0.3).

The northern and central portions of the survey (Fort McPherson to Fort Simpson) showed a dominance of coniferous forest over all other types. In the southern area (Fort Simpson - Mahaumi Butte - Trout Lake) brule predominated.

TABLE 11

Frequency occurrence of cover types, moose, and moose tracks, recorded during March 1956 aerial moose survey, Mackenzie District

		Habitat Type						
		Deciduous	Brule	Coniferous	Creek & River Bottoms	Other	Totals	
A. McPherson to Norman Wells (859 transect miles)								
Type Frequency	#	14	62	87	7	17	187	
	%	7.5	33.1	46.5	3.7	9.1		99.9
Moose Observed	#	10	19	3	10	3	45	
	%	22.2	42.3	6.7	22.2	6.7		100.1
Moose Tracks Observed								
Singles	#	12	27	90	19	32	180	
	%	6.7	15.0	50.0	10.5	17.8		100.0
Common	#	7	33	11	23	12	86	
	%	8.2	38.4	12.8	26.8	13.9		100.1
Abundant	#	2	17	0	17	11	47	
	%	4.3	36.2	0.0	36.2	23.4		100.1
B. Norman Wells to Fort Simpson (962 transect miles)								
Type Frequency	#	4	42	76	2	24	148	
	%	2.7	28.4	51.3	1.4	16.2		100.0
Moose Observed	#	0	14	7	13	8	42	
	%	0.0	33.3	16.7	31.0	19.0		100.0
Moose Tracks Observed								
Singles	#	10	53	81	49	17	210	
	%	4.8	25.2	38.5	23.3	8.1		99.9
Common	#	11	33	15	15	8	82	
	%	13.4	40.3	18.3	18.3	9.8		100.1
Abundant	#	1	17	6	13	4	41	
	%	2.4	41.5	14.6	31.8	9.8		100.1
C. Fort Simpson - Mahanni Butte - Trout Lake (829 transect miles)								
Type Frequency	#	0	46	7	1	1	55	
	%	0.0	83.7	12.7	1.8	1.8		100.0
Moose Observed	#	4	23	10	0	4	41	
	%	9.8	56.1	24.4	0.0	9.8		100.1
Moose Tracks Observed								
Singles	#	9	86	29	17	7	148	
	%	6.1	58.1	19.6	11.5	4.7		100.0
Common	#	9	60	5	8	5	87	
	%	10.3	69.0	5.7	9.2	5.7		99.9
Abundant	#	7	34	0	10	8	59	
	%	11.9	57.6	0.0	16.9	13.6		100.0

TABLE 12

Percentage occurrence of cover types, moose, and moose tracks, recorded during March 1958 aerial moose survey, Mackenzie District Summary

	Habitat Type					
	Deciduous	Brule	Coniferous	Creek & River Bottoms	Other	Totals
Type Frequency	4.6	38.5	43.6	2.6	10.8	100.1
Moose Observed	10.8	45.8	11.7	19.2	12.5	100.0
Moose Tracks Observed						
Singles	5.8	30.9	37.2	15.8	10.4	100.1
Common	10.6	49.4	12.2	18.0	9.8	100.0
Abundant	6.8	46.3	4.1	27.2	15.6	100.0

Single tracks were most frequently seen in coniferous forest, indicating, perhaps, that when moose move from one feeding area to another they do so in solitary fashion. Tracks recorded as "common" or "abundant" were most frequently seen in brule and in creek and river bottoms (with the r.u. values for both track categories being much higher for the latter than for brule), indicating that moose tend to concentrate in such habitat. In conducting future surveys it would be well to keep this behaviour in mind. Planning transects so that they would pass through as little coniferous forest and as much of the more preferred habitats as possible should prove to be good economics, provided only an index to population density is required. Also, in analyzing the samples, giving consideration to the fact that the moose are not randomly distributed should aid in placing reasonable confidence limits on the results.

TABLE 13

"Relative use" values for four habitat types,
Mackenzie District, N.W.T., March 1956

	Habitat Type				
	Deciduous	Brule	Coniferous	Creek & River Bottoms	Other Types
A. Fort McPherson to Norman Wells					
Kind of Observation					
Moose	2.7	1.3	0.1	6.0	0.7
Single Tracks	0.9	0.5	1.1	2.8	2.0
Tracks "Common"	1.1	1.2	0.3	7.3	1.5
Tracks "Abundant"	0.6	1.1	0.0	10.7	2.6
B. Norman Wells to Fort Simpson					
Kind of Observation					
Moose	0.0	1.2	0.3	22.2	1.2
Single Tracks	1.8	0.9	0.8	16.6	0.5
Tracks "Common"	5.0	1.4	0.4	13.1	0.6
Tracks "Abundant"	0.9	1.5	0.3	22.7	1.2
C. Fort Simpson - Mahanni Butte - Trout Lake					
Kind of Observation					
Moose	---	0.7	1.9	0.0	5.4
Single Tracks	---	0.7	1.5	6.4	2.6
Tracks "Common"	---	0.8	0.4	5.1	3.2
Tracks "Abundant"	---	0.7	0.0	9.4	7.6

TABLE 14

"Relative use" Values for four habitat types,
Mackenzie District, N.W.T., March 1956.
Summary

	Habitat Type				
	Deciduous	Brule	Coniferous	Creek & River Bottoms	Other Types
Kind of Observation					
Moose	2.3	1.2	0.3	7.4	1.2
Single Tracks	1.3	0.8	0.9	6.1	1.0
Tracks "Common"	2.3	1.3	0.3	6.9	0.9
Tracks "Abundant"	1.5	1.2	0.1	10.4	1.4

Fig. 2. Seven antlered bull moose, in brule with deciduous cover, near Trout River, December 13, 1953. (Note fire killed spruce).

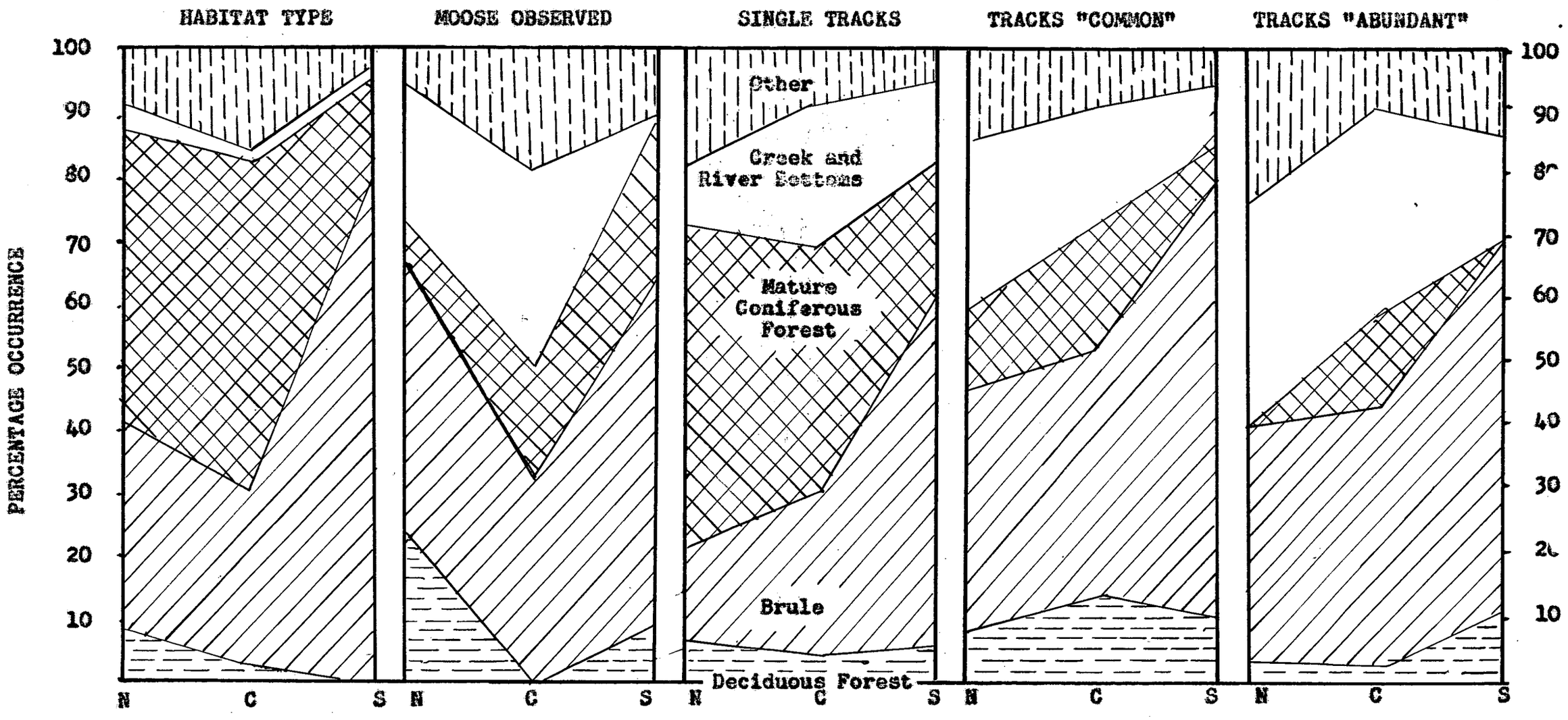
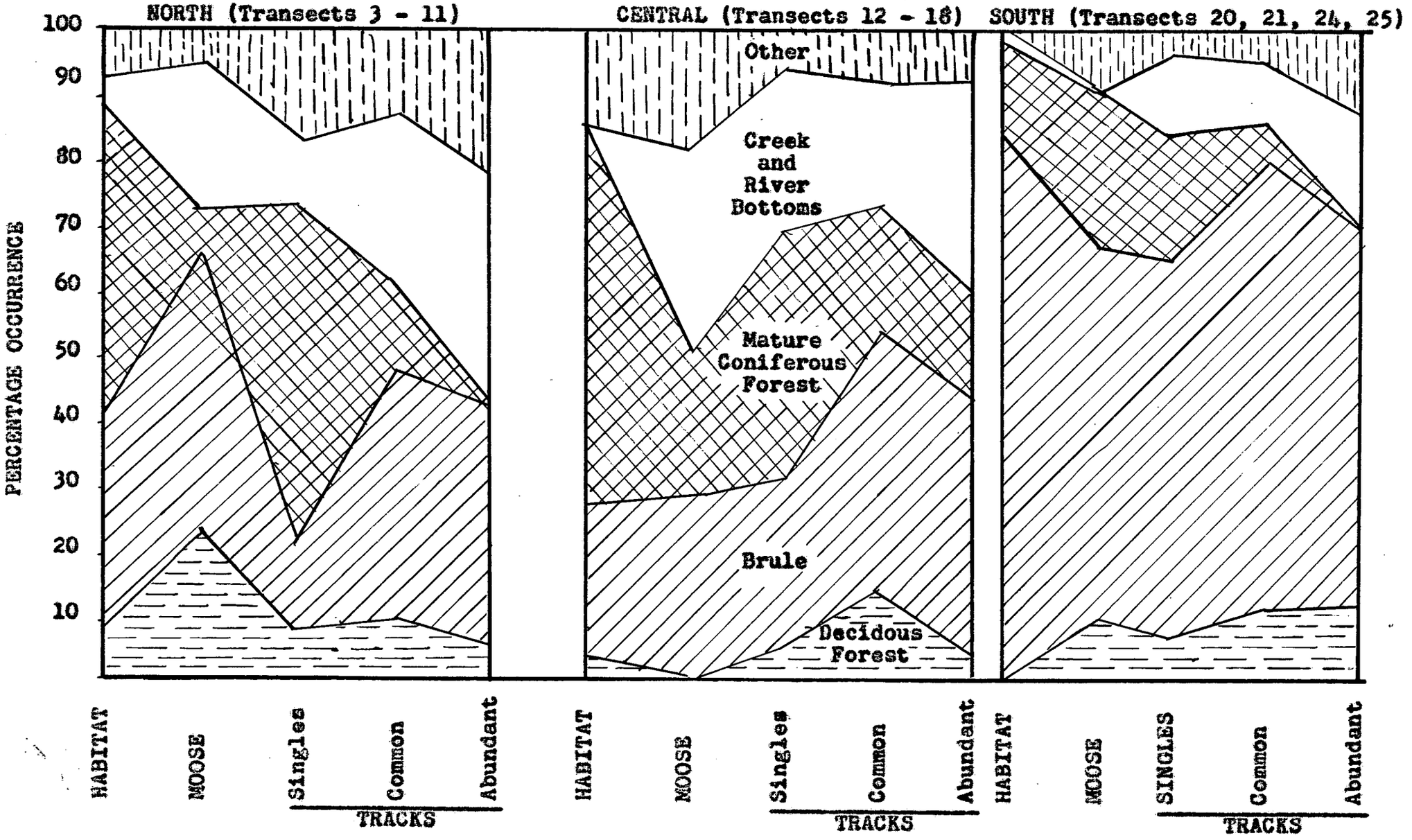


Fig. 3. Relative occurrence of habitat types, moose, and moose tracks observed during March 1956 in the Mackenzie District, N.W.T. N = Northern Mackenzie District (transects 3 - 11); C = Central Mackenzie District (transects 12 - 18); S = Southern Mackenzie District (transects 20, 21, 24 & 25).

Fig. 4. Relative occurrence of habitat types, moose, and moose tracks observed during March 1956 aerial survey in the Mackenzie District, N.W.T.



Marten track observations

On the 1956 survey, in order to make moose tracks more visible by accentuating shadows, Flook tried wearing yellow-colored goggles. It was found that they actually did facilitate observations of tracks, especially when clouds cut off direct sunlight.

It was found possible while wearing the goggles, to pick out marten tracks quite readily. Since searching for moose required full attention, recording of marten tracks was rather haphazard in the survey, and was done when time permitted and usually when marten tracks were present in particular abundance.

On March 26 Flook observed frequent marten tracks on transects 7 and 8 about 133° 15' W, 66° 10' N and 133° 45' W, 66° 00' N, in black spruce habitat. The locations are on the western headwaters of the Arctic Red River and near the mouth of the Snake River (Yukon Territory) respectively. On March 27, Flook observed frequent Marten tracks on transect 12, beginning about 126° 20' W and continuing on the transect to Kilkale Lake and south to Smith Arm, Great Bear Lake. The habitat in which they occurred was uniformly small, sparse black spruce. At one point between Kilkale Lake and the Smith Arm, where tracks were particularly abundant, an attempt was made to count those tracks crossing the flight line. Fourteen tracks were counted in one and a half minutes. Occasional marten tracks were also observed by Flook in black spruce habitat on transect 15 in the area northwest of Lac Ste. Therese. Bryant observed an abundance of marten tracks in the vicinity of the Nyarling River on transect 28 on April 1.

These casual observations indicated two areas of substantial marten populations; the area west of Fort Good Hope

near the Yukon Boundary and the area north and west of Smith Arm, Great Bear Lake. The absence of toboggan trails in these areas at the time of the survey would indicate that they were probably not being trapped, and , in the case of the area near the Yukon Boundary, it is known that it has not been trapped for at least ten years. Both areas are quite far from the nearest settlement.

The observations indicate that aerial surveying has possibilities worth exploring for exploring for extensive appraisals of marten abundance and distribution. Where such information is required, use of aircraft would permit much wider coverage than is possible by dog team, and would be more economical. Probably the best time for such a survey would be as early as possible following freeze-up and the first good autumn snows. The slowest light aircraft available would be best and it would be necessary to wait for a calm clear day to do the work. Glasses of colors other than yellow might be tested for accentuating the shadows in the tracks.

RECOMMENDATIONS

Management

No changes are recommended in the regulations concerning the hunting of moose by holders of general hunting licenses.

It is recommended that plans be laid for permitting hunting of moose by residents of the Northwest Territories who do not hold general hunting licenses. At the present time such a resident, if he is the head of a family, is allowed to take five barren-ground caribou but no moose. In view of the critical status of the caribou and the satisfactory status of the moose, this arrangement does not seem sound.

There are large areas carrying moose populations which no longer are hunted by Indians or other holders of general hunting licenses. Such moose constitute an unutilized resource. The area between the north arm of Great Slave Lake and the Horn River is one example of an unutilized, moose producing area. The east side of it was hunted lightly by Indians from Trout Rock when Flook was working in that region in 1952, and the southwest part of it is generally hunted by the Fort Providence Indians. The area lying between is not hunted at all. It has been observed to carry a substantial population of moose. It could advantageously be opened to moose hunting by residents. On the basis of population data obtained by aerial surveys, the harvest could be controlled through the number of permits issued or through the length of season.

Future Investigations

Results of the surveys reported here provide some bases for planning future inventories of moose in the Mackenzie District.

Two types of error are involved in the data presented; experimental error and sampling error. Experimental error is the difference between the number of moose present on a transect and the number of moose observed. No matter what the magnitude of the error, it would not be serious if it were consistent, as the data could be used to show trends in the population. However, the proportion of moose missed has apparently varied greatly in the surveys made.

A consistent experimental error may be attained in either of two ways. One way is for the observers to close their eyes. A consistent error of 100% would result.

The alternative is to refine the technique to a point where every moose on each transect is seen on every survey, producing an unvarying error of 0%. Therefore maximum observing efficiency should be the goal. In practice, 100% observing efficiency probably would never be reached, but by making it the goal, and by refining the technique accordingly, the highest possible consistency of results would be obtained.

Experience in the present surveys has indicated that efficiency of observation might be improved in the following ways:

1. Modifying the time of surveys -- results indicate that moose are more readily observed in December than later in the winter. It is possible that observability of moose is as great or greater in November than in December, with the added advantage that adult bulls may be identified in November by the presence of antlers. In addition, longer daylight periods in November might facilitate surveys in the northern district.
2. Surveying only in calm, clear weather.
3. Using a reliable tape or wire recorder to eliminate the necessity for interrupting observations in order to write notes.
4. Using a suitable type of aircraft -- it is important that the slowest aircraft be used for moose surveys. An aircraft which will afford ease of observation close to the flight line and ahead of the plane should be used.

Further refinements in technique are necessary in order to attain high efficiency of observation and consistency of results. The latter is particularly important so that variations in the proportion of moose overlooked will not be confused with population changes.

Because the transect width used in population density calculations has a great bearing on the results obtained, it is suggested that the present method of determining strip width be continued. It may be found that when surveys in a given area are conducted under uniform conditions, the width of strip in which moose are observed efficiently will be consistent. If so, then only one strut marker would be necessary. It would mark the outside of the strip.

Sampling error is due to chance. The transects flown, even though selected without conscious bias, may not represent a cross section of the area surveyed. It is recommended that future surveys be designed so that sampling error can be estimated and confidence limits set for the population estimate. In order to do this practically, transects could be laid out in a parallel pattern with a common interval. By using time checks and landmarks each transect could be divided into equal segments to be used as sampling units in statistical analysis. The type of analysis to be used should be determined before the samples are taken.

It does not appear practical to undertake aerial moose surveys of the entire Mackenzie Valley. To survey the area with an intensity sufficient to reduce the sampling error to acceptable limits would require much more flying time than was used in the 1958 survey. To survey as large an area as the Mackenzie Valley would necessitate holding an aircraft for several weeks if flying were done only under optimum weather conditions. It is necessary to pay for aircraft charter on every day on which the weather is fit for flying even if it is not suitable for surveying. Thus to survey the Mackenzie Valley properly the cost of operation would be too high to be consistent with the value of the moose crop.

It is therefore recommended that future aerial surveys be carried out in a few productive areas to develop a technique which will give consistent results and to follow trends in moose numbers, sex ratios and calf crops. In that way the surveys could be made under optimum weather conditions and more adequate sampling could be obtained on the areas selected.

Areas suggested for more intensive surveying are:

1. The area west of the Mackenzie River in the Fort Good Hope district.
2. The triangular area southwest of Fort Simpson, bounded by the Liard River, Mackenzie River and the Mahanni Range.
3. The area between the north arm of Great Slave Lake and the Horn River.

Due to the proximity of the last region to Yellowknife, it is well suited to experimentation and refinement of survey methods.

At least until such time as survey methods are developed which will permit placing reasonable confidence limits on the results, it would be desirable to fly a minimum of two consecutive surveys, within a week or two of one another, in the sample areas chosen. Close spacing of the surveys should permit elimination of many of the variables which precluded comparisons being made of the surveys reported here and would serve as reciprocal checks on the results.

Respectfully submitted:

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D. R. Flook

J. E. Bryant.
J. E. Bryant

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FLIGHT LINES

AERIAL MOOSE SURVEYS, MACKENZIE DISTRICT

December 1953

March-April 1956

Flown on both surveys

Boundary of planimetered area

(Scale: 35 miles = 1 inch)

BD CD DD ED FD GD
63°
CC DC EC FC GC
62°
C A
61°
CB DB EB FB GB
N
047°
310°
Bartlett Lake
Windflower Lake
Raccoon L
Lac Levis
Horn River
Fawn Lake
Mink Lake
Laferté River
Birch Lake
Slemon Lake
Marian Lake
Russell Lake
Stagg Lake
Awry Lake
Thistlethwaite Lake
McCrea
Cameron
Gordon Lake
1000
692
Duncan Lake
Ross River
Prosperous Lake
Prelude L
Cameron
Beaulieu
Harding Lake
XKA22 4455
Rae
FORT RAE
519 99
Waite Island
YELLOWKNIFE
672 L 50
975 (150)
YELLOWKNIFE
519 S 99
Whitebeach Point
Chedabucto Lake
Yellowknife Bay
YELLOWKNIFE RADIO
233 ZF 12' & 42'
Redrock Point
EVEN 2100
EVEN 2000
Matonabbee Pt
Whaleback Rocks
CARIBOU ISLA
ILES DU LARGE
WIL
Gypsum Point
Hardisty Island
519
BLUE ROUTE 84
AMBER ROUTE 6
GREAT SLAVE LAKE
Nov. 25, 1956
Nov. 26, 1956
MAR 22 1957
Caen Lake
Dieppe Lake
Calais Lake
Falaise Lake
Sulphur Bay
Jones Point
Mills Lake
473
PROVIDENCE
214.3 RV
(on request)
CS
PROVIDENCE RADIO 4355
(on request)
PROVIDENCE
473 99
MERIDIAN ISLAND
Fort Providence
PROVIDENCE
530 51
Deep Bay
BIG ISLAND
Stave Point
HAY RIVER
550 L 48
HAY RIVER
311 HY
(on request)
CS
HAY RIVER RADIO
4355 2917
(on request)
FORT RESOLUTION
530 L 42
FORT RESOLUTION
214.3 FR
(on request)
CS
FORT RESOLUTION RADIO 4355
(on request)
Fort Resolution
FORT RESOLUTION
519 99
Burnt Islands
Pine Point
PINE POINT
731 26
Pointe Desmarais
Kakisa Lake
Lady Evelyn Falls 48
Kakisa River
Tathlina Lake
Alexandra Falls 109
MACKENZIE HIGHWAY
BLUE ROUTE 7
HAY RIVER
519 S 99
Hay River
Sulphur Point
Buffalo River
Buffalo River
Little Nyarling R
AMBER ROUTE 6
EVEN 2100
EVEN 5000
EVEN 2000
31°E
Mag.
810
1024
733
1050
918
934

Flook, D. R.
Aerial survey of moose, Mackenzie District, NWT, March 1956, ...

TITLE

DATE LOANED	BORROWER'S NAME