

**AERIAL MOOSE CENSUS OF MANAGEMENT UNITS 5, 6, AND 7 IN THE WESTERN
NEWFOUNDLAND MODEL FOREST, 1993 AND 1994.**

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Date: September 1994

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Abstract

The total moose population in the management areas in the Western Newfoundland Model Forest was estimated at 10,000 animals based on aerial surveys conducted during the winter of 1993 and 1994. The density of moose in these areas have increased and/or remained relatively stable and currently range from 1.42 - 2.08 moose/square km. These densities are well within the generally accepted range for moose populations in the boreal forest system. Furthermore productivity and adult sex ratios fall within the values that can be expected for favourable moose habitat. We therefore suggest a target density of between 1.5 to 2.0 moose/km².

Introduction

Moose are a major influent on boreal forests. Damage by moose browsing has been reported throughout their North American range (Bergerud and Manuel 1968, Murie 1934, Krefling 1951, Peterson 1953 and 1955, Kelsall 1963, Thompson *et al.* 1992). Numerous studies have indicated that browsing by moose affects forest succession patterns in Newfoundland (Bergerud and Manuel 1968, Thompson *et al.* 1992) resulting in altered species composition, reduced future availability of merchantable timber and a reduced moose carrying capacity on effected range. Management actions have been required to ensure an adequate wood supply, full ecological representations of forests (i.e. balsam fir and hardwood components) and a healthy viable moose population.

Since their introduction in 1878 and 1904, the moose population on the island of Newfoundland has attained one of the highest densities in the world (Mercer 1994). However, when high moose densities are maintained over a period of years moose range may become depleted through overbrowsing especially under circumstances where insect damage, fire or timber harvesting are absent or ineffectual in instigating successional regeneration. This leads to a

reduced carrying capacity of the area and subsequent declines in moose numbers (Bergerud and Manuel 1968, Mercer *et al.* 1988).

The objective of the Western Newfoundland Model Forest is to develop, demonstrate and integrate the wildlife values and objectives into an integrated resource management plan for the balsam fir boreal forest ecosystem of the west coast of the island of Newfoundland. The Newfoundland and Labrador Wildlife Division is similarly concerned with these dynamics, but at a broader, province wide scale. In light of these shared research needs the WNMF and the Newfoundland and Labrador Wildlife Division agreed to census the moose population in an effort to obtain baseline information on the current moose population in the Western Newfoundland Model Forest before any research or management strategies were developed.

The objective of this study was: i) to determine the current population and density of moose in management units (MMU 5, 6, and 7) in the Western Newfoundland Model Forest; ii) to assess the current productivity (i.e. calf production (% calves) and adult male:female ratios (bulls/100 cows) of the moose populations in these areas; iii) to present a preliminary analysis of the trends in the aerial census information for the moose populations in these areas, and; iv) to help provide an empirical basis for population targets for moose populations in the Western Newfoundland Model Forest, as part of a longer term study proposal already submitted.

Study Area

The Western Newfoundland Model Forest is bounded on the north by Gros Morne National Park, the east by the Buchans Plateau and the Lloyd's River, the south by the Burgeo highway and the west by the Gulf of St. Lawrence (Fig. 1) and covers a large portion of the Western Newfoundland Ecoregion. The Western Newfoundland Ecoregion is characterized by a humid climate with a relatively long frost-free period and contains a wide variety of forest types ranging from young regeneration to overmature timber including some of the most productive Balsam fir (*Abies balsamea*) forest stands in Newfoundland. Moose management units within the Western Newfoundland Model Forest include the Trout River area (MMU 5), Corner Brook (MMU6), and

South Brook (MMU7) (Fig. 1).

Methods

Population size and density of moose in the Western Newfoundland Model Forest were estimated during the winters of 1993 (MMU 5: February 2-5) and 1994 (MMU 6: February-March; MMU 7: February 9-18) using a stratified random block survey (Gasaway et al. 1986). Blocks within each management unit were identified on 1:250,000 index map and were then surveyed using 1:50,000 topographic maps. Flights were conducted with a helicopter on days when the weather was clear or partially overcast and there was 100% snow cover. The front seat observer typically navigated each block for the pilot, watched for moose and plotted any observations on the maps. The back seat observer(s) watched for and classified moose according to age and sex and reported their observations to the recorder. Sex was determined by presence or absence of the vulval patch. Ages were classified as calf or adult based upon differences in body size and antler conformation. Each block was searched until the crew felt the area was adequately covered.

Results and Discussion

A total of 213 moose were counted and classified in the Trout River area (MMU 5) in February 1993; and 407 and 215 moose were counted and classified in the Corner Brook (MMU 6) and South Brook (MMU 7) area, respectively, in February and March 1994. Maps identifying survey blocks within the management units and the tabulations for the various population parameters are provided in the appendix. Population estimates and densities represented in Table 1 are adjusted for sightability bias (Gasaway *et al.* 1986).

The population of moose was estimated at 3258 ± 489 (MMU 5), 4330 ± 1015 (MMU 6) and 2054 ± 218 (MMU 7) (Table 1) for a total estimated population of 9642 animals. Net recruitment (% calves) ranged from 20-25% in the WNMF and adult sex ratios were 49♂:51♀ (MMU 6) and 39♂:61♀ (MMU7). Data from Sweden (Skuncke 1949), Alaska (Spencer and Chatelain 1953) and Newfoundland (Pimlott 1959) indicate that a net productivity of 25% and 36♂:64♀ sex ratio (Spencer and Chatelain 1953) can be expected on good range.

The estimated density of moose within these areas have increased and/or remained relatively stable and currently range 1.2 - 2.1 moose/square km (Fig. 2). While carrying capacities of 2.3 moose/square km have been reported in Newfoundland for habitat with rich soils and forest succession dominated by regeneration 3-20 years post-logging (Pimlott 1953), the densities reported here fall well within the generally accepted range for moose populations (0.38-2.3 moose/square) in the boreal forest system for eastern ranges in North America (Voit and Cumming 1960). These estimates will be incorporated with other information on moose license sales, hunter success rates and location and dates of hunter kills to suggest appropriate targets or population goals for moose in the Western Newfoundland Model Forest.

Acknowledgements

Observers on the flights for the 1993 and 1994 surveys included S. Anstey, B. Greene, J. Maloney, G. Penny, B. Pilgrim of the Newfoundland and Labrador Wildlife Division and J. Graham and D. Snow of the Western Newfoundland Model Forest. Pilots were H. Day and S. Aldie of Canadian Helicopters. Tammy Joyce (NLWD) provided calculation of variance and population estimates.

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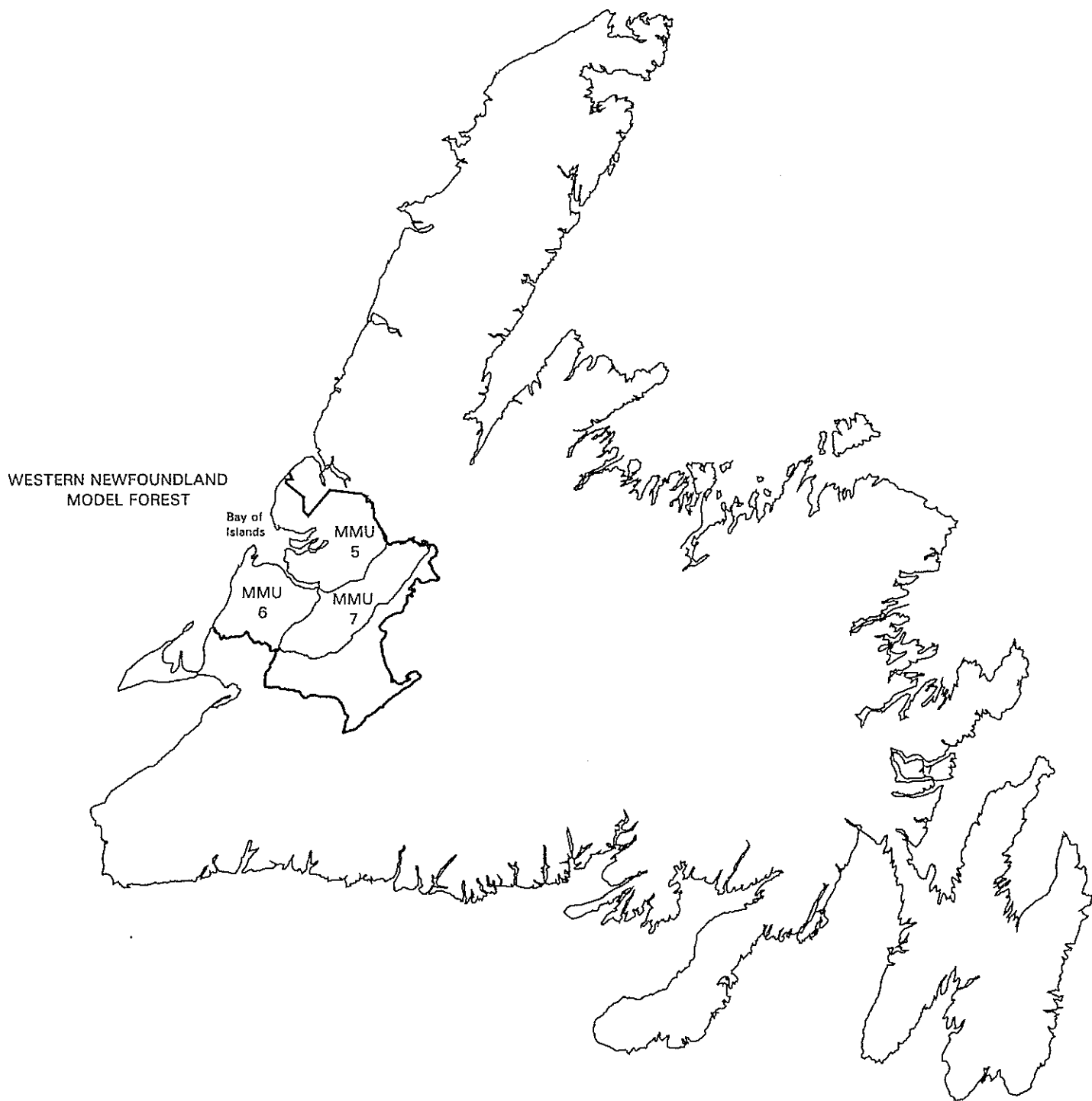


Fig. 1: Moose management units in the Western Newfoundland Model Forest.

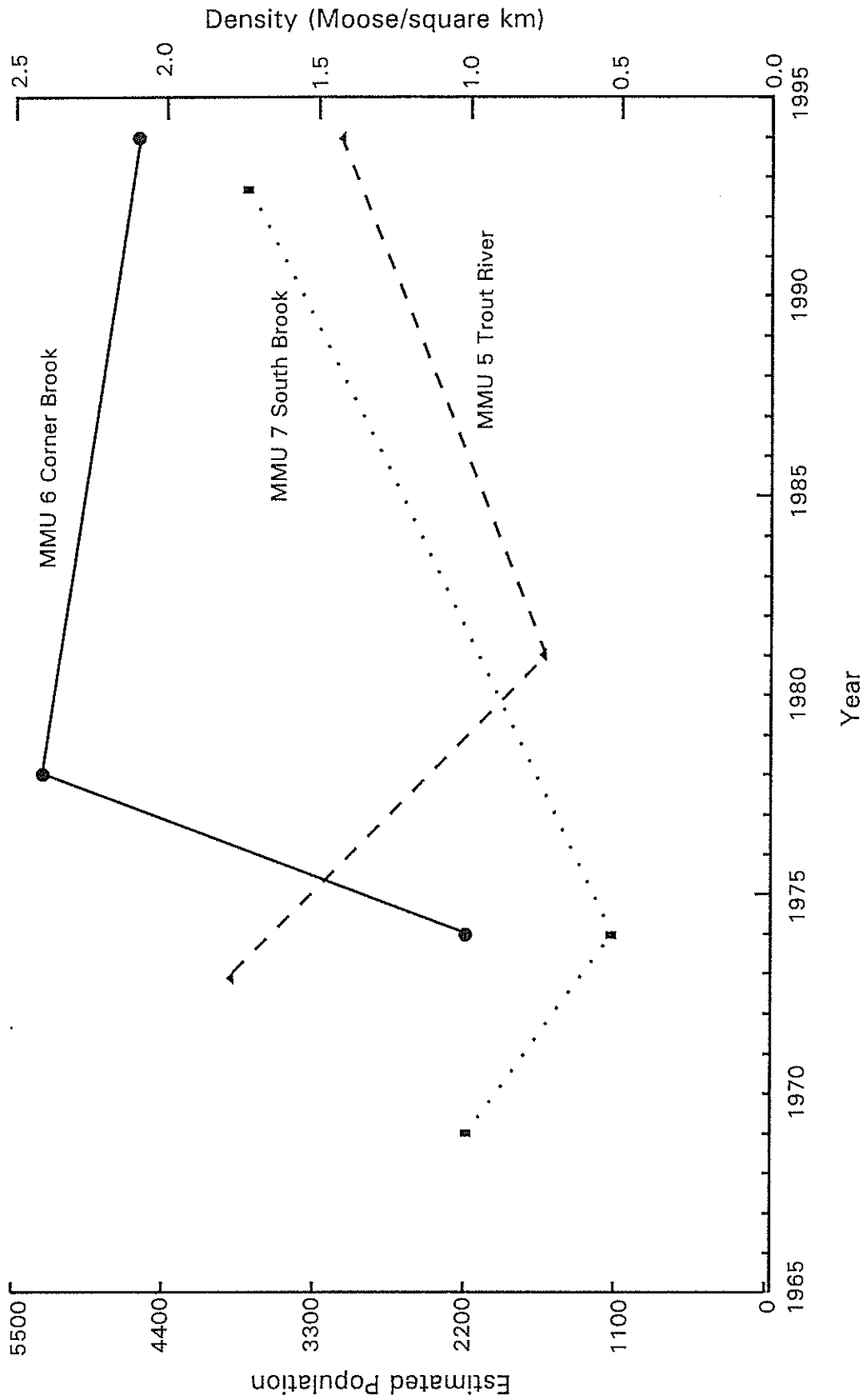


Fig. 2: Estimated population and density (moose/square km) of moose in management units 5, 6, and 7 in the Western Newfoundland Model Forest, 1965-1994.

Table 1: Results of the 1993 and 1994 moose block census in management units in the Western Newfoundland Model Forest.

MMU	Location	Date	Total		Coverage (%)	Moose/sq.km*	Confidence Interval	Estimated Population*
			Moose Counted	Area (km)				
5	Trout River	1993	213	240	13	1.74	489	3258
6	Corner Brook	1994	407	344	17	2.08	1015	4330
7	South Brook	1994	215	304	21	1.42	218	2054
Total			835	888				9642

* Adjusted for sightability

Table 2: Results of the 1993 and 1994 moose classifications in management units in the Western Newfoundland Model Forest.

MMU	Location	Date	Total		Bulls	Cows	Calves	Bulls/100 Cows	% calves (C/C+A)	C/100 Adults	C/100 Cows
			Total Counted	Adults							
5	Trout River	1993	213	159			54		25	34	
6	Corner Brook	1994	407	324	101	200	83	51	20	26	42
7	South Brook	1994	215	166	37	96	49	39	23	30	51

APPENDIX

Table 4: MMU 6: Estimate of moose population using aerial census data taken during February and March 1994.

Block	N	Observations					SUM	Factor N/n	Estimate of variance sample sum	Estimate of block population	Estimate of variance of block pop.(uncor)	Correction Factor (N-n)/N	Estimate of variance of finite block population	Estimate of variance within blocks	Degrees of Freedom	Block Adjustment
		1st	2nd	3rd	4th	5th										
1	22	4	0	0	4	3	7	5.5	17	39	514	0.82	421	12.75	3	99
2	25	5	3	17	1	2	14	37	282	185	7050	0.80	5640	225.20	4	100
3	25	5	4	0	0	0	0	4	16	20	400	0.80	320	12.80	4	100
4	9	2	5	2	0	0	0	7	9	32	182	0.78	142	4.50	1	32
5	10	2	0	0	0	0	0	5.0	0	0	0	0.80	0	0.00	1	40
6	25	5	10	4	14	7	2	37	114	185	2850	0.80	2280	91.20	4	100
7	25	5	2	4	33	5	3	47	877	235	21925	0.80	17540	701.20	4	100
8	25	5	20	0	0	3	3	26	354	130	8850	0.80	7080	282.80	4	100
9	7	1	2	0	0	0	2	7.0	0	14	0	0.86	0	0.00	0	42
10	6	1	4	0	0	0	4	6.0	0	24	0	0.83	0	0.00	0	30
11	22	5	10	1	1	2	7	21	84	92	1626	0.77	1257	66.80	4	75
12	25	4	0	2	0	2	10	14	79	88	3086	0.84	2592	59.00	3	131
13	25	2	4	4	0	0	8	12.5	0	100	0	0.92	0	0.00	1	288
14	21	2	1	0	0	1	10.5	1	1	11	110	0.90	100	0.50	1	200
15	3	1	4	0	0	0	4	3.0	0	12	0	0.67	0	0.00	0	6
16	25	5	4	3	3	2	1	13	7	65	175	0.80	140	5.20	4	100
17	25	5	11	5	51	2	1	70	2215	350	55375	0.80	44300	1772.00	4	100
18	23	4	1	17	2	12	32	5.8	243	184	8034	0.83	6637	182.00	3	109
19	25	1	0	0	0	0	0	25.0	0	0	0	0.96	0	0.00	0	600
20	7	1	6	0	0	6	7.0	7.0	0	42	0	0.86	0	0.00	0	42
21	6	1	0	0	0	0	0	6.0	0	0	0	0.83	0	0.00	0	30
22	25	3	0	0	0	0	0	8.3	0	0	0	0.88	0	0.00	2	183
23	25	1	0	0	0	0	0	25.0	0	0	0	0.96	0	0.00	0	600
24	25	5	10	11	4	32	2	59	711	295	17775	0.80	14220	568.80	4	100
25	7	1	0	0	0	0	0	7.0	0	0	0	0.86	0	0.00	0	42
26	12	1	4	0	0	4	12.0	12.0	0	48	0	0.92	0	0.00	0	132
27	12	3	0	0	0	0	4.0	4.0	0	0	0	0.75	0	0.00	2	36
28	4	1	0	0	0	0	4.0	4.0	0	0	0	0.75	0	0.00	0	12
29	7	2	2	1	0	3	3.5	3.5	1	11	12	0.71	9	0.50	1	18
30	15	3	1	0	0	1	5.0	5.0	1	5	25	0.80	20	0.67	2	60
Total	518	86				407			2165	102698	3985.92		56		3607	256735.74

Coverage = 17%

Classification

101 bulls	20 % calves	SE =	507
200 cows	42 calves/100 cows	t, 0.05, 56 =	2.003
83 calves		95% confidence interval	1015
23 unknown adults	1 bull 1.98 cows	Unadjusted Population Estimate =	2165 +/- 1015 moose
407 total		Adjusted Population Estimate =	1.04 moose/sq.km
		Density =	4330 moose
		Density =	2.09 moose/sq.km

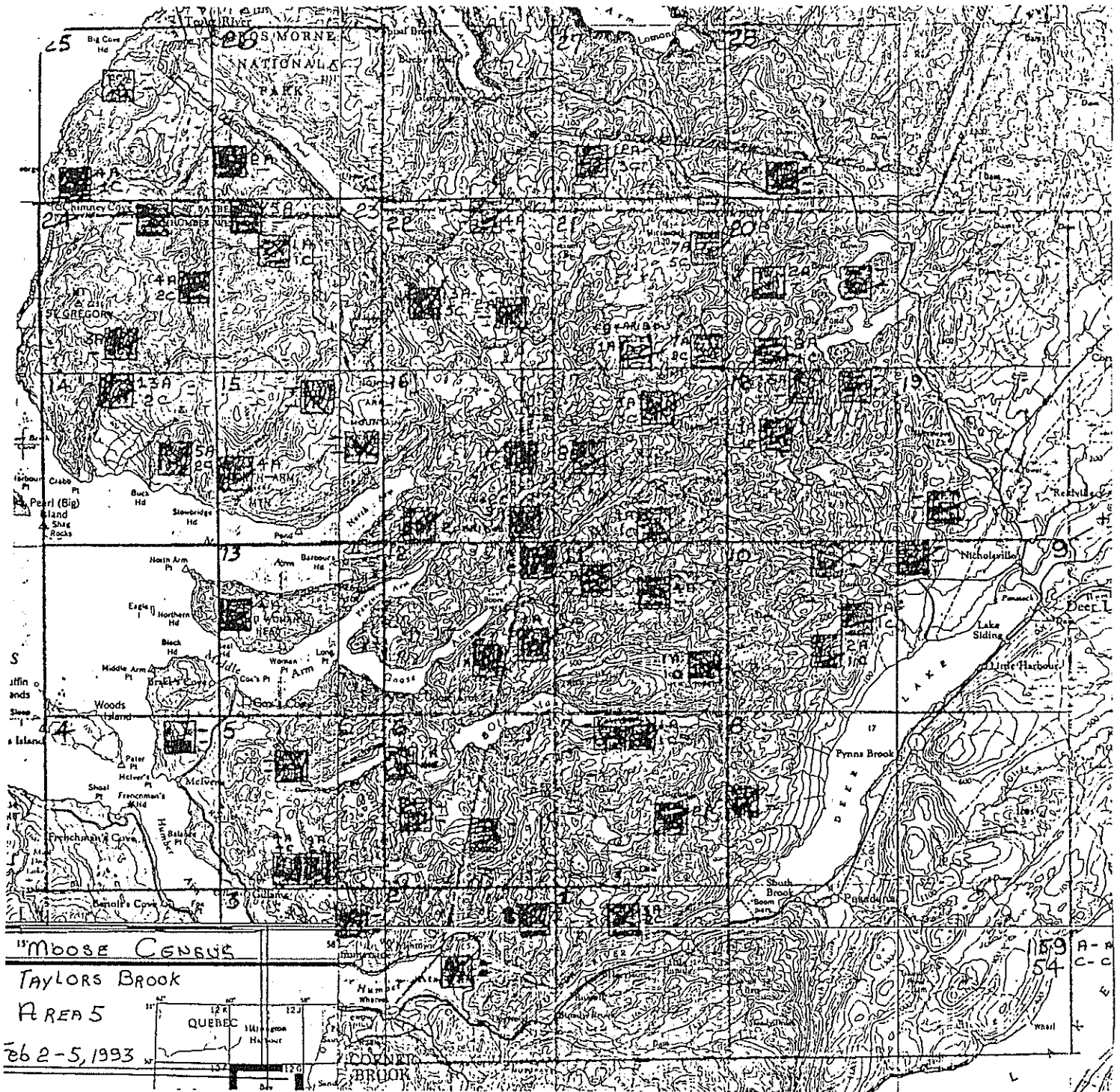


Fig. 3: Aerial survey blocks flown February 2-5, 1993 in moose management unit 5.

Table 3: MMU 5: Estimate of moose population using aerial census data collected from Feb.2-5, 1993.

Block	N	n	Observations				SUM	Factor N/n	Estimate of variance		Estimate of variance of block pop.(uncor)	Correction Factor (N-n)/n	Estimate of variance		Degrees of Freedom	Block Adjustment
			1st	2nd	3rd	4th			Estimate of variance of sample sum	Estimate of block population			Estimate of variance within blocks	Estimate of finite block population		
1	10	1	5				5	10	0	0	0.90	0	0	0	90.0	
2	16	2	0	0			0	8	0	0	0.88	0	0	1	112.0	
3	9	1	0	0			0	9	0	0	0.89	0	0	0	72.0	
4	6	1	0	0			0	6	0	0	0.83	0	0	0	30.0	
5	9	3	0	8	15		23	3	169	1521	0.67	1014	113	2	18.0	
6	23	3	1	0	0		1	8	1	59	0.87	51	1	2	153.3	
7	24	3	0	2	2		4	8	4	256	0.88	224	3	2	168.0	
8	16	1	0	0			0	16	0	0	0.94	0	0	0	240.0	
9	11	1	0	0			0	11	0	0	0.91	0	0	0	110.0	
10	24	3	0	2	3		5	8	7	448	0.88	392	5	2	168.0	
11	25	3	2	4	9		15	8	39	2708	0.88	2383	26	2	183.3	
12	21	3	2	1	1		4	7	1	49	0.86	42	1	2	126.0	
13	13	1	5				5	13	0	0	0.92	0	0	0	156.0	
14	16	2	15	7			22	8	64	4096	0.88	3584	32	1	112.0	
15	19	3	0	0	4		4	6	16	642	0.84	540	11	2	101.3	
16	24	3	0	5	2		7	8	19	1216	0.88	1064	13	2	168.0	
17	25	3	8	6	2		16	8	28	1944	0.88	1711	19	2	183.3	
18	25	3	5	0	2		7	8	19	1319	0.88	1161	13	2	183.3	
19	11	1	0	0			0	11	0	0	0.91	0	0	0	110.0	
20	17	3	2	9	0		11	6	67	2151	0.82	1772	45	2	79.3	
21	25	3	12	9	1		22	8	97	6736	0.88	5928	65	2	183.3	
22	25	3	4	18	2		24	8	228	15833	0.88	13933	152	2	183.3	
23	16	2	5	2			7	8	9	576	0.88	504	5	1	112.0	
24	25	3	0	6	3		9	8	27	1875	0.88	1650	18	2	183.3	
25	16	2	0	5			5	8	25	1600	0.88	1400	13	1	112.0	
26	6	1	2				2	6	0	0	0.83	0	0	0	30.0	
27	9	1	15				15	9	0	0	0.89	0	0	0	72.0	
28	3	1	0				0	3	0	0	0.67	0	0	0	6.0	
Total	469	60					213			1629		37353	535	32	3446	

Coverage = 13%

Observed: Adults 159, Calves 54 > 25% calves (of total)
> 34 calves 100 adults

SE = 240.03
t,0.05,32 = 2.037
95% confidence interval 489

Unadjusted: Population estimate = 1629 +/- 489 moose
Density = 0.87 moose/sq.k

Adjusted: Population estimate = 3259 moose
Density = 1.74 moose/sq.k

Table 5: MMU 7: Estimate of moose population using aerial census data collected from February 9-18, 1994.

Block	N	n	Observations					SUM	Factor N/n	Estimate of variance of sample sum	Estimate of block of population	Estimate of variance of block of pop.(uncor)	Correction Factor (N-n)/N	Estimate of variance of finite block population	Estimate of variance within blocks	Degrees of Freedom	Block Adjustment
			1st	2nd	3rd	4th	5th										
1	25	5	10	2	2	0	5	19	5	76	1900	0.80	1520	61	4	100	
2	22	5	2	0	1	0	4	7	4	14	271	0.77	209	11	4	75	
3	9	2	2	3			5	5	5	1	20	0.78	16	1	1	32	
4	25	5	2	5	5	0	4	16	5	24	600	0.80	480	19	4	100	
5	4	1	5				5	5	4	0	0	0.75	0	0	0	12	
6	14	3	1	2	0		3	3	5	3	65	0.79	51	2	2	51	
7	23	5	0	5	4	2	0	11	5	26	550	0.78	431	21	4	83	
8	23	5	1	0	0	3	8	12	5	57	1206	0.78	944	45	4	83	
9	25	5	1	0	2	0	0	3	5	4	100	0.80	80	3	4	100	
10	25	5	2	0	0	2	5	9	5	21	525	0.80	420	17	4	100	
11	21	5	2	3	0	4	8	17	4	44	776	0.76	591	35	4	67	
12	18	4	13	0	1	5		19	5	140	2835	0.78	2205	105	3	63	
13	25	5	9	1	6	6	9	31	5	54	1350	0.80	1080	43	4	100	
14	20	4	0	3	3	0		6	5	12	300	0.80	240	9	3	80	
15	12	2	0	4				4	6	16	576	0.83	480	8	1	60	
16	14	3	2	1	10			13	5	73	1590	0.79	1249	49	2	51	
17	24	5	3	1	2	9	0	15	5	63	1452	0.79	1149	50	4	91	
18	21	4	2	5	6	7		20	5	19	524	0.81	424	14	3	89	
19	13	3	0	0	0			0	4	0	0	0.77	0	0	2	43	
Total	363	76						215		1032	11569		493	57		1380	

Coverage = 20.9 %

SE = 109
 $t_{0.05,57} = 2.004$

Classification

37	bulls	23	% calves	218	95% confidence interval
96	cows	51	calves/100 cows		
49	calves				
33	unknown adults	1	bulls:	2.6	cows
215	total				

Unadjusted: Population estimate = 1032 +/- 218 moose/sq.k
 Density = 0.71

Adjusted: Population estimate = 2064 moose
 Density = 1.42 moose/sq.k

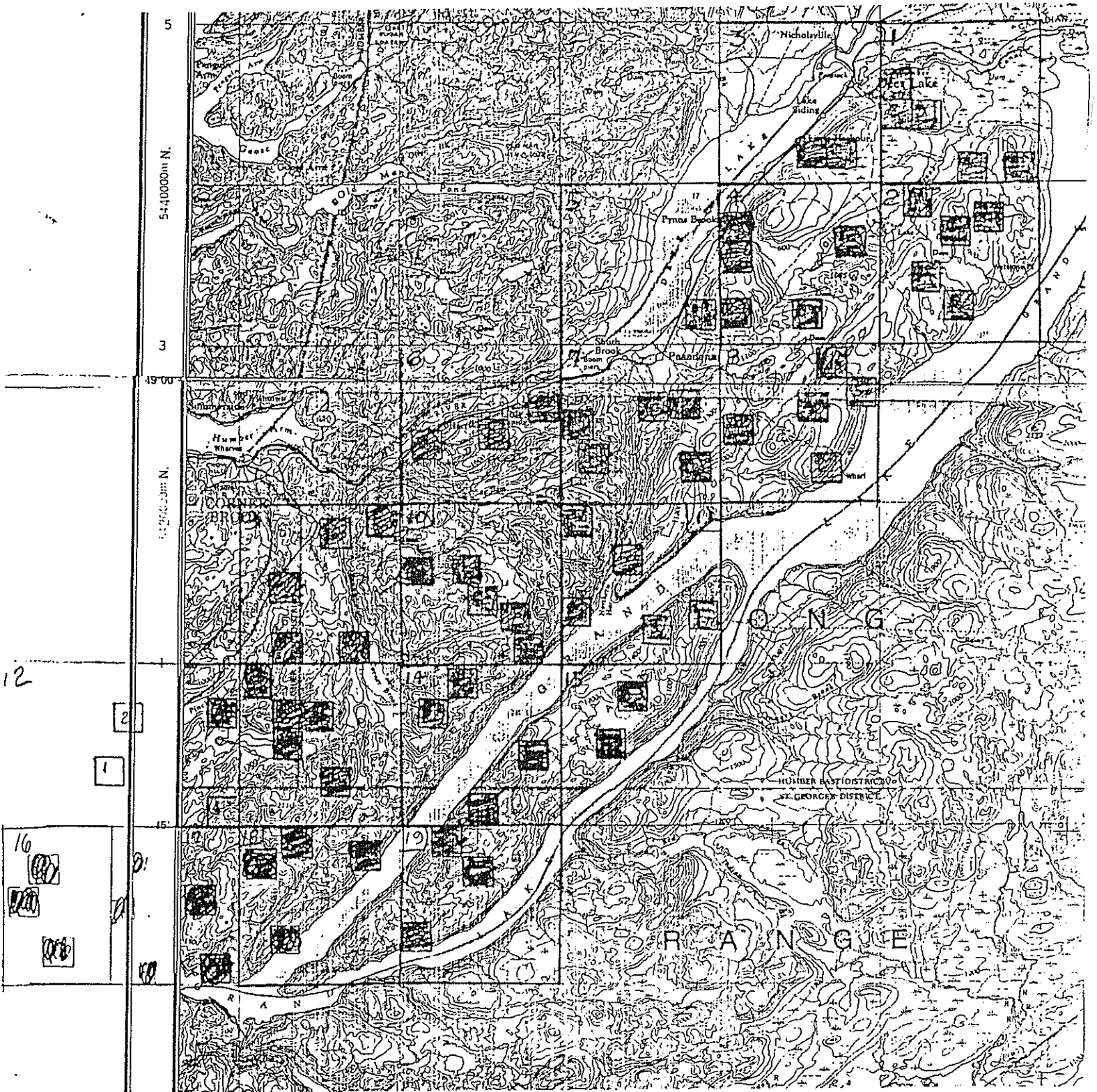


Fig. 4: Aerial survey blocks flown February 9-18, 1994 in moose management unit 7.