EARLY WINTER SOCIAL STRUCTURE OF HUNTED vs UNHUNTED MOOSE POPULATIONS IN N. CENTRAL ONTARIO

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ABSTRACT: Early winter social structure of moose (*Alces alces*) in hunted and unhunted populations are compared from 30 and 27 aerial surveys, conducted in northcentral Ontario between 1975 and 1993 respectively. All animal aggregates (range 1-16, n=5,394) are classified into 8 social classes including single males, multiple males, single females, multiple females, mixed male/female groups, females with calves, lone calves, and unsexed adult groups. Bulls were further designated into 4 groups on the basis of antler shape and size. In hunted populations, the proportion of single males and females increased while multiple male and mixed male/female groups declined from December through February. In unhunted populations, multiple males and females increased, while mixed male/female and female/calf groups decreased from December through January. Mean group sizes in hunted populations were similiar from December through February (2.05, 1.93, 1.79 respectively $P > 0.10$) and also remained similar in unhunted populations during December and January (2.20 vs 2.00 $P > 0.10$).The mean aggregate size of all bulls in four antler classes and the time of antler casting were similiar for both hunted and unhunted populations. However, December aggregates ≥ 6 in unhunted populations were nearly twice as frequent ($P < 0.05$) as in hunted populations while those ≥ 10 were 8 times more frequent. The majority of these large December aggregates were composed of both sexes with bulls dominating. Observed moose densities were 5 to 6 times higher in unhunted than in hunted populations.

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Counting and classifying moose from aircraft when they are on winter range is the most common method of estimating moose numbers and determining social structure in North America (Timmermann 1974). The majority of agencies conduct aerial moose surveys in December through early February prior to movement into dense tree cover (Timmermann 1993). Since aerial surveys commonly underestimate the number of animals present (Caughley and Goddard 1972), sightability estimates have been developed to more accurately determine actual numbers. The mean aggregate size of moose observed is one of three methods commonly used (Bergerud and Manuel 1969, Timmermann 1993). Fresh tracks are counted where moose are not sighted and then multiplied by the mean aggregate size of moose observed to estimate actual numbers.

Moose aggregations (excluding cows and calves) are highest in late autumn and early winter across North America (LeResche 1974, Peek *et al.* 1974, 1976, Ballard *et al.* 1991). During autumn single cows without calves often associate with other adults up to 2 months longer than cows with calves (Rounds 1978). Mytton and Keith (1981) in Alberta suggested that barren cows remain in groups from August to December. Bull-dominated aggregates reported near Rochester Alberta averaged 1.0 (n=65) in early August and 2.3 (n=105) in November (Mytton and Keith 1981). The largest bull aggregations (up to 9) occurred immediately following the rut during mid October to late November and bulls were usually solitary between December and July.

There is a scarcity of information in the published literature concerning early winter social structure even though many agencies routinely conduct annual aerial surveys during the December to February period. Houston (1974) observed that groups containing both adult males and females (*A.a. shirasi*) were comparatively uncommon and involved only 11% of animals observed during winter and early spring. Ballard *et al.* (1991: 26) reported that average group size of Alaskan moose (*A.a. gigas*)" was about 2 from January through July" and cows with calves did not associate with large rutting groups. Mean aggregate size of Newfoundland moose from December to March varied between 1.8 and 2.3 with little evidence of declining size from early to late winter (Bergerud and Manuel 1969).

The most complete description of social studies that include the early winter period are those of Peek *et al.* (1974) who compared moose aggregations in Alaska, Minnesota and Montana and the more recent studies of sexual segregation in Alaskan moose by Miquelle *et al.* (1992). Peek *et al.* (1974 : 126) found the "largest group sizes occurred when moose were primarily on the most open parts of their habitat: alpine tundra on the Kenai; recent cut over areas in northeastern Minnesota; and willow bottoms in Montana". Sexual segregation of *gigas* was greatest in winter and "rates of social interaction of males were low when in mixed groups in winter". Further "large males were segregated from females in January and remained so into April" (Miquelle *et al.* 1992 :5).

In Ontario intensive searching of stratified, randomly selected, standard size plots using the mean aggregate size method to estimate missed moose has been a key component of the province's selective harvest strategy since 1983. Such aerial surveys help estimate population size and trends, and determine the age and sex composition of moose populations. Data is used in setting annual harvest quotas and evaluating management strategies (Timmermann and Whitlaw 1992, Timmermann 1993). Knowledge of the sex-age composition is important in properly assessing a moose population, especially one that is heavily hunted and uses a selective harvest strategy (Bubenik *et al.* 1975).

The purpose of this paper is to compare the early winter social structure of hunted and unhunted moose populations in northcentral Ontario. We were interested in monitoring the impact of selective harvest strategies introduced in 1983 that were designed to protect a larger proportion of breeding cows and focus more hunting pressure on bulls and calves. The study area previously described by Timmermann and Whitlaw (1992), was located in the boreal mixedwood forest north and west of lake Superior and north of the Minnesota Ontario border.

METHODS

Each of 9 Wildlife Management Units (WMU's) open to hunting in northcentral Ontario were aerially surveyed in the period December - February, approximately every 3 years between 1982-92 (Timmermann and Gollat 1986, Timmermann and Whitlaw 1992). On average, 40 to 50, 25km^2 plots in each WMU were randomly selected from a stratified sample and systematically searched for moose, using a standardized procedure (Bisset 1991). Size of WMU land areas varied from 1,489 to 14,946 km^2 (Timmermann and Whitlaw 1992:147, Table 3), and all had experienced significant logging disturbance over the last 40 years. Four study areas varying in size from 100 to 200 km^2 were selected in previously logged habitats to serve as unhunted controls. All were logged during the period 1970 to 1993. Each unhunted control area was gridded into closely spaced parallel flight lines and observed moose aggregates identified and located on a composite photo mosaic. No attempt was made to intensively search the area as most consisted of open habitats yielding a high degree of sightability within the tightly spaced flight lines Surveys therein were conducted annually beginning as early as 1975 and extending to 1993. None had previously been hunted. Rotary-wing aircraft were used in all sex/age composition surveys reported here (Timmermann 1993) Adult sex/age identifyers used to classify all animals sighted included the presence or absence of antlers, the shape and size of the bell (Timmermann *et al.* 1985), the presence or absence of a vulva patch (Mitchell 1970), the association of an unantlered adult with one or two calves and the degree of facial pigmentation on the nose bridge of unantlered adults (Bubenik *et al.* 1977). Antler shape and size or the absence thereof, were used to classify males into one of four classes (Timmermann 1993). Class I antlers are those composed of either spike, fork, or multiple fork; Class II are small palmated antlers; Class III are large palmated antlers, while Class IV are unantlered. Pre-survey workshops were held annually prior to survey commencement to ensure accuracy and consistency among survey crews.

All aggregates were counted and classified as to sex and relative age. An aggregate is defined as 1 moose or > 1 moose that occur within reasonable proximity to each other, and when there appears to be a behavioural or social bond between those moose (Bergerud and Manuel 1969, Peek *et al.* 1974). Differences in observed mean group sizes were determined for December through February. There were no differences among years, similar to that reported by Ballard *et al.* (1991) for Alaskan moose. All years were therefore pooled into either hunted or unhunted aggregates, separated by month and placed into 1 of 8 categories. They included single males, multiple males, single females, multiple females, mixed male/female groups, females with calves, lone calves, and an unsexed adult category. Late November survey data was included with December data to increase sample size. All 27 surveys in unhunted populations spanned the period late November through the end of January. In contrast even though some surveys in hunted populations also began in late November, 12 of 30 surveys extended into February, with at least one extending as late as February 24th. The objective of our analysis was three-fold: 1) to construct a social structure profile of both hunted and unhunted early-winter moose populations in northcentral Ontario, 2) contrast differences and trends in their profile over time and, 3) to identify significant differences in social structure between December and January hunted and unhunted populations. The analysis includes 57 surveys yielding 10,756 animals in 5,398 aggregates, conducted during the period 1975 to 1993. Differences in mean aggregate size were tested using a T test and a Bonferroni - adjusted probability for multiple comparisons, while a Chi square test was used to compare occurrence of groups ≥ 6. Unless specifically stated, $P < 0.05$ was required for statistical significance.

RESULTS AND DISCUSSION

Mean aggregate size

Mean aggregate sizes in hunted populations were similar in December and January ($t=1.97$, df = 42, $P > 0.10$) and in January and February ($t = 1.87$, df = 32, $P > 0.10$) as well as those in unhunted December and January populations ($t = 1.54$, df = 26, $P > 0.10$) (Table 1). In addition there were no differences between hunted and unhunted December ($t = 1.45$, df = 40, $P > 0.10$) and January ($t = 1.14$, df = 28, $P > 0.10$) mean group sizes. Unhunted areas had larger aggregates (≤ 16) than did hunted areas (≤ 11) (Table 1). Larger group sizes in unhunted areas may be due to several factors such as higher densities and/or earlier survey completion in unhunted vs hunted populations. Peek *et al.* (1974) reported group sizes in their study were related to density; highest and most variable in Alaskan moose whose densities were > 9.32 /km^2 and lowest and least variable in Montana moose where densities

Table 1. Mean moose aggregate size in hunted and unhunted populations in northcentral Ontario, 1975-93.

	Number of			$\bar{x}$ aggregate		
	Surveys[1]	Moose	Aggregates	Size	SD	Range
Hunted						
Dec.	22	2498	1230	2.05[2]	.30	1-11
Jan.	24	4489	2400	1.93[2]	.14	1-11
Feb.	12	552	309	1.79[2]	.19	1-7
Unhunted						
Dec.	22	2790	1268	2.21[2]	.26	1-16
Jan.	6	427	213	2.01[2]	.29	1-7

[1] Survey duration, November 28-February. 24, in hunted areas; November 25-January 30, in unhunted areas.

[2] No statistical differences found between months with similar superscript.

averaged 1.11/km^2. Aggregation size, however was quite constant (1.8 - 2.3) in a Newfoundland study, regardless of changes in density (Bergerud and Manuel 1969). Adult sex ratios and densities in our study ranged from 58 to 66 bulls/100 cows and 0.13 - 0.46 / km^2 in hunted populations and 73 to 83 bulls/ 100 cows and 0.82 - 2.46 / km^2 in unhunted populations (Timmermann and Whitlaw 1992). However, all unhunted areas were surveyed by the end of January, while some surveys in hunted populations were not completed until the end of February.

Distribution of single and multiple groups

The proportion of single bull and single cow groups and cow/calf groups was slightly higher in hunted populations, while the proportion of mixed bull / cow groups was lower (P < 0.05) suggesting that hunting may have had an impact on social structure (Fig 1).

A social structure profile compares hunted and unhunted populations using pooled data (Table 2). We recognize group dynamics and

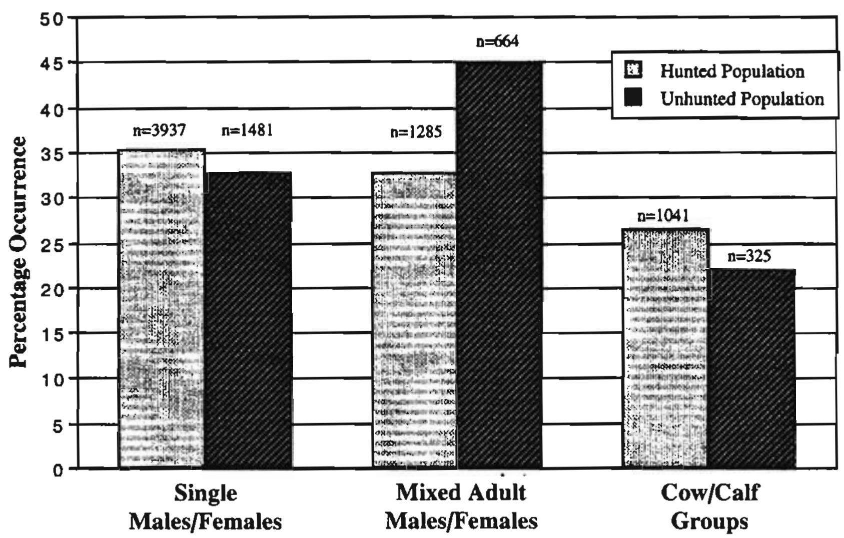

Fig. 1 Percentage occurrence of aggregate makeup for hunted and unhunted populations. n = number of moose observed.

the transitory nature of groups may play a dominant role in the occurrence representation between aggregation social groups over time. Single bulls and single cows occurred at similar frequencies in all months for both hunted and unhunted populations (Table 2). However, if the lone cow/calf group is treated as a single cow group then bulls are more social. These findings agree with those of Peek *et al.* (1974) who also lumped single cow groups with cow/calf groups. They reported bulls to be consistently more gregarious than cows during the same period in Minnesota and Montana. Multiple bull groups occurred at lower frequencies on the Kenai in Alaska during December and January "probably reflecting both the higher density and disparate sex ratio" (Peek *et al.* 1974 : 130). The occurrence of both single hunted bull and cow groupings increased from December through February while little change is seen in the proportion of single bull and cow groupings in unhunted December and January populations. This difference may also reflect different densities in hunted and unhunted populations as previously discussed. The occurrence of lone calves is similar, while that of unsexed adults is higher in hunted populations, again perhaps reflecting the greater search effort employed in hunted population surveys.

The occurrence of multiple bull groups in hunted populations declined (9% in Dec. to 5% in Feb.) and those of both multiple bulls (10% - 13%) and cows (12% - 15%) increased in unhunted populations (from Dec. through Jan., (Table 2). Mixed bull / cow group occurrences (22% vs 16%, Dec., 17% vs 14.5%, Jan.) are higher in unhunted populations and exhibit a similar decline from December to January as do mixed groups in hunted areas. The lower proportion of cows with calves in unhunted populations during December and January however, raise the proportion of cows in other groups. Hence, changes in the presence of calves will have a major affect on the proportion of classes containing cows. Younger bulls were more likely to be associated with cows than were larger bulls, similar to that reported by Miquelle *et al.* (1992) in Alaska during winter.

The occurrence of multiple cow groups is lower in hunted populations (10% vs 12% Dec., 11% vs 15%,Jan.) and exhibited a slight increase from December through January (Table 2). Unhunted cow/calf group occurrences were lower (23% vs 27%, Dec.,18% vs 26%, Jan.) than in hunted populations and declined from December to January, perhaps influenced by lower productivity, a less intensive

Table 2. Percentages of eight sex/age aggregation categories observed in 30 hunted and 27 unhunted populations surveyed in northcentral Ontario, December through February 1975-93.

	Percent of Groups				
Sex/Age Category	Hunted Dec.	Unhunted Dec.	Hunted Jan.	Unhunted Jan.	Hunted Feb.
Single bull	17	16	18	16	19
Multiple bull	9	10	7	13	5
Mixed bull/cow	16	22	14.5	17	11
Single cow	16	16	18	17	20.4
Multiple cow	10	12	11	15	9.4
Cow/calf	27	23	26	18	29.1
Lone calves	0.2	0.3	0.7	0.5	0.6
Unsexed adult	5	0.9	5	3	5.5

search effort employed in unhunted areas and the effect of selective removal of a higher proportion of adults than calves in hunted populations.

Distribution of bull social groups

The mean aggregate size of all four antler classes was similar for both hunted and unhunted populations in December and January (Table 3). Hunted Class I mean group sizes dropped from 1.3 to 1.2 but remain similar (1.2) in both unhunted December and January populations. Small January sample sizes may partially account for these similarities. A similar reduction in mean aggregate size from December to January was evident in all remaining classes except the unhunted January unantlered class. No statistical tests were done on this sample.

The proportion of hunted and unhunted December Class I bull occurrences were similar while January's are lower in unhunted populations, again perhaps due to small sample sizes or reduced productivity (Fig 2). A greater variation is apparent in both December and January Class II occurences and December Class III occurences, the latter suggesting a higher proportion of trophy bulls in unhunted populations. Finally the proportion of unantlered bulls is similar (about 10% in Dec.) and rising to 40% of all bulls classified in January hunted and unhunted populations. Oswald (1984) reported a 19% end of December (n=16) and a 44% end of January (n=41) antler loss in an unhunted northeastern Ontario population surveyed between 1976 and 1981. Similarly Novak (1981) extrapolated a 50% rate of antler casting by January 30th 1976 in WMU 23, a heavily hunted moose population near Hearst Ontario. Hence classification of moose, given good snow cover is much more efficient in December when antler retention is high.

Large aggregates $\geq$ 6 and composition $\geq$10

The incidence of December groups was higher (3.4% vs 2.1%, $P < 0.05$) and the maximum size higher (16 vs 11) in unhunted populations (Table 4). The majority of large aggregates consisted of mixed sex groups (96% in hunted, 86% in unhunted). Bulls dominated hunted mixed groups in December (46% hunted vs 32% unhunted); cows in unhunted populations (46% vs 23%). Equal number of bulls and cows were found in 31% of hunted mixed sex aggregates and 22% of unhunted mixed sex aggregates. Single sex aggregates dominated unhunted groups (14% vs 8%) while the number of aggregate groups with one or more calves was similar (21% vs

Table 3. Mean bull aggregate size of four antler classes (n=2,559 aggregates) observed in 30 hunted and 27 unhunted populations surveyed in early winter in northcentral Ontario, 1975-93.

	Bull Antler Class				
	I	II	III	UA[1]	All Bulls
December:					
Hunted	1.3 (152)	1.4 (187)	1.4 (173)	1.1 (82)	1.3 (594)
Unhunted	1.2 (195)	1.3 (194)	1.5 (270)	1.1 (84)	1.3 (743)
January:					
Hunted	1.2 (250)	1.1 (235)	1.2 (149)	1.2 (454)	1.2 (1088)
Unhunted	1.2 (20)	1.2 (38)	1.1 (24)	1.3 (52)	1.2 (134)

[1]Unantlered

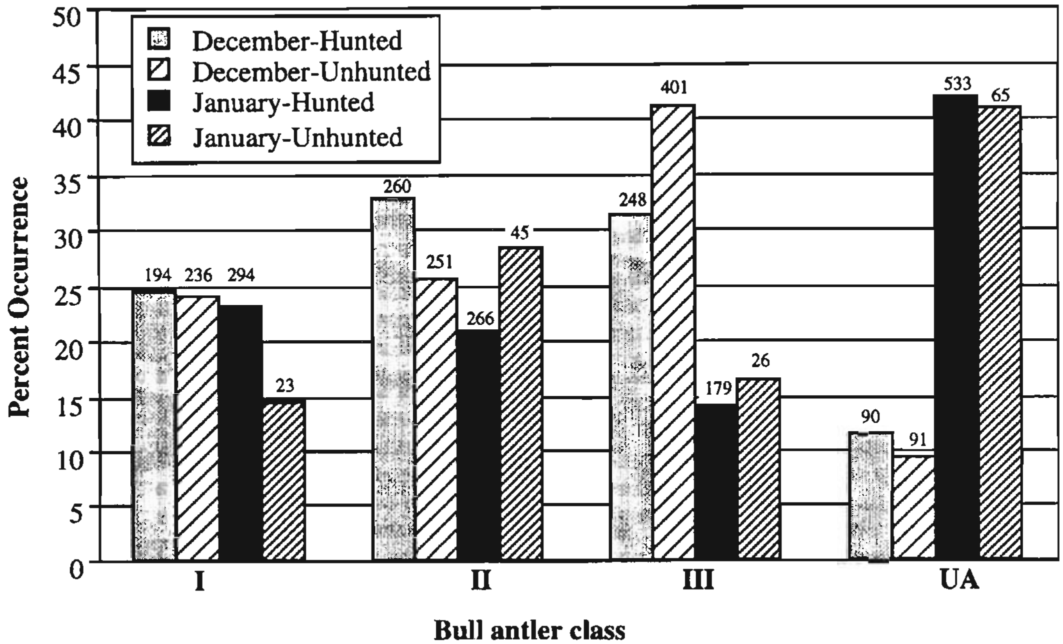

Fig. 2. Percentage occurrence of four antler classes among 3,202 male moose categorized in northcentral Ontario (sample size of animals placed above respective bars. Antler classes are described by Timmermann (1993).

Table 4. Large aggregates ≥ 6 observed in 22 hunted and 22 unhunted December populations surveyed in northcentral Ontario, 1975-93.

UNHUNTED (n=1,268 aggregates)		HUNTED (n=1,230 aggregates)
43 (3.4%)[1]	Number & percentage	26 (2.1%)[1]
6 - 16	Range	6 - 11
37 (86%)	**Mixed sex aggregates**	**28 (96%)**
12 (32%)	# Bulls > # Cows	12 (46%)
17 (46%)	# Cows > # Bulls	6 (23%)
8 (22%)	# Cows = # Bulls	8 (31%)
9 (21%)	# Groups with calves	5 (19%)
6 (14%)	**Single sex aggregates**	**2 (8%)**
5 (12%)	Bull	--
1 (2%)	Cow	2 (8%)

[1] $P < 0.05$

[2] Includes calves

Table 5. Composition of December aggregates ≥ 10 observed in 30 hunted and 27 unhunted populations surveyed in early winter in northcentral Ontario, 1975-93

Bulls by antler class:				Cows with and without calves:				
I	II	III	UA	Single	+1 Ca	+2 Ca	Unk	Total
A) Unhunted (8 of 1,268):								
1	1	3	-	6	-	-	-	11
1	-	9	-	6	-	-	-	16
5	1	2	-	3	-	-	-	11
3	3	3	2	-	-	-	-	11
2	3	9	1	1	-	-	-	16
2	4	4	-	-	-	-	-	10
1	3	-	1	5	-	-	-	10
1	1	-	1	8	-	1	-	14
B) Hunted (1 of 1,230):								
4	-	1	-	4	1	-	-	11

19%).

The majority of aggregates ≥ 10 were composed of both sexes while the incidence of groups ≥ 10 were 8 times more frequent in unhunted than in hunted populations (Table 5). Calves were mixed in only 1 of 8 unhunted and in the 1 hunted group ≥ 10. Bulls occurred more frequently than cows in larger groups; similar to that reported by Peek *et al.* (1974).

SUMMARY and CONCLUSIONS

Baseline data is presented contrasting the social structure profile of hunted and unhunted early winter moose populations in northcentral Ontario. Hunting appears to have affected the social structure and density in this sample comparison. Resultant lower densities, skewed adult sex ratios (Timmermann and Whitlaw 1992) and higher calf occurrences in hunted populations may be partially responsible. Although mean group sizes were statistically similar between hunted and unhunted populations and between months, we believe real biological differences exist. Group sizes were larger and large groups more frequent in unhunted populations, particularly in December when moose select more open habitats. The occurrence of both multiple bulls and multiple cow groups was higher in unhunted compared to hunted populations. In addition the occurrence of single bulls and cows was slightly lower in unhunted populations as was a lower proportion of cow/calf groups. Bulls dominated mixed groups in hunted populations while cows did so in unhunted populations.

Readers should be cautioned however, as this hunted / unhunted comparison has major limitations. Composition surveys in our small (≤ 200 km^2) unhunted controls focused on high density and recently disturbed portions of the survey areas. Those in larger hunted WMU's (≤ 14,946 km^2) were more random and contained a mix of disturbed and undisturbed habitats. In addition some hunted WMU's contain large inaccessible areas that are only lightly hunted. It is also possible as reported by Gasaway *et al.* (1986) that the lower intensity composition surveys missed a proportion of cow/calf groups and over - estimated bulls, relative to cows.

Composition surveys should be conducted as early in winter as possible and to be representative; should strive to sample all habitats with similar effort. Ideally late November - December classification surveys conducted when antler retention is high and moose are more gregarious, should yield a more efficient and representative sample of existing social structure. Peek *et al.* (1974) concluded that diversity of habitat stability has a major influence on the social system and aggregation patterns. We believe additional studies are needed to examine these influences and to further investigate the impact of hunting on moose social structure including differences in survival of males and females as well as aggregate stability and longevity.

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REFERENCES

BALLARD, W.B., J.S. WHITMAN, and D.J. REED. 1991. Population dynamics of moose in south-central Alaska. Wildl. Monogr. 114. 49pp.

BERGERUD, A.T., and F. MANUAL. 1969. Aerial census of moose in central Newfoundland. J. Wildl. Manage. 33:729-746.

BISSET, A.R. 1991. Standards and guidelines for moose population inventory in Ontario. Ont. Min. Nat. Resour., Wildl. Br., Toronto. 37 pp.

BUBENIK, A.B., O. WILLIAMS, and H.R. TIMMERMANN. 1977. Visual estimation of sex and social class in moose (*Alces alces*) from the ground and the plane (a preliminary report). Proc. N.Am. Moose Conf. Workshop. 13:135-140.

CAUGHLEY, G., and J. GODDARD. 1972. Improving the estimates from inaccurate censuses. J.Wildl. Manage. 36:135-140.

GASAWAY,W.C., S.D., DUBOIS, D.J. REED, and S.J. HARBO. 1986. Estimating moose population parameters from aerial surveys. Biological Papers. Univ. of Alaska. 22:108pp.

HOUSTON, D.B. 1968. The Shiras moose in Jackson Hole, Wyoming. Tech. Bull. Grand Teton Nat. Hist. Assoc. 1:1-110.

LERESCHE, R.E. 1974. Moose migrations in North America. Naturalist can. 101:393-415.

MIQUELLE, D.G., J.M. PEEK, and V. VAN BALLENBERGHE. 1992. Sexual segregation in Alaskan moose. Wildl. Monogr. 122. 57pp.

MITCHELL, H.B. 1970. Rapid aerial sexing of antlerless moose in British Columbia. J. Wildl Manage.,34:645-646.

MYTTON, W.R., and L.B. KEITH. 1981. Dynamics of moose populations near Rochester, Alberta, 1975-78. Can. Field Nat. 95:39-49.

OSWALD, K. 1984. Antler casting in an unhunted moose population in northeastern Ontario. Alces 20: 283-297.

PEEK, J.M., R.E. LERESCHE, and D.R. STEVENS. 1974. Dynamics of moose aggregations in Alaska, Minnesota and Montana. J.Mamm. 55:126-137.

______, D.L. URICH, and R.J. MACKIE. 1976. Moose habitat selection and relationships to forest management in northeastern Minnesota. Wildl. Monogr. 48. 65pp.

NOVAK, M. 1981. The value of aerial inventories in managing moose populations. Alces 17:282-315.

ROUNDS, R.R. 1978. Grouping characteristics of moose (*Alces alces*) in Riding Mountain National Park, Manitoba. Can. Field-Nat. 92:223-227.

TIMMERMANN, H.R. 1974. Moose inventory methods : a review. Naturaliste can. 101 : 615-629.

_______. 1993. Use of aerial surveys for estimating and monitoring moose populations review. Alces 29: 35-46.

_______, M.W. LANKESTER, and A.B. BUBENIK. 1985. Morphology of the bell in relation to sex and age of moose (*Alces alces*). Alces 21 : 419-446.

_______, and R.GOLLAT. 1986. Selective moose harvest in North Central Ontario - a progress report. Alces 22: 395-416.

_______, and H.A. WHITLAW. 1992. Selective moose harvest in North Central Ontario - a progress report. Alces 28: 137-163.