DOES UNBALANCED SEX RATIO IN ADULT MOOSE AFFECT CALF SIZE IN THE FALL?

Marie Taquet[1], Jean-Pierre Ouellet[1], Réhaume Courtois[2], and Catherine Laurian[1]

[1]Université du Québec à Rimouski, Département de biologie et des sciences de la santé, 300 Allée des Ursulines, Rimouski, PQ, Canada G5L 3A1; [2]Direction Générale de la Faune et des Parcs, Service de la faune terrestre, 675 Boulevard René-Lévesque Est, boîte 92, Québec, PQ, Canada G1R 5V7

ABSTRACT: It has been suggested that the sex ratio should be close to parity among adult moose to ensure high productivity. When the sex ratio is female biased, the mating period may extend over 2 - 3 estrus cycles and the calving period is delayed. As a result, some calves may be smaller in the fall and less likely to survive over winter. The objective of this study was to test whether an unbalanced adult moose sex ratio affects calf size in the fall. To do so, 8 hunting zones were sampled out of 24 in the province of Québec; their sex ratio among adults was based on aerial surveys. ANOVAs were conducted on 3 body measurements (head width, left ear, and hind foot lengths) on calves collected in the fall by hunters between 1995 and 1997 to compare body measurements from zones with different adult sex ratios. Our results showed that 2 of the measures were positively related to the percentage of males among adults. Consequently, we cannot reject the hypothesis that calves are smaller in the fall when the adult sex ratio is unbalanced. However, differences were very small. Assuming that such events occur, we suggest that the impact is weak at the population level, unless affected calves are least likely to survive until fall. However, the productivity (estimated in winter) in the various hunting zones of Québec is not related to the adult sex ratio. Thus, our results indicate that it is not necessary to consider this potential impact in the management of moose populations under the current range of sex ratios observed.

Key words: *Alces*, body size, calf, cow-bull ratio, harvest, Québec, sex ratio

Résumé: Chez l'orignal (*Alces alces*), il a été suggéré qu'un rapport des sexes équilibré ou presque était nécessaire, chez les adultes, pour permettre une pleine productivité. En l'absence d'une proportion suffisante de mâles, la période d'accouplement serait allongée et la mise bas retardée. Par conséquent, les faons seraient potentiellement plus petits à l'automne et ils seraient plus susceptibles de mourir au cours de l'hiver suivant. L'objectif de l'étude est donc de vérifier si un déséquilibre du rapport des sexes chez les orignaux adultes affecte la taille des faons à l'automne. Pour cela, 8 zones de chasse sur 24 ont été échantillonnées sur l'ensemble du Québec et leur rapport des sexes chez les adultes a été déterminé à partir d'inventaires aériens. Des analyses de variance ont été effectuées sur 3 types de mesures morphométriques (largeur de la tête, longueurs de l'oreille gauche et du pied arrière) recueillies de 1995 à 1997 sur des faons récoltés à la chasse, pour comparer les différences en fonction du déséquilibre du rapport des sexes chez les adultes. Deux mesures étaient linéairement reliées au pourcentage de mâles chez les adultes. Nous ne pouvons donc pas rejeter l'hypothèse que les faons seraient plus petits à l'automne lorsque le rapport des sexes chez les adultes est déséquilibré. Par contre, les différences étaient très petites. On peut déduire que l'impact est également très faible au niveau de la population, à moins qu'une proportion importante de faons plus petits n'aient pas survécu jusqu'à l'automne, et ne se retrouvent donc pas dans la récolte. Cependant, la productivité est aussi élevée dans les différentes zones de chasse du Québec, quel que soit le rapport des sexes chez les adultes dans ces populations. Ainsi, il ne semble pas nécessaire de prendre en compte ce phénomène dans la gestion des populations d'orignaux du Québec, sous les conditions actuelles du rapport des sexes.

Mots-clés: adultes, *Alces,* faons, mesures morphométriques, Québec, rapport des sexes, rapport mâles-femelles, récolte

In moose (*Alces alces*) populations, a decrease in the harvest of cows, without a similar reduction in the harvest of bulls, will inevitably result in an unbalanced adult sex ratio (Michel *et al.* 1994). However, it has been suggested that an adult sex ratio near equilibrium is necessary to ensure the greatest proportion of cows reproduce (Bubenik 1977, 1985, 1987; Crête *et al.* 1981; Boer 1992; Timmermann 1992). A recent literature review (Laurian 1997) suggests several potentially harmful consequences of an unbalanced adult sex ratio: (1) an extension of the mating period which allows increased participation of young males, in the absence of a sufficient number of dominant animals (Edwards and Ritcey 1958, Lent 1974, Bubenik 1987); (2) a delayed calving period following the extended rut (Schwartz *et al.* 1994), which may result in smaller calves in the fall; (3) a decrease in reproductive rate resulting in lower fecundity and gestation, leading to diminished recruitment and the growth of populations (Ginsberg and Milner-Gulland 1994); and (4) a skewed sex ratio among newborn calves in favour of males, thereby increasing their reproductive potential (Trivers and Willard 1973, Crichton 1992).

A cow moose not mated during her first estrus may experience a second estrus (Schwartz and Hundertmark 1993). Edwards and Ritcey (1958), Markgren (1969), and Miquelle (1990) showed that calving is delayed when cows are mated during their second estrus since the length of gestation remains unchanged (Schwartz and Hundertmark 1993). In the event of a third estrus, gestation results in an even later calving period. Calves originating from a second or third estrus would have a reduced growth period and would be smaller in the fall with less time to accumulate the necessary body reserves to survive the winter (Chesser and Smith 1987, Festa-Bianchet 1988, Gaillard *et al.* 1993, Schwartz *et al.* 1994), which could be particularly detrimental in years of high snow accumulation. It would be useful to know whether or not these potentially harmful consequences actually result from an unbalanced adult sex ratio and limit the growth of moose populations. All the more so if later calving periods also favour increased predation rates (Markgren 1969; Bubenik 1987; Crichton 1988; Ballard *et al.* 1991; Wilton 1992, 1995; Williamson 1993).

At the end of the 1980's, the moose population in Québec was estimated to be 67,000 (Courtois 1991). Densities on the order of 1 moose / 10 km^2 were below carrying capacity in hunted areas (Crête 1989), with the possible exception of northern Québec which is less accessible to hunters (MLCP 1993). The overall sex ratio was skewed in favour of females, with approximately 65 bulls for every 100 cows. Before the 1994 - 98 management plan, the moose harvest was oriented towards adults, including the most productive cows. Consequently, the growth and, sometimes, maintenance of populations could not be assured (Courtois 1991).

Simulations have shown a weak impact of bull harvest on the dynamics of moose populations, provided that an unbalanced sex ratio does not cause a decrease in the productivity of cows (Michel *et al.* 1994). The management plan for 1994 - 98 therefore provided minimum harvest quotas for cows, to maintain populations and eventually allow them to increase. Thus, in most hunting zones, the cow harvest will be limited until their mean age reaches the average age of full productivity at 4.5 years (Edwards and Ritcey 1958, Simkin 1965, Crichton 1988).

The objective of this study was to determine whether or not the size of calves is affected in the fall of their birth as a consequence of an extended calving period in populations with an unbalanced adult sex

ratio. We predict the average size of calves should be smaller in hunting zones where the adult sex ratio is particularly unbalanced.

METHODS

Morphometric Measures

From 1995 - 1997, we took advantage of mandatory reporting to make morphometric measurements of harvested calves in the fall of each year. The maximal width of the head (distance between the orbital protuberances on the outer sides of the head, including the skin), the length of the 2 ears (on the inner surface, between the tip and the bottom of the notch at the base of the ear), and the length of the hind foot (in a straight line from the top of the heel to the tip of the hoof) were measured according to the methods described by Anderson (1948) and Peterson (1974). Since there was no difference in the length of the 2 ears ($t = 6.62$, $P = 0.53$), the length of the left ear was used in subsequent analyses.

Measurements were made within ± 2 mm with a tape measure. These 3 measures were made because they are easy to take in the field. Body mass, which would have been the most useful variable to analyse, was not measured because it is difficult to collect on a large scale. We standardized the measurement methods for officials receiving harvest reports by providing a protocol accompanied with detailed colour photographs clearly illustrating the positions of the tape measure, as well as the beginning and end of the structures to measure. The consistency of measurements was verified through statistical comparison of mean values obtained by officials within Zones 13 and 18 West, which had large samples. No significant differences ($P > 0.05$) were found.

Classification of Hunting Zones

Eight hunting zones (Zones 03, 04, 07, 13, 14, 15, 18 West, and 19) were used in our study. Cow harvest was prohibited in Zones 03 and 04, but was allowed in 1 of the 2 years in Zone 13. Cow harvest was forbidden in Zones 14 and 15 during 1994 and 1995. In Zone 18 West, the cow harvest was limited to 10% through the issue of a number of special permits for hunting this segment of the population. In Zones 07 and 19, there were no quotas set for the cow harvest. The different zones had variable adult sex ratios based on the results of the last 2 aerial surveys for moose (Table 1).

Statistical Analyses

Since the calf harvest was spread over an approximately 1.5-month period (from 9 Sep - 22 Oct in 1995, 17 Sep - 27 Oct in 1996, and 16 Sep - 26 Oct in 1997), a regression between each of the morphometric measures and harvest date was calculated to verify that this was not a source of variation. Average harvest dates for all zones combined were 7 Sep 1995 (± 9 days, $n = 309$), 11 Oct 1996 (± 8 days, $n = 278$), and 11 Oct 1997 (± 8 days, $n = 375$). Since no significant ($P > 0.05$) relationships were found, harvest date was not included in subsequent analyses.

Analysis of variance (ANOVA) was used to compare morphometric measures between sexes, proportions of adult bulls, and interactions between these factors. We used linear contrasts (PROC GLM) to determine relationships between adult sex ratios and each of the morphometric measurements of the calves. The ORPOL procedure in SAS-IML was used to calculate test values for the contrasts based on the proportions of adult bulls estimated from aerial surveys in the 8 zones where calves were measured. The sex of the calves and interaction between sex and proportions of adult bulls were included in the model as covariates. Data were not transformed prior to statistical analyses because the underly-

Table 1. Percentage of adult males among adults during the last 2 moose aerial surveys conducted in the hunting zones sampled and total number of harvested calves sampled from 1995 - 1997 in these zones. *[Pourcentage de mâles chez les adultes lors des 2 derniers inventaires aériens de l'orignal dans les zones étudiées, et nombre total de faons récoltés de 1995 - 1997 dans ces zones.]*

Zones	Year *Années*	Males (%) *Mâles (%)*	Calves harvested *Récolte des faons*	
			Males *Mâles*	Females *Femelles*
07	1989	40	34	44
	1992	35		
19	1988	47	24	18
04	1993	31	89	80
13	1994	36	137	157
	1998	25		
14	1992	27	39	30
	1997	27		
15	1990	27	59	80
	1996	33		
03	1993	24	36	48
18 West	1994	19	116	110

ing assumptions were met (i.e., normality of residuals and homogeneity of their variances). SAS (SAS Institute 1985) and Systat (Wilkinson *et al.* 1997) were used in the statistical analyses, with $\alpha = 0.05$ in all tests.

RESULTS

Morphometric measurements were made on a total of 1,101 calves, harvested in the 8 hunting zones from 1995 - 1997 (Table 1). Analyses by contrasts indicated a significant linear relationship between the proportions of adult bulls and the length of the hind foot ($F = 4.77$, 1 df, $P = 0.0292$); the relationship with ear length was not significant ($F = 1.55$, 1 df, $P = 0.2129$). There was a significant interaction between proportions of bulls and sex of the calves in analyses of head width ($F = 3.12$, 7 df, $P = 0.0029$). Subsequent analyses by sex showed that the relationship between the proportions of adult bulls and head width was significant for female calves ($F = 25.63$, 1 df, $P = 0.0001$) but not for males ($F = 0.07$, 1 df, $P = 0.7963$).

These results indicate that average values of head width and hind foot length increase slightly with an increase in the proportion of adult bulls in a population. The head width of female calves is 16.7 cm when there are 19% adult bulls, compared to 19.3 cm when there are 47% adult bulls (Fig. 1); a size difference of 15.6%. However, this apparent relationship may be due to a single outlying point (i.e., at 47% adult bulls). For the hind foot, average extreme values (for combined sexes) differ by 5.6%; 64.2 cm vs. 67.8 cm at 19% and 47% adult bulls, respectively.

These analyses also showed that for each of the 3 variables analyzed, significant differences were observed between the sexes of the calves (head width: $F = 15.13$, 1 df, $P = 0.0001$; length of the left ear: $F = 3.95$, 1 df, $P = 0.0470$; hind foot length: $F = 3.97$, 1 df, $P = 0.0465$). When taken on males, the 3 morphometric measures are usually larger, on average, than those made on females (Table 2, Fig. 1), although absolute differences are not large.

DISCUSSION

Our hypothesis supposed that moose calves would be born later, and thus would be smaller in the fall, in populations where the adult sex ratio is strongly unbalanced. Our analyses showed a significant linear relationship for 2 of the 3 morphometric measurements made, which supports our hypothesis. Since the average size of calves is slightly smaller when the adult sex ratio is strongly unbalanced, it may be deduced that at least some proportion of the calves were born later in these circumstances. How-

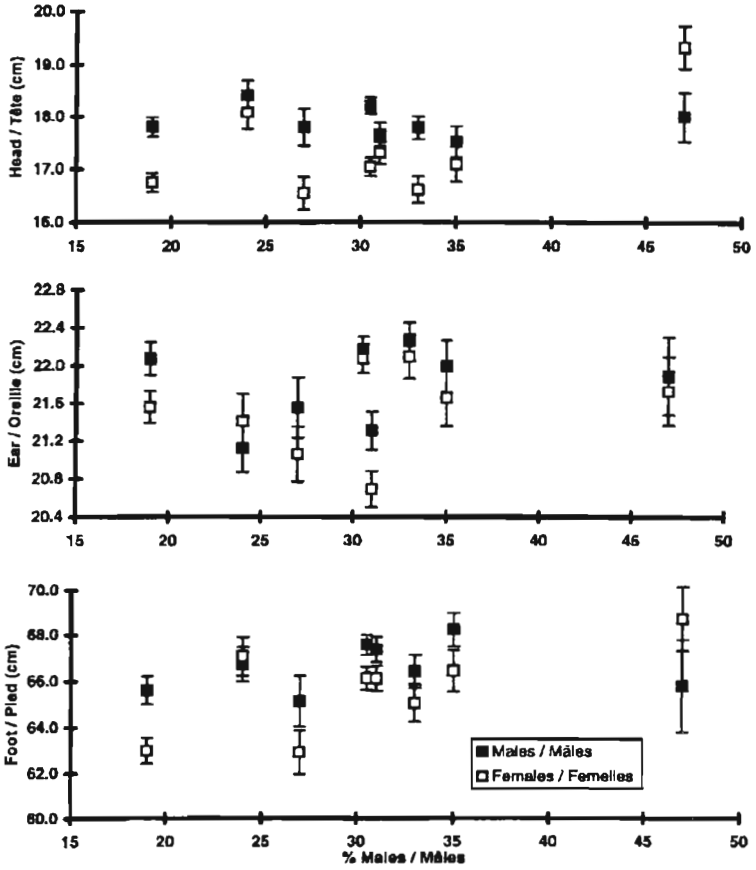

Fig. 1. Relationship between percentage of males among adults as estimated by aerial surveys and mean values (± standard error) of the body measurements recorded in moose calves harvested in the fall between 1995 and 1997. Means were weighted by the number of calves measured in each zone, all years combined. *[Relation entre le pourcentage de mâles chez les adultes estimé par inventaire aérien et la valeur moyenne (± erreur type) des mesures morphométriques des faons récoltés à la chasse sportive entre 1995 et 1997. Les valeurs ont été pondérées en fonction du nombre faons récoltés dans chaque zone, toutes années confondues.]*

Table 2. Mean values of the body measurements (cm) recorded in harvested moose calves in the fall (all hunting zones and years combined). *[Mesures morphométriques moyennes (cm) (écart type) en fonction du sexe des faons récoltés, pour l'ensemble des zones et des années étudiées.]*

	Males *Mâles*		Females *Femelles*	
	Mean (SD) *Moyenne (ÉT)*	*n*	Mean (SD) *Moyenne (ÉT)*	*n*
Head width *Largeur de la tête*	17.9(2.06)	561	17.1(1.89)	533
Left ear length *Longueur de l'oreille gauche*	21.9(1.95)	559	21.6(1.64)	527
Hind foot length *Longueur du pied arrière*	66.9(4.42)	441	65.4(5.74)	414

ever, the size differences are weak, indicating that the occurrence of later births is rare. We can conclude that in populations with as few as 19% adult bulls, the majority of calves were born at approximately the same time as those born in more stable populations; unless a significant proportion of calves born later died before the fall or their growth rate was greater than those born in the normal calving period. These latter 2 possibilities can be excluded because the number of calves with cows in winter is comparable in hunting zones with unbalanced sex ratios (Courtois and Lamontagne 1999) and it has been shown that summer growth rates of calves originating from the first and second estrus does not differ (Schwartz *et al.* 1994).

The absence of an important effect of sex ratio on calves is supported by another study of moose reproduction in 2 other Québec populations with very different adult sex ratios (Laurian 1998). The sex ratio was unbalanced in the first study area where hunting was liberal, and balanced in the second area where moose hunting was prohibited. Thus, later calving would be expected in the hunted area. However, the results of the study showed that calving dates were comparable in the 2 areas, for all 3 years considered (1995 - 1997).

Gestation time is relatively constant in moose (about 232 days) (Edwards and Ritcey 1958, Markgren 1969, Miquelle 1990, Schwartz and Hundertmark 1993) and calves conceived in the second estrus are the same size at birth as those conceived in the first estrus, but are born 20 - 25 days (i.e., an estrus cycle) later (Schwartz and Hundertmark 1993). Since they grow at the same rate as those born earlier, they are close to 20% smaller in the fall (first estrus: 169.7 kg; second estrus: 139.5 kg; Schwartz *et al.* 1994). Similarly, Gaillard *et al.* (1993) showed that in roe deer (*Capreolus capreolus*), birth date does not have any effect on calf size at birth or on postnatal growth rate. Thus, even if late births occurred in the hunting zones we studied, they were proportionately small since the differences in morphometric measures among zones with different adult sex ratios were not very strong and were significant for only 2 of the 3 variables.

The other principal result of our analyses is that male moose calves have a wider head, as well as a longer hind foot and left ear, than female calves. According to Schwartz *et al.* (1994), there is no evidence that male moose calves grow faster than

females during their first year of life. Cows attain their maximum size after about 4 years, while bulls continue to grow for 7 - 9 years (Schwartz 1998). Adult bulls are therefore naturally bigger than cows due to their extended growth period. On the other hand, at birth and during the first few months of life, body mass and size of the 2 sexes are comparable (Schwartz and Hundertmark 1993). In many polygamous ungulates (e.g., *Cervus elaphus*, *Rangifer tarandus*), however, body mass at birth and postnatal growth rates are greater in males than females (Clutton-Brock and Albon 1979, Clutton-Brock *et al.* 1982, Gaillard *et al.* 1993). In our study, even if significant differences were found between the sexes for the 3 morphometric measures, these are very small (head width: 0.8 cm; length of the left ear: 0.3 cm; hind foot length: 1.5 cm), with differences on the order of only 5, 1, and 2% for head width, length of the left ear, and hind foot length, respectively.

MANAGEMENT IMPLICATIONS

In Québec moose populations, the occurrence of late births produced by an unbalanced adult sex ratio seems rare. Even though our results somewhat supported our prediction, the differences in morphometric measures were small. Late births in moose can occur naturally (Markgren 1969) and have been observed on some occasions. For example, a calf of about 2 months in age was harvested during the sport hunt in October 1995 (Claude Brassard, Ministère de l'Environnement et de la Faune, Rouyn-Noranda, *pers. comm.*). However, it appears that these are rare events that only affect a small proportion of calves, unless these later calves are more susceptible to mortality, which would prevent them from being observed in the fall. This is unlikely since the cow:calf ratio in winter is comparable or higher in zones with unbalanced sex ratios (Courtois and Lamontagne 1999). In the short term, it does not appear necessary to take this phenomenon into account in management plans, at least when bulls constitute ≥30% of the adults at the time of the rut (Laurian 1998).

ACKNOWLEDGEMENTS

We want to underline the contribution of Daniel Banville, Monique Boulet, Réjean Tremblay, Jean-Jacques Dubois, André Gingras, Marc-Jacques Gosselin, Éloi Mathieu, Jean Milette, Marcel Paré, Charles Pichette, and Bruno Rochette of Ministère de l'Environnement et de la Faune (MEF) as well as registration officers that collected the data. Special thanks are addressed to Laurier Breton of MEF who standardized data collection, and Réjean Tremblay (MEF), Alain Caron of l'Université du Québec à Rimouski, and Hélène Crépeau of l'Université Laval who participated in the data analysis. We also thank Art Rodgers who kindly translated this paper from French to English. We finally acknowledge Jean Huot and François Messier who criticised an earlier version of this paper. Their comments improved the analysis and the interpretation of the data.

REFERENCES

ANDERSON, R. M. 1948. Methods of collecting and preserving vertebrate animals. Natl. Mus. Can., Biol. Series No. 18, Bull. 69. 169 pp.

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

BOER, H. 1992. Fecundity of North American moose (*Alces alces*): a review. Alces Suppl. 1: 1-10.

BUBENIK, A. B. 1977. Moose and man. Recent studies and their relationship to hunting. Ont. Fed. Anglers and Hunters, Toronto, ON. 15 pp.

_____. 1985. Reproductive strategies in

cervids. The Royal Society of New Zealand, Bull. 22: 367-373.

_____. 1987. Behaviour of moose (*Alces alces* spp.) of North America. Swedish Wildl. Res. Suppl. 1: 333-365.

CHESSER, R. K. and M. H. SMITH. 1987. Relationship of genetic variation to growth and reproduction in the white-tailed deer. Pages 168-177 *in* C. M. Wemmer (ed.) Biology and management of the Cervidae. Smithsonian Inst. Press, Washington, DC.

CLUTTON-BROCK, T. H. and S. D. ALBON. 1979. The roaring of roe deer and the evolution of honest advertisement. Behaviour 69: 145-170.

_____, F. E. GUINESS, and S. D. ALBON. 1982. Red deer behavior and ecology of two sexes. Univ. Chicago Press, Chicago, IL. 378 pp.

COURTOIS, R. 1991. Résultats du premier plan quinquennal d'inventaires aériens de l'orignal au Québec, 1987-1991. Ministère du Loisir, de la Chasse et de la Pêche, Service de la faune terrestre, PQ, Report 1921. 36 pp.

_____ and G. LAMONTAGNE. 1999. The protection of cows: its impact on moose hunting and moose populations. Alces 35: 11-29.

CRÊTE, M. 1989. Approximation of K carrying capacity for moose in eastern Quebec. Can. J. Zool. 67: 373-380.

_____, R.J. TAYLOR, and P.A. JORDAN. 1981. Optimization of moose harvest in southern Québec. J. Wildl. Manage. 45: 598-611.

CRICHTON, V. 1988. In utero productivity of moose in Manitoba. Alces 24: 143-149.

_____. 1992. Six years (1986/87-1991/92) summary of in utero productivity of moose in Manitoba, Canada. Alces 28: 203-214.

EDWARDS, R. Y. and R. W. RITCEY. 1958. Reproduction in moose populations. J. Wildl. Manage. 22: 261-168.

FESTA-BIANCHET, M. 1988. Birthdate and lamb survival in bighorn lambs (*Ovis canadensis*). J. Zool. (Lond.) 214: 653-661.

GAILLARD, J. M., D. DELORME, J. M. JULLIEN, and D. TATIN. 1993. Timing and synchrony of birth in roe deer. J. Mammal. 74: 738-744.

GINSBERG, J. R. and E. J. MILNER-GULLAND. 1994. Sex-biased harvesting and population dynamics in ungulates: Implications for conservation and sustainable use. Conserv. Biol. 8: 157-166.

LAURIAN, C. 1997. Revue de littérature sur la reproduction et la productivité de l'orignal (*Alces alces*), avec référence aux autres cervidés. Ministère de l'Environnement et de la Faune, Service de la faune terrestre, PQ, Report 3826. 48 pp.

_____. 1998. Effets d'une exploitation intensive sur la reproduction de l'orignal (*Alces alces*). M.Sc. Thesis, Univ. Québec, Rimouski. 70 pp.

LENT, P.L. 1974. A review of rutting behavior in moose. Naturaliste can. 101: 307-323.

MARKGREN, G. 1969. Reproduction of moose in Sweden. Viltrevy 6: 127-299.

MICHEL, M.D., R. COURTOIS, and J.P. OUELLET. 1994. Simulation de l'effet de différentes stratégies d'exploitation sur la dynamique des populations d'orignaux (*Alces alces*). Ministère de l'Environnement et de la Faune, Service de la faune terrestre, PQ, Report 2506. 48 pp.

MIQUELLE. D. G. 1990. Why don't bull moose eat during the rut? Behav. Ecol. Sociobiol. 27: 145-151.

(MLCP) MINISTÈRE DU LOISIR, DE LA CHASSE ET DE LA PÊCHE. 1993. Plan de gestion de l'orignal 1994-

1998. Objectifs de gestion et scénarios d'exploitation. Publications du Québec, Québec, PQ. 137 pp.

PETERSON, R. L. 1974. A review of the general life history of moose. Naturaliste can. 101: 9-21.

SAS Institute. 1985. SAS User's guide: statistics, version 6 edition. SAS Institute Inc., Cary, NC. 956 pp.

SCHWARTZ, C. C. 1998. Reproduction, natality and growth. Pages 141-171 *in* A. W. Franzmann and C. C. Schwartz (eds.) Ecology and management of the North American moose. Smithsonian Inst. Press, Washington, DC.

_____ and K. J. HUNDERTMARK. 1993. Reproductive characteristics of Alaskan moose. J. Wildl. Manage. 57: 454-467.

_____, _____, and E. F. BECKER. 1994. Growth of moose calves conceived during the first versus second estrus. Alces 30: 91-100.

SIMKIN, D. W. 1965. Reproduction and productivity of moose in northwestern Ontario. J. Wildl. Manage. 29: 740-749.

TIMMERMANN, H. R. 1992. Moose sociobiology and implications for harvest. Alces 28: 59-77.

TRIVERS, R. L. and D. E. WILLARD. 1973. Natural selection of parental ability to vary the sex ratio of offspring. Science 179: 90-91.

WILKINSON, L., G. BALNK, and C. GRUBER. 1997. Desktop data analysis with Systat. Prentice-Hall, NJ. 798 pp.

WILLIAMSON, S. J. 1993. Considerations regarding skewed age ratios in male deer. Pages 41-42 *in* Trans. 29th Annu. Meet Northeast Deer Technical Committee, Madison, CT, September 20-23, 1993.

WILTON, M. L. 1992. Implications of harvesting moose during pre-rut and rut activity. Alces 28: 31-34.

_____. 1995. The case against calling and hunting dominant moose during the main rut period. Alces 31: 173-180.