EXTERNAL FACTORS AFFECTING BULL MOOSE VOCALIZATIONS AND VULNERABILITY TO HUNTING

Claude Dussault

and

Jean Huot

Département de biologie, Université Laval

Ste-Foy, Québec, G1K 7P4

Abstract: A study was conducted on the relationships between bull moose (*Alces alces*) vocalization activities, weather conditions and vulnerability of bulls to hunting. Vocalization behaviour was studied in the Parc National de la Jacques-Cartier (Québec) between August 15 and October 31, 1984 and hunting statistics were obtained for a 12 years period (1973-1985) for the Réserve des Laurentides. Vocalization activities peaked in late September and early October and hunting success for bulls was also greatest during the last week of September. None of the external factors was found to affect vocalization activities or hunting success for bulls. Breeding behaviour is probably under photoperiodic control and is responsible for the increased vulnerability of bulls, at least with the hunting technique used in Québec.

ALCES 22 (1986)

In Québec, bull moose traditionally have been hunted using the so-called "birch-bark call" method, and associated with the high mobility of the males during the rutting period (Knowlton 1960, Houston 1968, Goddard

1970, Phillips *et al*. 1973, Roussel *et al*. 1975), the sex ratio in the harvest has been biased in favor of bulls. Between 1973 and 1985, in some areas the ratio can exceed 160 bulls per 100 cows but in the average the ratio is close to 135:100 (Bouchard *et al*. 1974, Bouchard and Gauthier 1975, 1976, 1977, 1978, 1979, 1980, Bouchard and Roy 1981, 1982, Roy 1983). This situation, associated with high hunting pressure, may have reduced the availability of bulls in some regions to a point where the reproduction rate is lowered (Crête *et al*. 1981). For this reason, these authors suggested equalizing female vulnerability to that of males to maintain a sex-ratio of the adult segment of the population of at least 40%.

The objectives of the present study were to determine at what time of the season bulls were most vulnerable to hunting and what factors affected their vulnerability. The study included an investigation of the vocalization activities of bulls and an analysis of 12 years of hunting statistics of the Réserve des Laurentides, Québec.

STUDY AREA

An area of approximately 10 km^2 located in the Parc National de la Jacques-Cartier was chosen for the study of vocalization behaviour (Figure 1). Elevation in the study area ranges from 450 to 1000 m. The forest is typically boreal and is dominated by balsam fir (*Abies balsamea*) and black spruce (*Picea mariana*). Paper birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*) are the main second growth species. In 1973, the area was closed to logging, hunting and trapping. In January 1980, moose density reached 0.53 moose km^{-2} (Gauvin 1980).

The hunting statistics were obtained from the Québec Park Service which operates a controlled hunt in the Réserve des Laurentides, adjacent

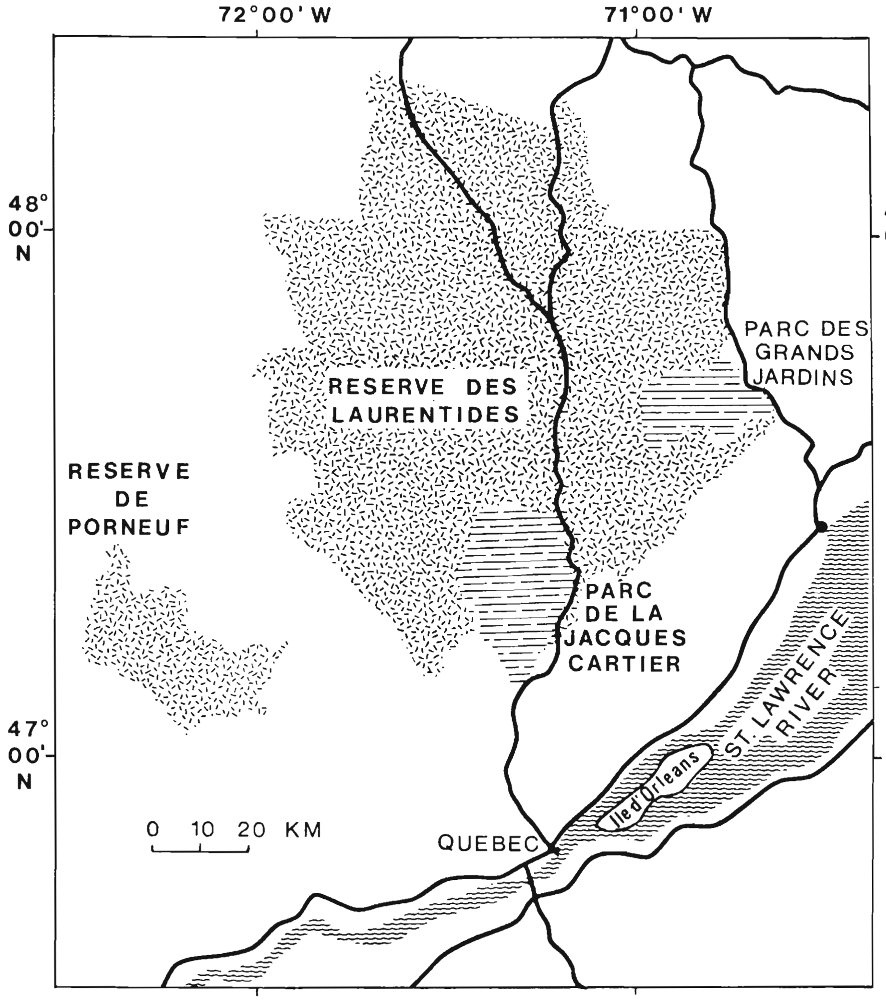

Figure 1. Location of study area.

to the Parc de la Jacques Cartier (Figure 1).

METHODS

Field observations

Field observations for the vocalization study were conducted by two persons, between August 15 and October 31, 1984. From August 15 to September 5, data were collected every second day and every day for the rest of the period. Observations were made from towers and were continuous between sunrise and sunset. Males were individually identified by the size and shape of their bell and their antlers. The day was divided into four periods: the first three hours after sunrise; three hours after sunrise to the moment when the sun is at the zenith; from that moment to three hours preceding the sunset and three hours preceding the sunset.

Human calls were used to stimulate responses from bulls every second period of observation, alterning with a period without any voluntary human stimulations called the "spontaneous period". Previous studies on wolves (Canis lupus) have shown that wolves responded more readily to live human simulations than to playbacks of recordings of either human simulations or actual wolf howls (Pimlott 1960, Joslin 1967, Theberge and Falls 1967, Voigt 1973) and that they responded to human howling in the same way as they responded to the howling of wolves from other packs (Joslin 1967, Harrington and Mech 1979). During the periods with simulations we tried to obtain a response from bulls by emitting two female call imitations every ten minutes. The first day, the first and third period were "stimulation periods" while on the following day the pattern was reversed. Four observation towers were located in trees overlooking four different lakes, and each observer spent a complete day at a given lake. Observers rotated among observation stations, completing the cycle every four days.

The search for a cow and answer to a cow call is characterized by the emission of grunts or croaks by the bull (Altmann 1959, De Vos et al. 1967, Markgren 1969). On that basis, we pooled both spontaneous vocalizations and responses to a call, as described below, under the term vocal males. For analysing the seasonal changes, we recorded as "one daily vocal male" one or more vocalizations heard, or responses, from the same bull during a single day. For establishing the distribution of the vocal males during the day the same principle was applied within a period instead of a day. For this reason the number of vocal males during periods may be higher than during the day. We considered that we had obtained a response to a call when: croaks were heard within ten minutes of a call; following a call a male approached the caller either silently or vocally.

Weather conditions considered were: mean temperature and wind velocity, number of hours of sunshine (%) and rainfall during a day. These were obtained from a meteorological station located 10 km north of our study area.

Hunting statistics

Hunting was permitted from mid-September to mid-October in the Réserve des Laurentides. In order to study the variation in bull vulnerability, moose density was assessed using an equation developed by Crête et al. (1981) and the correction factor suggested by Crête et al. (1986). The adult sex-ratio (38♂♂:62♀♀; C. Fortin, pers. comm.) at the beginning of the hunting season was based on an aerial survey conducted in the nearby Réserve de Portneuf (Figure 1) in 1985, and with harvest results obtained in

1984 from the same area.

The hunting effort required to kill a bull moose was obtained from the hunting statistics. These data were corrected to take into account the decreasing availability of males during the season and to obtain an unbiased evaluation of their vulnerability. The following correction was used:

$$HE_c = HE_j * (M_j/M_i)$$

where: HE_c = Corrected hunting effort to shoot a male,

HE_j = Observed hunting effort to shoot a male at time "j",

M_i = Number of males in the population at the opening of the season,

M_j = Number of males in the population at time "j".

Statistical analyses

Statistical tests concerning vocal males frequencies and weather conditions were chi-square tests and tests for analysis of availability-utilization data (Neu et al. 1974, Byers and Steinhorst 1984). Relationships between lunar phase and number of daily vocal males and hunting success were analysed using a circular-linear correlation technique (Batschelet 1981).

RESULTS

Field observations

A total of 64 daily vocal males were noted during 1400 hours of observation, attributed to 33 different males; a positive identification could not be obtained in 8 additional cases. Fifty-five per cent (35/64) of the daily vocal males were obtained during a period with human calls and 45% (29/64) during periods without human calls. The first spontaneous croak was heard on August 19 and the first response was obtained on September 13. The last spontaneous and response croaks were heard on October 19 and October 31 respectively (Figure 2). Because the daily numbers of vocal males were low between August 15 and September 12, this period was eliminated for the statistical analyses.

Chi-square on the number of males heard during stimulatory and spontaneous periods, did not show any difference (X^2=0.56, $p > 0.10$). However, except on 8 occasions, the estimated distance from the site of observation to the nearest point when bull displayed vocalizations activity or responded to the call, was shorter (Wilcoxon two-sample test, $p < 0.05$) during stimulatory period (median=50 m) than spontaneous period (median=325 m).

When the number of vocal males noted during stimulatory and spontaneous periods were pooled together, chi-square tests indicated significant differences among weeks ($p < 0.05$). The number of vocal males was significantly lower ($p < 0.05$) during the last week of October when only 2 vocal males were observed. The number of vocal males was highest in the first week of October (Figure 2).

Excluding males who could not be identified and a male who was first heard on August 19, 9 different males were heard for the first time between September 12 and September 26. The number of different vocal males heard for the first time was significantly higher ($p < 0.05$) during the last week of September and in the first week of October when 14 males were heard (Figure 3). After that date, 9 other different males were heard for the

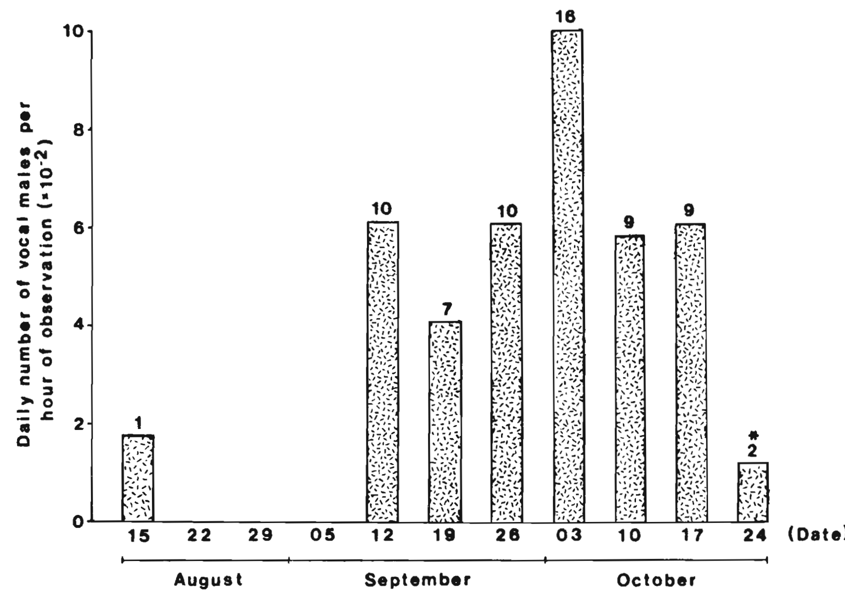

Figure 2. Distribution of the number of daily vocal males in the Parc de la Jacques Cartier between mid-August and late October 1984. Figures above each column indicate the number of males. Dates indicate first day of each week.

* Indicates a difference at the 0.05 level of significance.

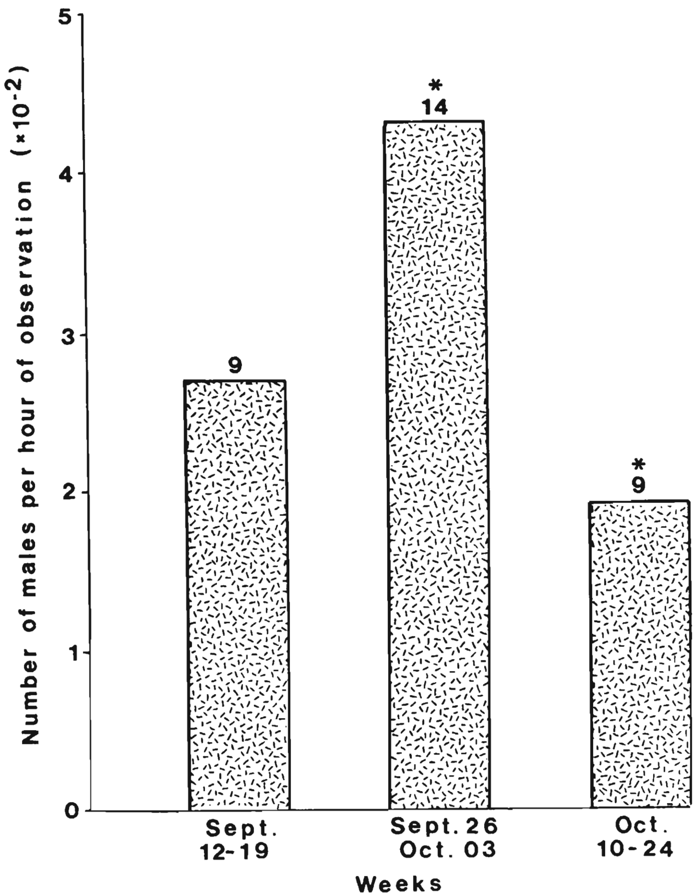

Figure 3. Number of males heard per hour, for the first time, during the rutting season. Figures above each column indicate the number of males. Dates indicate first day of each week.

* Indicates a difference at the 0.05 level of significance.

first time, between October 10 and October 31 and this figure was significantly lower ($p < 0.05$) than for the preceding weeks.

There was no significant correlation ($r=0.09$; $p > 0.10$) between the lunar phase and the number of diurnal vocal males (Figure 4). With rainfall being the only exception, weather conditions were not related with the daily number of vocal males (Figure 5). In 1984, rainfall was concentrated late in September and early in October, which is at the peak of vocalization and it is probably for that reason that a positive relation was found between rainfall and the number of vocal males.

Vocal males were observed any time during the day but were significantly more numerous ($p < 0.05$) within three hours after sunrise (Figure 6). We observed 49% (32/66) of the vocal males during that period. The second period showed a significantly lower level of activity ($p < 0.05$). Only 8% (5/66) of the vocal males were observed during that period.

Hunting statistics

The hunting data showed that the corrected effort required to shoot a bull moose was significantly higher ($p < 0.05$) at the beginning and at the end of the hunting season (Figure 7). After the first week the required hunting effort decreased and was significantly lower ($p < 0.05$) during the last week of September and increased after that. Neither weather conditions ($p > 0.10$) (Figure 8) nor lunar phase ($r=0.04$; $p > 0.10$) (Figure 9) significantly affected hunting success.

DISCUSSION

Bull moose are known to vocalize (Altmann 1959; Peterson 1955; De Vos

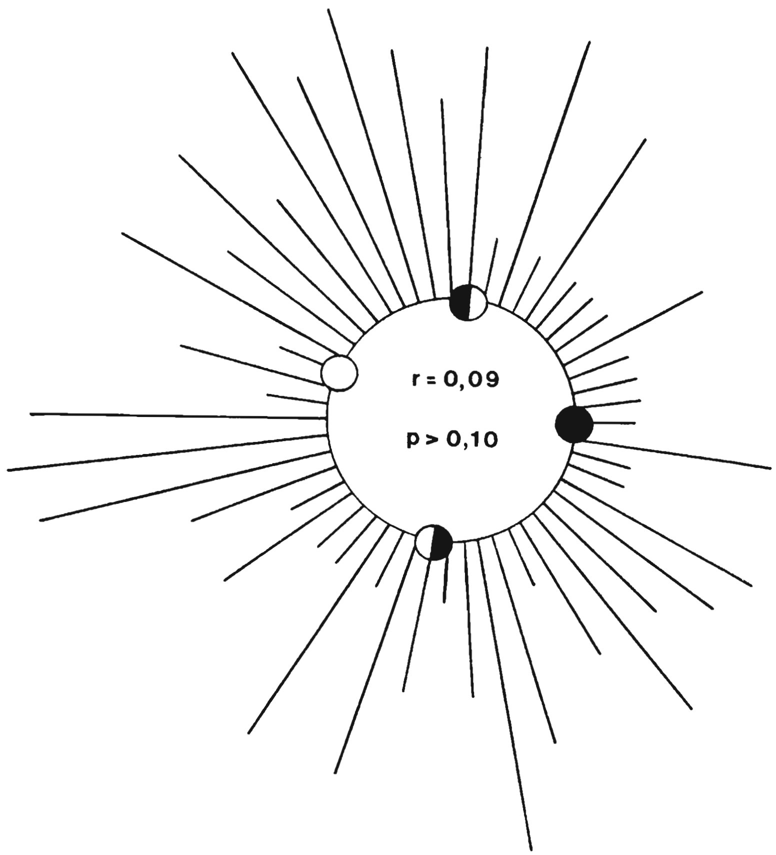

Figure 4. Relationship between lunar phase and the rate of moose vocalizations. The ranks of the daily number of vocal males per hour of observation are represented by the length of the bars for a given age of the moon. Higher ranks correspond to longer bars. (r= circular-linear correlation).

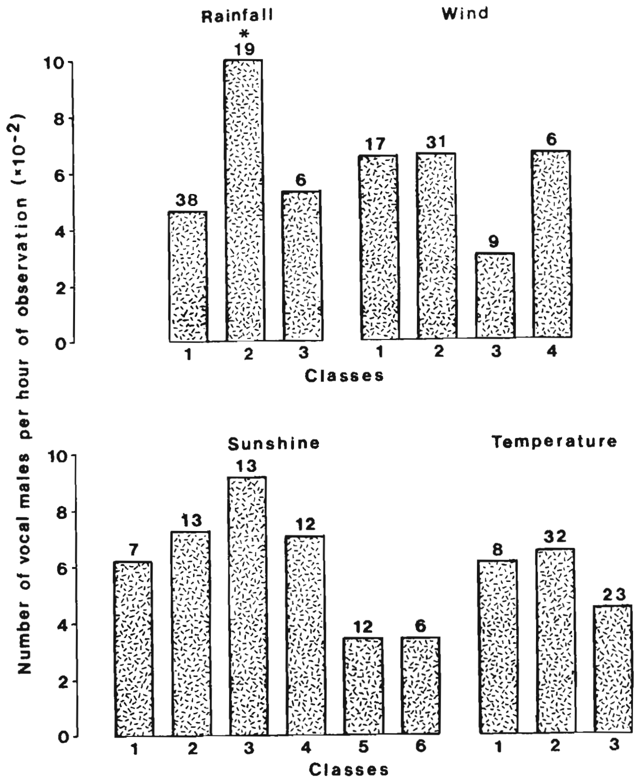

Figure 5. Relationship between certain weather conditions and the number of males heard per hour of observation. Figures above each column indicate the number of males.

A) Rainfall (mm): 1= No rain, 2= 0-0.5, 3= > 0.5; Wind velocity (km/h): 1= < 5, 2= 5-10, 3= 10-15, 4= 15-18; Sunshine (% daytime): 1= 0, 2= 0.1-20, 3= 20-40, 4= 40-60, 5= 60-80, 6= ≥80; Temperature ^{o}C): 1=< 0, 2= 0-5, 3= 5-21.

* Indicates a difference at the 0.05 level of significance.

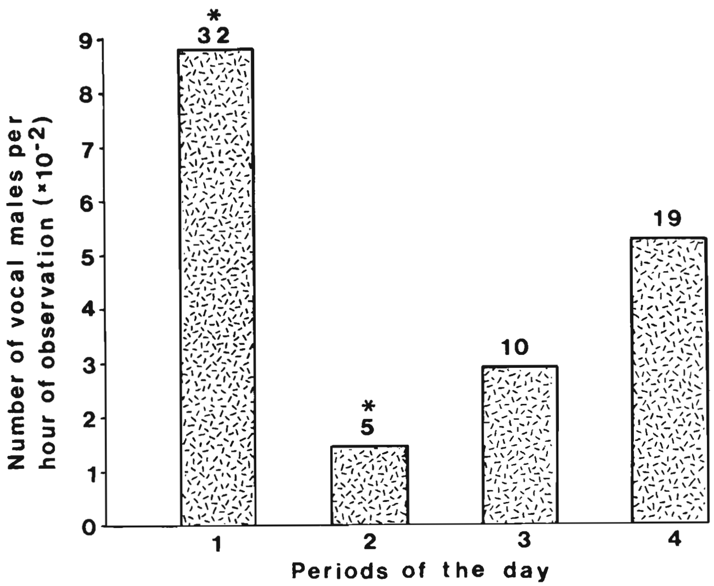

Figure 6. Number of males heard per hour of observation in relation with the period of the day. Figures above each column indicate the number of males.

* Indicates a difference at the 0.05 level of significance.

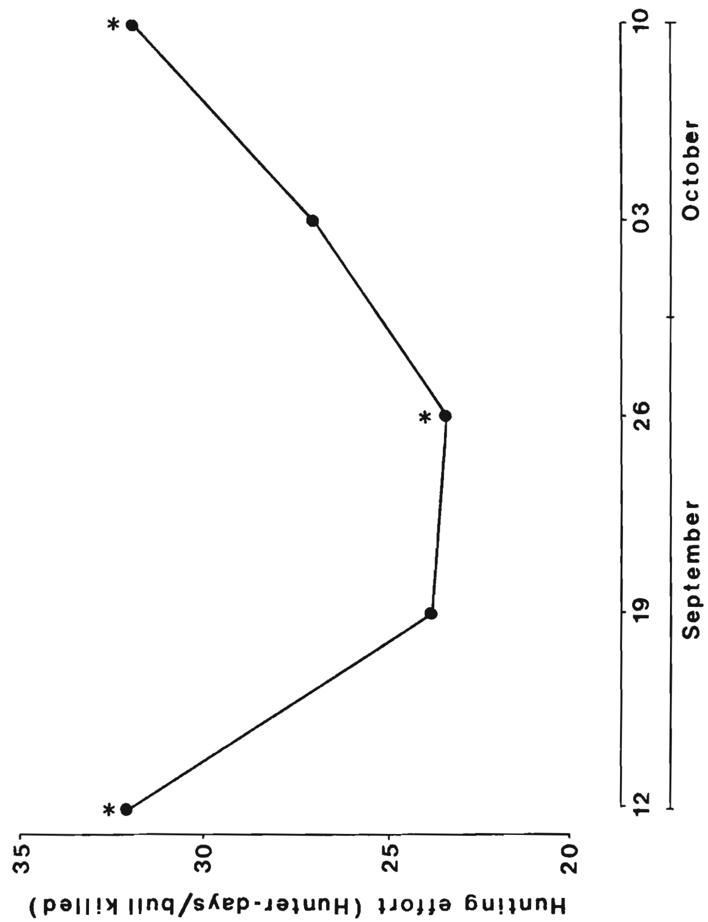

Figure 7. Changes in the hunting effort required to shoot one bull during the hunting season in the Réserve des Laurentides, Québec (1973 to 1985).

* Indicates a difference at the 0.05 level of significance.

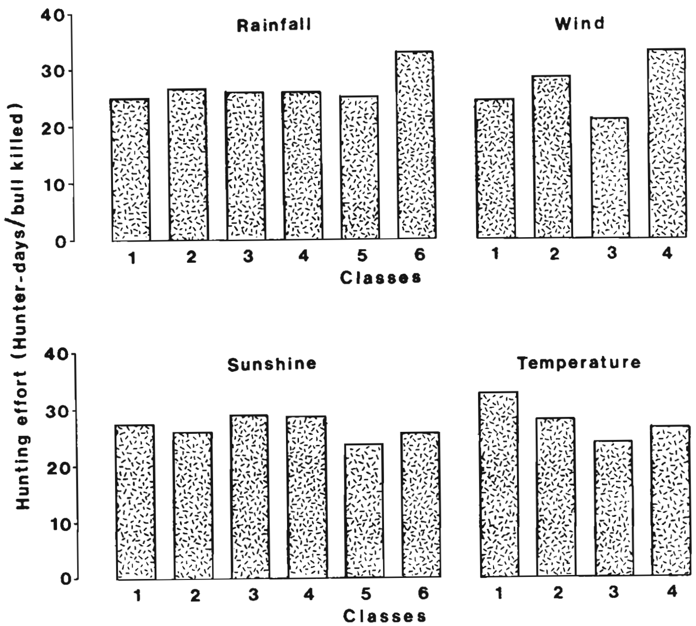

Figure 8. Relationship between certain weather conditions and hunting effort required per bull killed.

A) Rainfall (mm): 1= No rain, 2= 0-0.5, 3= 5-10, 4= 10-15, 5= 15-20, 6=> 20; Wind velocity (km/h): 1= < 5, 2= 5-10, 3= 10-15, 4= 15-23; Sunshine (% daytime): 1= 0, 2= 0.1-20, 3= 20-40, 4= 40-60, 5= 60-80, 6=≥80; Temperature °C): 1=< 0, 2= 0-5, 3= 5-10, 4= 10-15, 5= 15-21.

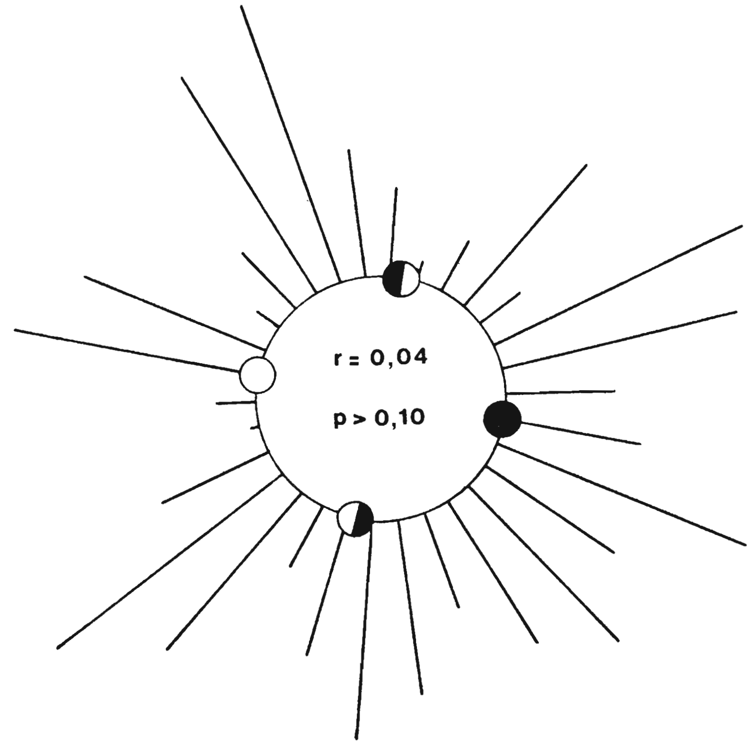

Figure 9. Relationship between lunar phase and hunting effort required to shoot a bull. The ranks of the hunting effort to shoot a bull are represented by the length of the bars for a given age of the moon. Higher ranks corresponds to the longer bars. (r= circular-linear correlation).

et al. 1967) and be more mobile (Knowlton 1960; Houston 1968; Goddard 1970; Phillips et al. 1973; Roussel et al. 1975) during the breeding period. The comparison of the results obtained during the spontaneous periods and the stimulatory periods, suggests that imitating the call of the female did not increase the mobility of the males or the rate of vocalization, but acted as a lure to attract bulls, then this may affect their vulnerability.

Despite the limited duration of the field study, the data presented here tend to confirm that there is a peak of vocalization activity for bull moose during the last week of September and the first week of October. The trends observed in the field, associated with results of 12 hunting seasons, suggest that the mobility of bulls and then their vulnerability, is lower in mid-September and October and is highest at the end of September. From a management standpoint if we want to keep a higher sex-ratio in the population, the most effective solution would be to open the season after the first week of October where feasible.

No relationship was detected between moose vocalization activities or hunting success and weather conditions considered on a daily basis. However, the data on vocalization are based on only one year, which limits their potential to detect such correlations. On the other hand it was not possible to relate the influence of weather conditions on hunting success at the time when a bull was shot, since we did not have these data. Our results should be interpreted as the relation of mean daily weather conditions and receptivity or vulnerability of bulls.

Reports based on qualitative observations suggest that breeding activities of elk and moose might be influenced by weather conditions (Markgren 1969, Lent 1974). We could not document any of these effects but we agree

with Lincoln and Guiness (1973), and Woodin (1978) that weather conditions, especially high winds and heavy rain, can affect the audible distance of vocalizations or calls. For that reason Lincoln and Guiness (1973) concluded that high winds gave the impression of reduced activity in elk but close observations on a single stag showed that this was due to the observers inability to hear the roars. In our study, moose were also heard under the whole range of observed meteorological conditions including heavy rain and high winds.

Several authors also reported the effects of external factors on reproductive activities of ungulates, but in most cases observations were qualitative. In lower latitudes, it was suggested that lunar cycle could be responsible for the synchronicity of the estrous cycle on wildebeest (Connochaetes taurinus) and on water buffalo (Bubalus bubalis) in connection with others factors (Sinclair 1977a, 1977b). We do not know if nocturnal mobility was affected by lunar cycle or by the visibility of the full moon because only limited observations were conducted during the night. But if there was any such effect, it did not alter the behavior of bull moose between sunrise and sunset. Collins et al. (1978) did not observe any measurable effect of the phase of the moon on the nocturnal feeding of elk (Cervus canadensis). The same conclusion was reached for studies on the relationships between wolf (Canis lupus) and coyote (Canis latrans) reply rates and the phase of the moon or the visibility of the full moon (Joslin 1967, Wolfe 1974, Harrington and Mech 1982).

Our results showed that vulnerability of bulls moose is higher late in September, especially based on the analysis of hunting statistics, and did not show any evidence of an effect of the lunar cycle on vulnerability.

This suggest that the photoperiod is the major factor responsible for the synchronicity of rutting ativities displayed by males and possibly on the general activities of the rutting season, at least in northern latitudes. This is in agreement with authors who suggested that the photoperiod is the principal stimulus which promotes the phenomenon of seasonal breeding (Ortavant et al. 1964, Fraser 1968, Sadleir 1969).

ACKNOWLEDGEMENTS

This study was financed by the Ministère du Loisir, de la Chasse et de la Pêche, Direction générale de la faune. We also appreciated the support of Guy Chouinard (MLCP), for providing housing facilities in the Park, and the assistance of Serge Paré for field observations.

REFERENCES

ALTMANN, M. 1959. Group dynamics in Wyoming moose during the rutting season. J. Mammal. 40(3):420-424.

BATSCHELET, E. 1981. Circular statistics in Biology. Academic Press. 371pp.

BOUCHARD, R. and C. GAUTHIER. 1975. Gros gibier au Québec en 1974 (Exploitation par la chasse et mortalité par des causes diverses). Min. Tour. Chasse et Pêche. Faune du Québec. Rapport spécial No. 5. 64pp.

BOUCHARD, R. and C. GAUTHIER. 1976. Gros gibier au Québec en 1975 (Exploitation par la chasse et mortalité par des causes diverses). Min. Tour. Chasse et Pêche. Faune du Québec. Rapport spécial No. 6. 61pp.

BOUCHARD, R. and C. GAUTHIER. 1977. Gros gibier au Québec en 1976 (Exploitation par la chasse et mortalité par des causes diverses). Min. Tour. Chasse et Pêche. Faune du Québec. Rapport spécial No. 7. 57pp.

BOUCHARD, R. and C. GAUTHIER. 1977. Gros gibier au Québec en 1976 (Exploitation par la chasse et mortalité par des causes diverses). Min. Tour. Chasse et Pêche. Faune du Québec. Rapport spécial No. 7. 57pp.

BOUCHARD, R. and C. GAUTHIER. 1978. Gros gibier au Québec en 1977 (Exploitation par la chasse et mortalité par des causes diverses). Min. Tour. Chasse et Pêche. Faune du Québec. Rapport spécial No. 10. 57pp.

BOUCHARD, R. and C. GAUTHIER. 1979. Gros gibier au Québec en 1978 (Exploitation par la chasse et mortalité par des causes diverses). Min. Loisir Chasse et Pêche. Faune du Québec. Rapport spécial No. 12. 56pp.

BOUCHARD, R. and C. GAUTHIER. 1980. Gros gibier au Québec en 1979 (Exploitation par la chasse et mortalité par des causes diverses). Min. Loisir Chasse et Pêche. Faune du Québec. Rapport spécial No. 13. 35pp.

BOUCHARD, R. and M. H. ROY. 1981. Gros gibier au Québec en 1980 (Exploitation par la chasse et mortalité par des causes diverses). Min. Loisir Chasse et Pêche. Faune du Québec. Rapport spécial No. 14. 41pp.

BOUCHARD, R. and M. H. ROY. 1982. Gros gibier au Québec en 1981 (Exploitation par la chasse et mortalité par des causes diverses). Min. Loisir Chasse et Pêche. Faune du Québec. Rapport spécial No. 17. 45pp.

BOUCHARD, R., E. AUDY and C. GAUTHIER. 1974. Gros gibier au Québec en 1973 (Exploitation par la chasse et mortalité par des causes diverses). Min. Tour. Chasse et Pêche. Faune du Québec. Rapport spécial No. 3. 58pp.

BYERS, C.R. and R.K. STEINHORST. 1984. Clarification of a technique for analysis of utilization availability data. J. Wildl. Manage. 48(3):1050-1053.

COLLINS, W.B., P.J. URNESS and D.D. AUSTIN. 1978. Elk diets and activities on different lodgepole pine habitat segments. J. Wildl. Manage. 42(4):799-810.

CRÊTE, M., R.J. TAYLOR, and P. A. JORDAN. 1981. Optimization of moose harvest in Southwestern Quebec. J. Wildl. Manage. 45(3):598-611.

CRÊTE, M., L.P. RIVEST, H. JOLICOEUR, J.M. BRASSARD, and F. MESSIER. 1986. Visibility bias and precision for moose density estimated from helicopter, and fixed wing aircraft in Southern Quebec. J. Applied Ecol. (in press).

De VOS, A., P. BROKX and V. GEIST. 1967. A review of the social behaviour of the North American cervids during the reproductive period. Am. Midl. Nat. 77:390-417.

FRASER, A.F. 1968. Reproductive behaviour of ungulates. Acad. Press. New-York. 202pp.

GAUVIN, G. 1980. Expérience d'observation de la faune par le public dans le parc des Laurentides en 1979. Ministère du Loisir de la Chasse et de la Pêche, RRF 65, 13 p. (Unpublished).

GODDARD, J. 1970. Movements of moose in a heavily hunted area of Ontario. J. Wildl. Manage. 34(2):439-445.

HARRINGTON, F.H. and L.D. MECH. 1979. Wolf howling and its role in territorial maintenance. Behaviour 68:207-249.

HARRINGTON, F.H. and L.D. MECH. 1982. An analysis of howling response parameter useful for wolf pack censusing. J. Wildl. Manage. 46(3):686-693.

HOUSTON, D.B. 1968. The shiras moose in Jackson Hole, Wyoming, Grand Teton National History Association, Tech. Bull. 1. 160pp.

JOSLIN, P.W.B. 1967. Movements and home sites of Timber wolves in Algonquin Park. Am. Zool. 7:279-288.

KNOWLTON. F.F. 1960. Food habits, movements and populations of moose in the Gravelly Mountains, Montana. J. Wildl. Manage. 24(2):162-170.

LENT, P.C. 1974. A review of rutting behavior in moose. Nat. Can. 101:307-32.

LINCOLN, G.A. and F.E. GUINESS. 1973. The sexual signifiance of the rut in red deer. J. Reprod. Fert. suppl. 19:475-485.

MARKGREN, G. 1969. Reproduction of moose Sweden. Viltrevy 6(3): 127-299.

NEU, C.W., C.R. BYERS and J.M. PEEK. 1974. A technique for analysis of utilization availability data. J. Wildl. Manage. 38(3):541-545.

ORTAVANT, R., P. MAULEON and C. THIBAULT. 1964. Photoperiodic control of gonadal and hypophyseal activity in domestic mammals. Ann. N. Y. Acad. Sci. 157-193.

PETERSON, R.L. 1955. North american moose. Univ. Toronto Press. London. 280pp.

PHILLIPS, R.L., W.E. BERG and D.B. SINIFF. 1973. Moose movements pattern and range use in northwestern Minnessota. J. Wildl. Manage. 37(3):266-278.

PIMLOTT, D.H. 1960. The use of tape-recorded wolf howls to locate timber wolves. 22nd Midwest Wildl. Congr. pp 1-15 (mimeo).

ROUSSEL, Y.E., E. AUDY and F. POTVIN. 1975. Preliminary study of seasonal moose movements in Laurentides provincial park, Quebec. Can. Field-Nat. 88(1):47-52.

ROY, M.H. 1983. Gros gibier au Québec en 1983 (Exploitation par la chasse et mortalité par des causes diverses). Québec, M.L.C.P, Dir. gén. faune. 55pp.

SADLEIR, R.M.F.S. 1969. The ecology of reproduction in wild and domestic mammals. Mathuen and Co., Ltd. London. 321pp.

SINCLAIR, A.R.E. 1977a. Lunar cycle and timing of mating season in Serengeti wildebeest. Nature. 267:832-833.

SINCLAIR, A.R.E. 1977b. The african buffalo. A study of resource limitation of populations. Univ. Chicago Press. Chicago and London. 355pp.

THEBERGE, J.B. AND J.B. FALLS. 1967. Howling as a means of communication in timber wolves. Am. Zool. 7:331-338.

VOIGT, D.R. 1973. Summer food habits and movements of wolves (Canis lupus L.) in Central Ontario. M.S. Thesis, Univ. of Guelph.

WOLFE, G.J. 1974. Siren-elicited howling response as a coyote census technique. M.S. Thesis. Colorado State Univ., Fort Collins. 206pp.

WOODIN, M.C. 1978. Factors affecting the audible distance of coyote howls. M.S. Thesis. Colorado State University. 153pp.