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MOOSE AND SALT: A REVIEW OF RECENT RESEARCH IN ONTARIO

D. Fraser

Ontario Ministry of Natural Resources
Wildlife Research Section
P.O. Box 50, Maple, Ontario, Canada LOJ 1E0

Abstract: Recent mineral-related research on moose in Ontario is reviewed. Known natural licks in Ontario are mineral-rich springs. They occur in areas of sedimentary and volcanic bedrock, but rarely on granitic bedrock. An initial study indicated variable chemical composition, but sampling methods were inadequate. Improved methods were therefore devised and tested. All licks sampled by the new technique proved to be rich in Na, but high levels of other elements were common. In a cafeteria experiment at a natural lick, moose and white-tailed deer selected Na salts but not salts of Ca, Mg, K or Fe. No selection of anions (Cl, HCO_3, SO_4) was apparent. Moose use the licks mainly in spring and early summer, generally starting with the green-up and ending when aquatic feeding becomes common. During this period moose are often attracted to highways by accumulations of road salt in puddles. In preliminary work, moose were readily attracted for public viewing by artificial licks which were similar to natural licks.

In recent years, several co-workers and I have studied the significance of aquatic feeding in the nutrition of moose (*Alces alces*) in Ontario. One of our objectives was to evaluate the view of Jordan et al. (1973) that moose seek aquatic vegetation principally as a source of Na. As an aspect of this work, we studied natural mineral licks which attract moose. In particular we wanted to establish whether moose do show a specific hunger for Na, or for any other mineral nutrient, in the season when aquatic feeding occurs.

The literature contains conflicting results on the attractive properties of mineral licks. A number of studies have concluded

or assumed that Na is abundant in the lick material and accounts for the licks' attraction for wildlife (Stockstad et al. 1953, Knight and Mudge 1967, Hebert and Cowan 1971, Weeks and Kirkpatrick 1976). However many reports have disagreed. In a study in western Canada, Cowan and Brink (1949) failed to find an abundance of Na or of any other single substance in the licks examined, and suggested that trace elements might be the source of the licks' attraction. Domestic animals are known to show selection for specific trace metals including Cu (Braude 1954) and Co (Stewart 1953). Copper deficiency has been identified in an Alaskan moose population, but it was not established whether moose were attracted to sources of copper (Flynn et al. 1977). Inconclusive findings, similar to those of Cowan and Brink (1949), have been made in Ontario by Peterson (1953), in Quebec by Bouchard (1970), and in New Brunswick by Wright (1956). One alternative possibility is that a high sulphur content attracts wildlife to mineral licks (Hanson and Jones 1976); this is currently being studied in a continent-wide analysis of lick material. In view of the discrepant results, we began our own study of natural licks which attract moose in northern Ontario.

The licks we have found in Ontario are areas of 100 to 700 m^2 of bare soil, mud and standing water, known or thought to include a mineral-rich spring. The areas are usually devoid of vegetation, presumably because of repeated trampling by animals, and well-worn animal trails radiate from the licks. The point or points where mineral-rich water seeps into the lick are often very difficult to find because the seepage may be very slow, and generally occurs amid a large amount of standing water in the lick area.

Northern Ontario has comparatively few licks. In the large areas dominated by granitic bedrock, licks are rarely found. Most of the few dozen sites known in Ontario are concentrated in areas of sedimentary and volcanic bedrock near the north shore of Lake Superior. The scarcity of licks is perhaps characteristic of the Precambrian Shield. In Quebec, for example, many licks are known in areas of non-granitic rock south of the St. Lawrence River, but few in the Shield areas to the north.

SAMPLING METHODS

In 1976 we did some preliminary sampling at 13 licks which attract moose and/or white-tailed deer (*Odocoileus virginianus*). At each site we scooped up 2 L of water from the areas where animal activity seemed to be concentrated. Chemical analysis showed that most samples contained high levels of Na, but a few did not. Some samples were rich in Ca, Mg and K as well as Na, and almost all had high levels of Fe and Mn (Chamberlin et al. 1977).

After this preliminary work we realized that our samples might not be representative of the material which attracts animals to the licks. During the 3 subsequent summers, we have spent over 800 hours monitoring the activity of moose and white-tailed deer at 2 licks in Sibley Provincial Park. We noted 3 features of the animals' behavior which must be considered in any sampling program. First, the animals drink large amounts of water at the licks, but only rarely eat the mud or vegetation. Second, the animals usually drink at specific locations where mineral-rich water is known or believed to seep into the lick. Experienced animals generally walk directly to these points when they enter the lick; as a result, much of the standing water in the lick area is largely ignored. Third, the

animals frequently urinate in the lick area, although not often at the spring source. Because the lick soil is saturated during much of the year, the urine plus any rain or other surface water tends to remain in the lick area for days at a time.

In light of these observations, the first requirement for sampling licks is to locate the specific point or points where the animals actually consume the lick material. This is best determined by direct observation of animals at the lick in question. For spring-based licks, a conductivity meter can be used to locate areas where the water is richest in dissolved minerals; this often helps to pin-point even a tiny spring source (Fig. 1). New techniques described by Lee and Hynes (1977-78) may also prove useful for locating seepage points and collecting samples.

A second requirement is to avoid collecting samples which are contaminated by animal urine. In many cases we have found that pools of urine deposited by moose and deer turn a distinct red, wine or brown color after standing for a few hours exposed to the air. This makes it easy to avoid gross contamination. For Ontario licks, determination of total *Kieldahl* nitrogen (TKN) provides a useful check against more subtle contamination. Samples which we know or believe to be contaminated by urine had TKN levels ranging from 260 to 3400 ppm, while pure spring-water samples never exceeded 6 ppm (Fraser et al. 1980).

In Precambrian Shield areas, lick water is often no richer in minerals than the ordinary well water which occurs in other parts of the continent. It is important, therefore, to collect comparison samples of lake or stream water which is also available to the animals using the lick.

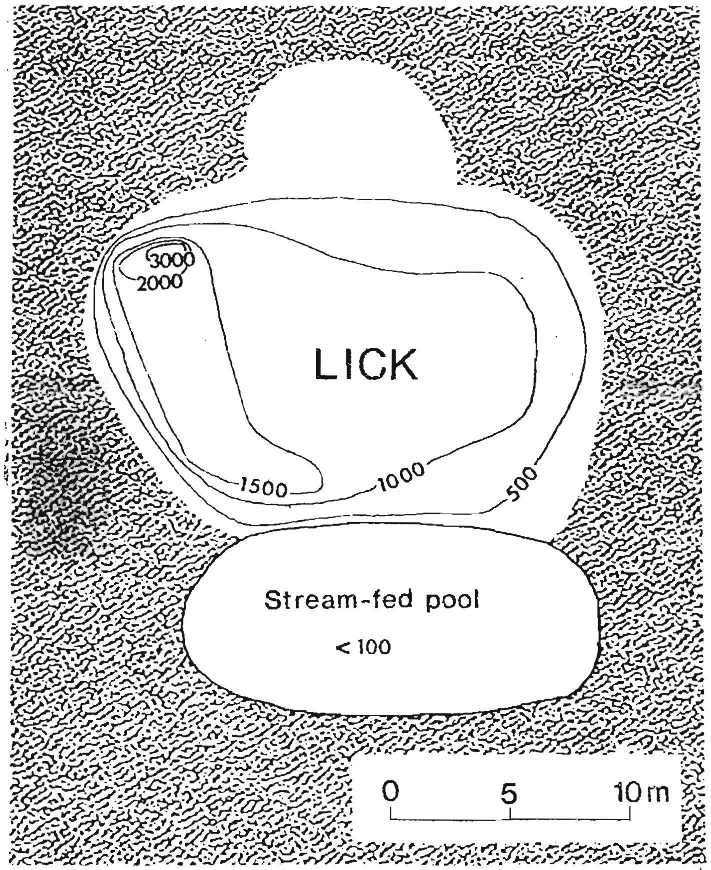

Figure 1. A map of a mineral lick used by moose, showing contours of conductivity of the water (in μmhos/cm). The mineral-rich water seeped into the lick at the point of highest conductivity. Based on Fraser et al. (1980).

However, lick water is often muddy, whereas lake or stream water is usually much clearer. This will confound any attempt to compare the two types of samples. In particular, the more muddy samples generally have spuriously high levels of Fe, Mn and other trace metals.

The simplest solution is to filter the water. This can be done efficiently in the field using apparatus designed by the U.S. Geological Survey (Kennedy et al. 1976) and modified by Fraser et al. (1980). A rechargeable reversible electric drill is used to drive a pumping head. This delivers water through a large diameter in-line filter. The system collects and filters a litre of muddy water through a pore size of 0.45μ in about 10 minutes without dripping the water through the air or exposing it to a vaccuum. We find that filtration in the field is necessary if the samples are to be analyzed for trace metals. For major cations and anions, however, the filtration can be done in the laboratory just before the samples are analyzed.

LICK CHEMISTRY AND ATTRACTION

We have now used the methods described above to sample 10 licks in Ontario, chosen to give a cross-section of the bedrock and soil types associated with licks in the province. A high level of Na is the only common factor found among all sites, with lick samples containing 14 to 120 times more Na than nearby control sites. In addition, some but not all licks had high levels of K, Ca, Mg, SO_4, HCO_3, Cl, N, Fe and Mn. No high levels of P, Cu, Co, Mo, Zn or Se were detected.

Our previous, less consistent findings seem to have been due to inadequate sampling: the low levels of Na in some of our earlier lick samples may reflect contamination by ordinary surface water, and the high levels of Fe and Mn were presumably caused by the muddy nature of the lick water samples. In earlier published studies, the same sampling problems have probably caused many of the conflicting results. In a study in the Matane area of Quebec, for example, Bouchard (1970) found high levels of Na in the 3 licks which had a conspicuous spring source. In the other licks, where there was no such obvious location for the collection of the sample, the lick sample was little different from ordinary stream water.

Despite the predominance of Na in lick water, some licks had high levels of other elements as well. We therefore did a choice experiment to determine which of the major elements are selected by the animals. Five pails were anchored in a row by the Marie Louise lick in Sibley Provincial Park. The pails were furnished, usually once per day, with various solutions of pure chemical compounds. Since Na and Cl were the principal ingredients of the lick water, a 0.1 M NaCl solution was used as a standard in all trials. The other compounds were the chlorides, bicarbonates and sulphates of K, Mg, and Ca, with ordinary stream water as a control. We also made 9 presentations of iron salts ($FeCl_2$ and $FeSO_4$) although these did not dissolve in water to give solutions equimolar to the NaCl standard.

Moose and white-tailed deer which used the pails had definite preferences (Fig. 2). Pails containing any of the Na solutions were usually drained within 1 day, while the other solutions were not usually altered more than the stream water control (Fraser and Reardon 1980).

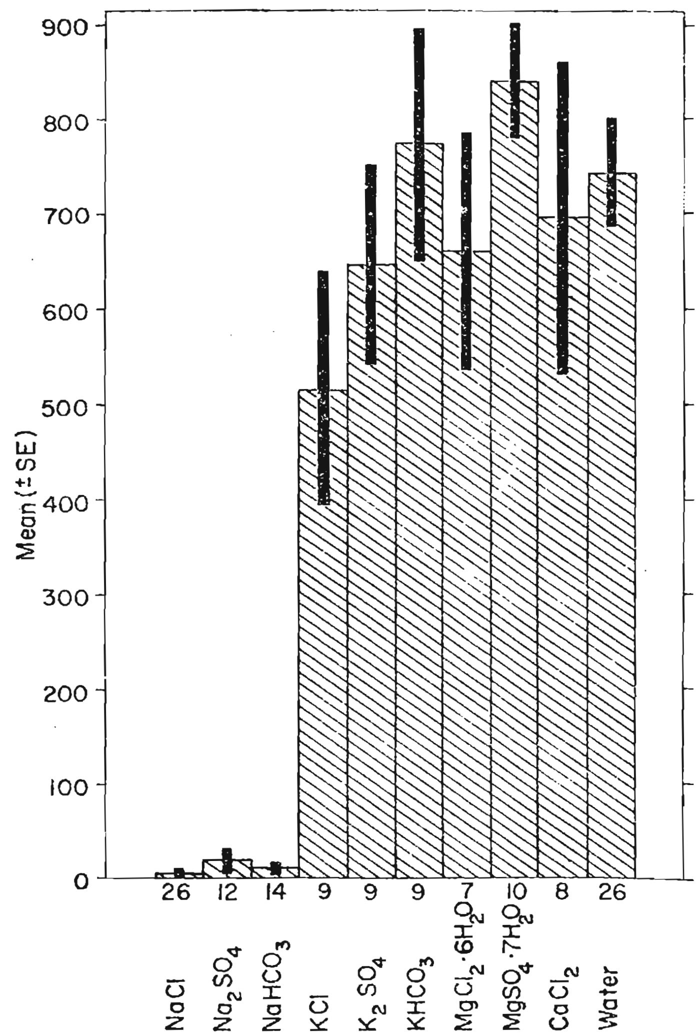

Figure 2. The results of a selection experiment in which moose and white-tailed deer were offered aqueous solutions of different salts. The graph shows the average quantity of solution remaining at the end of each trial out of 1000 ml offered initially. Numbers below the graph show the number of times each solution was offered. Based on Fraser and Reardon (1980).

Similar findings have been made for other ruminent species by Stockstad et al. (1953) and Ueckermann (1968).

From these results, I conclude that the moose did have a specific hunger for Na. Since Na was the only element consistently abundant in our cross-section of Ontario licks, I suspect that the Na hunger accounts for much or all of the animals' attraction to licks in the province. This conclusion could be checked by testing licks for the nutrient trace elements (Cr, F, I, Ni, Si, Sn and V: see Franzmann et al. 1975) which we did not include in our analysis.

We also wanted to know the time of year at which the Na hunger was active. Behavioral observations showed heavy use of the licks starting in late May or early June, near the time when green leaves appeared on the trees. Interestingly there was little use of the licks during the few weeks before the green-up, and in years with a late green-up, use of the licks was delayed correspondingly.

Use of the licks declined after early June. By late June and early July, when aquatic feeding was most common, moose were rarely seen at the licks. Since other evidence indicated that aquatic vegetation was indeed serving as a Na source for the moose, we were surprised that lick use and aquatic feeding did not coincide more closely. However the licks in this area were quite dilute (50 to 150 ppm Na), whereas preferred aquatic plants had much higher levels of Na and, of course, contained other nutrients as well. We suspect that moose seeking Na changed from the licks to aquatic plants as the preferred types of aquatic vegetation became available. Based on the seasonal pattern of lick use and aquatic

feeding, we conclude that the period of Na hunger generally begins about late May and ends about late July in our study area.

ATTRACTION OF MOOSE TO ROAD SALT

The period of Na hunger corresponds closely to the time when highway accidents involving moose are most common in Ontario (Fig. 3). Grenier (1974), working in Laurentides Park in Quebec, had noticed that moose were attracted to roadside puddles of salty water which apparently resulted from salting of the road in the winter. We found 5 salty puddles in the 45 km of road in our study area, and we recorded sightings of moose and other wildlife on or near the roads in relation to the puddles and other features (Fraser 1979).

In 1978, the year in which our records were most complete, we made 127 sightings of moose on or near the road. Sightings were most common in June, with lower frequencies in May and July, a pattern similar to that of road accidents in the province. In May and early June moose were often seen drinking from salty puddles, but aquatic feeding in roadside areas was more common in late June and early July. Many of the sightings could not be classified according to behavior, usually because the animal was glimpsed only briefly before it disappeared. However these unclassified sightings were conspicuously clustered in stretches of road which contained a salty puddle or an aquatic feeding area.

Our study area included only lightly salted secondary roads with relatively small salty puddles. Stretches of major highway often have much larger salt pools, some with a history of moose-vehicle accidents nearby. In Wawa Administrative District, Thomas (1979) reported 25 salty roadside pools actively used by moose in 231 km of highway. Of 27 moose-vehicle collisions in the District in 1979, 12 were known to occur at the saltwater locations, and several others, whose locations were less accurately recorded, may also have been related to the salty pools. We are now studying means of reducing the frequency of moose-vehicle accidents by managing roadside salt accumulations.

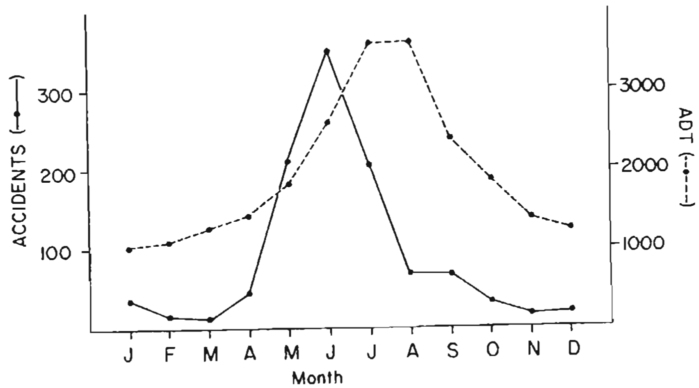

Figure 3. The number of moose reported killed by vehicles (solid line), and the average daily traffic (broken line) on northern Ontario highways from 1965 to 1975. The annual peak in moose-vehicle accidents (May to July) does not coincide with the peak of traffic. Based on Fraser (1979).

ATTRACTION OF MOOSE FOR VIEWING

The research also suggests a means of creating moose viewing areas for the public. A study in Quebec, (Grenier, pers. commun.) coupled with less systematic reports elsewhere, indicate that blocks of salt are often

rather unsuccessful in attracting moose: several years may be required for moose to learn to use these unnatural objects regularly. However, we were impressed by the speed with which moose would find a new salty puddle on the road soon after a rain, and we noted that moose, unlike the smaller animals, concentrated on salty water instead of licking soil or gravel thought to contain salt.

We therefore established 5 experimental locations with granular salt broadcast in a wet area where moose might be expected to pass. Two of the 5 locations were very encouraging.

One was a wet area of 10 m^2 situated on an old logging road well used by wildlife. Here we applied a total of 75 kg of granular salt in 5 applications between 15 May and 10 June. On the sixth day after the initial salting we saw an adult bull in the salted area. Additional sightings and observations of tracks suggested that the area received daily attention by moose, and sometimes by white-tailed deer, between late May and early July. In late June the trampling had been so extensive that the entire salted area consisted of bare mud with no vegetation remaining. In a location such as this, a keen photographer who is willing to spend a few hours in a blind would have a reasonable chance of getting excellent close-up photographs.

The other site was a stretch of boggy shoreline which could be seen across a small lake from a public picnic area. The location was chosen mainly because of easy public access, but we had only once seen a moose on the lake in 3 previous summers. We spread a total of 50 kg of granular salt along 40 m of wet shoreline in 3 applications. By the end of July we had made 14 sightings of adult moose, involving at least 3 different cows and 2 bulls. During the first year of management, this area had become a good place for moose observations, and we expect increased activity in the future. Other methods of establishing artificial licks are described by Bubenik (1959).

Fortunately the artificial wet licks became very dilute as the summer progressed. As a result, concentrated Na was available only during the season when moose naturally show a strong appetite for salt. If concentrated Na were available year-round, wildlife could become addicted. The resulting need for additional intake of water could pose a problem in winter, as the eating of ice or snow causes a substantial drain of energy (Bubenik 1962). In addition, undesirable changes of habitat use could result from addiction to supplementary sources of salt. An additional caution concerns possible transmission of diseases and parasites at artificial licks. For example, transmission of *Parelaphostrongylus tenuis* might be increased if moose and white-tailed deer were attracted to the same licks.

CONCLUDING REMARKS

The ecological significance of supplementary Na for moose remains a matter of debate. As Jordan et al. (1973) point out, the normal browse diet of the moose is very poor in Na. Accordingly moose appear to eat salt in almost any season if it is readily available: in Ontario, for example, moose occasionally lick salt off the highways in winter. However, the spring green-up seems to trigger a much more active hunger for Na. The new spring vegetation is very rich in K, thus rendering the Na/K ratio even less favorable than in other seasons (Weeks and Kirkpatrick 1976). In addition the sudden change to a lush diet seems

to cause wet feces presumably accompanied by an extra loss of Na in fecal moisture. Lactation and antler growth may make additional mineral demands at this time of year.

The resulting Na appetite of the spring and early summer seems much stronger than any seen during other seasons. The springtime appetite is enough to cause special migratory movements to licks (Best et al. 1977), a change of habitat (Joyal and Scherrer 1978), consumption of large volumes of water at licks, and energy-inefficient feeding on aquatic vegetation (Belovsky and Jordan 1978).

In view of all this, it seems unlikely that the springtime Na-seeking results merely from a capricious appetite. The degree to which the physiological Na-retention mechanisms might compensate for a shortage of licks or aquatic vegetation in moose habitat is unknown. Throughout the winter, moose appear to exercise physiological Na retention to an impressive degree, but an animal can step up these processes only at certain costs to other bodily functions (e.g. Myers and Bults 1979). Whatever the case, many moose seek salt in the spring and early summer, presumably because they cannot or do not wish to increase the physiological mechanisms to meet the special demands of the season. In managing moose habitat, we would do well to respect that choice.

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LITERATURE CITED

Belovsky, G.E. and P.A. Jordan. 1978. The time-energy budget of a moose. Theor. Pop. Biol. 14:76-104.

Best, D.A., G.M. Lynch and O.J. Rongstad. 1977. Annual spring movements of moose to mineral licks in Swan Hills, Alberta. Proc. N. Am. Moose Conf. Workshop 13:215-228.

Bouchard, R. 1970. Étude chimique préliminaire des vasières de la réserve Matane, 1965. Service de la Faune du Québec, rapport 5:343-352.

Braude, R. 1954. Pig nutrition. Pages 40-105 *in* J. Hammond, ed., Progress in the physiology of farm animals. Vol. 1. London: Butterworths Scientific Publications. 392 pp.

Bubenik, A.B. 1959. Wildernährung. DLV, Berlin.

__________. 1962. Kolko soli potrebuje zver? Polovníctvo a Rybárstvo (Bratislava) 16, nos 4, 5 and 6.

Chamberlin, L.C., H.R. Timmermann, B. Snider, F. Dieken, B. Loescher and D. Fraser. 1977. Physical and chemical characteristics of some natural licks used by big game animals in northern Ontario. Proc. N. Am. Moose Conf. Workshop 13:200-214.

Cowan, I. McT. and V.C. Brink. 1949. Natural game licks in the Rocky Mountain National Parks of Canada. J. Mammal. 30:379-387.

Flynn, A., A.W. Franzmann, P.D. Areneson and J.L. Oldemeyer. 1977. Indications of copper deficiency in a subpopulation of Alaskan moose. J. Nutr. 107:1182-1189.

Franzmann, A.W., J.L. Oldemeyer and A. Flynn. 1975. Minerals and moose. Proc. N. Am. Moose Conf. Workshop 11:114-139.

Fraser, D. 1979. Sightings of moose, deer, and bears on roads in northern Ontario. Wildl. Soc. Bull. 7:181-184.

__________ and E. Reardon. 1980. Attraction of wild ungulates to mineral-rich springs in central Canada. Holarct. Ecol. 3:36-40.

__________, E. Reardon, F. Dieken and B. Loescher. 1980. Sampling problems and the interpretation of chemical analysis of mineral springs used by wildlife. J. Wildl. Manage. (in press).

Grenier, P.A. 1974. Orignaux tués sur la route dans Le Parc des Laurentides, Québec, de 1962 à 1972. Naturaliste Can. 101:737-754.

Hanson, H.C. and R.L. Jones. 1976. The biochemistry of blue, snow and Ross' geese. Illinois Natural History Survey, Special Publication 1. 281 pp.

Hebert, D. and I. McT. Cowan. 1971. Natural salt licks as a part of the ecology of the mountain goat. Can. J. Zool. 49:605-610.

Jordan, P.A., D.B. Botkin, A.S. Dominski, H.S. Lowendorf and G.E. Belovsky. 1973. Sodium as a critical nutrient for the moose of Isle Royale. Proc. N. Am. Moose Conf. Workshop 9:13-42.

Joyal, R. and B. Scherrer. 1978. Summer movements and feeding by moose in western Quebec. Can. Field-Nat. 92:252-258.

Kennedy, V.C., E.A. Jenne and J.M. Burchard. 1976. Backflushing filters for field processing of water samples prior to trace-element analyses. U.S. Geological Survey, WRI # 76-126. 12 pp.

Knight, R.R. and M.R. Mudge. 1967. Characteristics of some natural licks in the Sun River area, Montana. J. Wildl. Manage. 31:293-299.

Lee, D.R. and H.B.N. Hynes. 1977-78. Identification of groundwater discharge zones in a reach of Hillman Creek in southern Ontario. Water Poll. Res. Canada 13:121-133.

Myers, K. and H.G. Bults. 1979. Stress in the rabbit. Proc. World Lagomorph Conf., Guelph, Ontario, Canada. (in press).

Peterson, R.L. 1953. Studies of food habits and the habitat of moose in Ontario. Cont. Royal Ont. Mus. Zool. Palaeont. No. 36. 49 pp.

Stewart, J. 1953. Grazing habits and trace elements. Brit. J. Anim. Behav. 1:116-117.

Stockstad, D.S., M.S. Morris and E.C. Lory. 1953. Chemical characteristics of natural licks used by big game animals in western Montana. Trans. N. Am. Wildl. Conf. 18:247-258.

Thomas, E.R. 1979. Occurrence of highway salt pools and their relationship to moose-vehicle collisions within the Wawa Administrative District 1977-79. Ontario Ministry of Natural Resources internal report. 35 pp.

Ueckermann, E. 1968. Vergleichsweise Vorlage von Lecksteinen. Z. für Jagdwissenschaft 14:107-117.

Weeks, H.P. and C.M. Kirkpatrick. 1976. Adaptations of white-tailed deer to naturally occurring sodium deficiencies. J. Wildl. Manage. 40:610-625.

Wright, B.S. 1956. The moose of New Brunswick. A report to the Minister of Lands and Mines, New Brunswick. Northeastern Wildlife Station, Fredericton, New Brunswick. 63 pp.