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Natural History

Year-round Activity Patterns of Moose (*Alces alces*) at a Natural Mineral Lick in North Central British Columbia, Canada

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Abstract

Mineral licks are used by ungulates throughout most of their ranges. At licks, ungulates ingest soil particles and water to meet numerous physiological demands. The majority of research on the use of licks by Moose (*Alces alces*) has focused on the early to mid-summer period. We monitored the year-round use of a lick by Moose in the John Prince Research Forest located in North Central British Columbia, Canada from 2002 to 2005 with a TrailMaster camera. Moose used the lick throughout the year, with peaks in activity occurring during early summer and mid-winter. Overall, adult female Moose (cows) used the lick more frequently than did calves and adult males (bulls). Cows were present at the lick proportionately more in May, June and July relative to bulls and calves while bulls were present proportionately more in April and May. Calf use generally mirrored that of their mothers except during the months of April and May, when calves were absent from the photo records. The total amount of time spent by cows and calves at the lick was greatest between December and February, and June through August, but bulls spent most of their time at the lick in June. All Moose predominantly used the lick late at night and during the early morning hours and less frequently during mid-day. Our observations of mineral lick use by Moose during winter suggests that Moose may also be facing a mineral deficiency in winter similar to that reported by others for Moose during spring and early summer.

Key Words: Moose, *Alces alces*, behaviour, British Columbia, mineral licks, winter.

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INTRODUCTION

Mineral licks are used by Moose (*Alces alces*) and other ungulates for mineral supplementation, as an aid for digestive disorders and imbalances, to obtain water, and for social gathering (Fraser and Hristienko 1981; Jones and Hanson 1985; Kruelen 1985; Risenhoover and Peterson 1986; Couturier and Barrette 1988; Heimer 1988; Klaus and Schmid 1998). Licks are reportedly used by Moose most often between dusk and dawn (Fraser and Reardon 1980; Tankersley and Gasaway 1983; Couturier and Barrette 1988) and in late spring and early summer (Fraser and Hristienko 1981; Tankersley and Gasaway 1983; Couturier and Barrette 1988; Filus 2002).

Seasonal peaks in lick use are thought to coincide with spring leaf flush when Moose switch from woody browses to more succulent summer forages (Jones and Hanson 1985; Risenhoover and Peterson 1986; Couturier and Barrette 1988; Ayotte *et al.* 2008). Forage switching in the spring can lead to imbalances and/or deficiencies in minerals such as sodium and iron and may vary by sex and age class (Atwood and Weeks 2002) as well as the physiological condition of the animal (e.g., pregnant or not; Jones and Hanson 1985). Visits to licks by Moose have been reported at other times of the year (Risenhoover and Peterson 1986; Thompson and Stewart 1998) but their frequency, and the sex and age of the visiting Moose have not been investigated in detail.

In an effort to understand better the ecological importance of mineral licks to Moose year-round, we sought to determine both the daily and seasonal patterns of lick use by Moose in North Central British Columbia, Canada. The objectives were to describe year-round trends in lick use and determine if differences in use occurred between different sex and age classes of Moose.

STUDY AREA

Our study area was located in the John Prince Research Forest (JPRF; 13000 ha) in North Central British Columbia, Canada. The area is located in the Sub-boreal Spruce Biogeoclimatic Zone and is characterized by rolling topography (Meidinger *et al.* 1991) and is between 700m and 1267m above sea level. The geology of the area is represented by two major sources of bedrock, limestone and ultra-mafic, with much of the area being covered by glacial till. The soils of the JPRF are shallow and composed mainly of luvisols with limited amounts of brunisols.

The mineral lick we chose to monitor for this study was one of four in the area from which we sampled water and soils for mineral analysis as part of a companion study. The lick was located on a north aspect of Pinchi Mountain (54° 41′ 22.31″ N, 124° 31′59.76″ W) and was surrounded by Black Spruce (*Picea mariana*) and Lodgepole Pine (*Pinus contorta* var. *latifolia*) forests. The site consisted of a bubbling spring and approximately 300 m2 of wet muddy substrate devoid of vegetation except for some grasses and sedges. Local traditional knowledge and presence of Moose signs (tracks, trails and pellets) indicated that this was the most visited lick of the four licks known to exist in the area. At the time of the study, there were 1.3 Moose/km^2 (post-hunt helicopter surveys; Rea 2005).

METHODS

We monitored the mineral lick 24 h per day from Jan 1, 2002 to March 12, 2005 using a TrailMaster® Wildlife TM 1550 Monitor/ TM 35-1 Camera Kit (Lenexa, Kansas, USA). We camouflaged the unit to avoid detection and minimize the risk of theft and damage. We programmed the unit for a 0.5 sec beam break time with 2 min between photos. Two minutes was the minimum interval between photographs that could be set. Visit times were measured using the date/time imprint on the photographs. We positioned the camera at a height of four meters above the lick in a spruce tree that overlooked the lick and set the flash to activate automatically. We then positioned the receiver/transmitter approximately one meter above the ground to maximize capturing the movements of Moose, while minimizing captures of smaller non-target animals at the lick. We used 200 and 400 ASA, 36-exposure films. We checked the unit approximately every 10 days to change film, batteries, look for obstructions, and ensure proper function. Occasionally, back-up cameras were employed to ensure more continuous data collection when parts needed to be replaced or serviced. Components were cleaned and serviced annually.

Photographs were analyzed to determine the presence of Moose. We categorized Moose in photographs as adult males (bulls; with antlers or pedicels and dark facial hair with no vulva patch), adult females (cows; antlerless with brown faces and vulva patches) and calves (young of the year). We also recorded the number of Moose in each photograph, the time of day, and the day of the year of each visit. If a Moose fell outside of the range of the flash at night, we were usually unable to classify them to a sex and age group. Therefore, we assigned these animals to an "unknown" category.

Photographs indicated that visits by individual Moose could be made several times per day, but were usually separated by hours or days, thus facilitating the determination of what we classified as an independent visit. If an individual Moose was successively photographed, we thoroughly reviewed the date/time stamps on the series of photographs and consulted information collected by Tankersley and Gasaway (1983) on Alaskan Moose (average lick visit durations of 3 to 22 min) to determine what constituted an independent visit. Determining exactly how many different Moose (tens but not hundreds) visited the lick over the course of the study was complicated by the fact that most visits occurred in low light conditions when individuals were difficult to identify. We recorded multiple visits to the lick by the same animals over the course of the study and we acknowledge that this can be considered pseudoreplication. For this reason, we focused on the number of individual visits to the lick rather than the number of individual animals using the lick.

The amount of time spent by different individuals at the lick was calculated by summing the time stamps on photographs that were taken successively and uninterrupted (but at least 2 min apart) during a visit. Time stamp did not record seconds, making minutes our only metric with which we could determine time at the lick. We acknowledge that this method is a coarse way to determine visits and could lead to over- or under-inflation of visit times. Under-inflation of visit times may have occurred if batteries died or the camera ran out of film during a visit, albeit this would still allow us to record a visit and then correct for the time which the camera was not operational (see below). Over- or under-inflation of visit times should apply equally to all sex and age classes.

To account for days when the camera was not operational due to factors such as snow loading, animal damage, film depletion (i.e., to standardize visitations; see Atwood and Weeks 2003), we corrected the number of visits to the lick in a given month by multiplying the number of independent visits recorded in that month by the number of days in the month and dividing by the number of days that the camera was operational during that month. We calculated basic statistics for the number of days the camera was functional, the number of independent visits to the lick by Moose, and how the total number of minutes spent at the lick (pooled across years) varied by sex and age class.

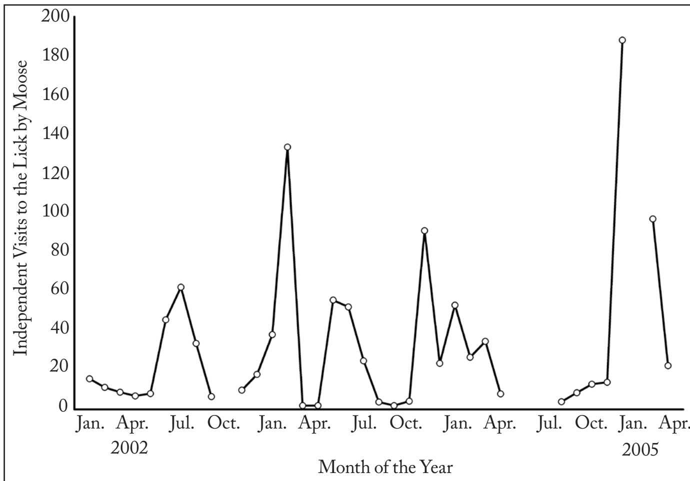

Figure 1. Monthly variation in visits (corrected for number of days that the camera system was working) to the mineral lick by Moose between January 2002 and March 2005.

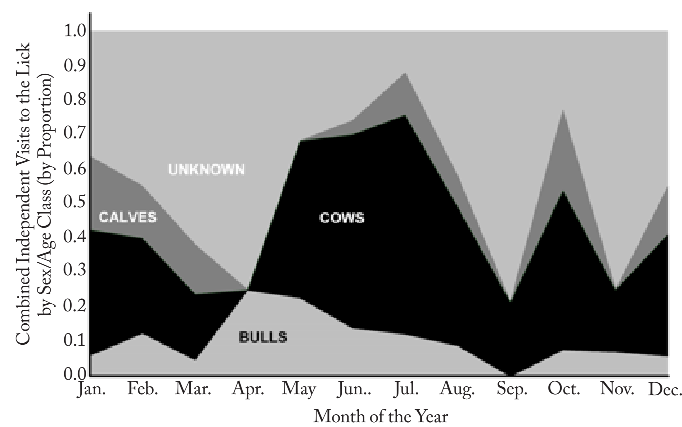

Figure 2. The total proportion of different age/sex classes of Moose captured on film visiting the lick during different seasons of the year with monthly visits pooled by month of year and corrected for camera inoperability for each full year of the study (January 2002 — January 2005).

RESULTS

Due to weather events (snow, falling leaves, vegetation movements and growth), wildlife damage to camera systems, a malfunctioning date/time stamp (spring/summer 2004), occasional dead batteries or fully utilized film, our camera was operational 397 of 851 days and averaged 13.3 (standard deviation ±10) days of error-free recording per month. However, our records do not indicate any multi-year bias towards a season or time of day that camera malfunctions occurred.

There was an apparent increase in visits (total number of visits to the lick = 356) to the lick by Moose during summer and winter (Figure 1). However, seasonal activity at the lick varied by sex and age class of Moose. Specifically, cows visited the lick mostly during the summer and from mid-October to March (Figure 2), calf visits mirrored those of their mothers, whereas bulls visited the lick in spring and early summer (April-June), but infrequently throughout the late summer and during winter (Figure 2).

The combined time spent by all Moose pooled for all years that we recorded was 1722 min with two peak visit times during mid-winter (December to February: 848 min) and mid-summer (June to August: 481 min). Cows, as a group, were recorded at the lick for more minutes (713 min) during each season than calves (272 min) and their male counterparts (114 min). However, cows and the unknown group spent an equal amount of time at the lick during the winter months (328 min vs. 325 min for cows). Visits to the lick occurred primarily between 17:00 h and 24:00 h (50% of the 356 visits) and between midnight and 07:00 h (40%), with few visits occurring during mid-day (10%). These temporal patterns of use varied between sex and age classes with bulls being slightly more active later in the morning (43% of all visits, around 08:00 h) and around mid-day (67% of all visits) than were the cows and calves. Cows dominated the number of visits both in the early morning (05:00-07:00 h; 56% of visits) and the late evening (20:00-24:00 h; 43% of visits) periods. On the other hand, the number of visits to the lick between 17:00-04:00 h was made mostly by the unknown group (50% of the visits).

DISCUSSION

Previous studies have reported peak use of licks by Moose in summer (Lynch 1978; Fraser and Hristienko 1981; Risenhoover and Peterson 1986; Couturier and Barrette 1988). Winter use of licks has also been reported (Risenhoover and Peterson 1986; Thompson and Stewart 1998). However, peak use of licks in winter has not been documented in the scientific literature. This may be due to the fact that previous studies have been conducted primarily between spring and fall, generally April – September (Carbyn 1975; Fraser 1979; Fraser *et al.* 1982; Tankersley and Gasaway 1983; Risenhoover and Peterson, 1986; Couturier and Barrette 1988; Ayotte *et al.* 2008).

Moose utilized the lick regularly in late spring and early summer during each year of this study. Although we could not include the data for the spring/summer of 2004 because of missing date/time imprints on our photographs due to a camera malfunction, our photographic record indicated a large increase in summer use in 2004. With the exception of the first year of this study (2002; a December 2001 peak may have gone unrecorded), Moose utilized the lick regularly during the winter months of December (2004) and January (2003 and 2005) with a pronounced peak in winter 2005 (Figure 3). The exact dates of these peaks varied among years, and may have been influenced by local environmental conditions (e.g., temperature, snow).

Figure 3. A Moose of unknown sex and age kneels at the study lick in the John Prince Research Forest, North Central British Columbia, February 12, 2003.

Why Moose visits to licks increase in mid-summer relative to spring and fall has been documented and explained by others (Fraser and Hristienko 1981; Jones and Hanson 1985; Risenhoover and Peterson 1986; Couturier and Barrette 1988; Ayotte *et al.* 2008). However, why visits to our lick by Moose increased in mid-winter is unknown. Increased use of mineral blocks in winter by domestic ungulates is well-documented (Chládek and Zapletal 2007) and supports the contention that Moose may be attracted to mineral deposits in winter because of winter-time mineral deficiencies (Jordon *et al.* 1973; Heikillä and Härkönen 1998).

Despite the ability of Moose and other ungulates to conserve minerals in winter through renal reabsorption and decreased excretion (DelGiudice *et al.* 1991) as well as storage in salivary rumen fluids (Belovsky and Jordan 1981) and possibly in bones (Botkin *et al.* 1973), ungulates reportedly lose minerals in urine and feces throughout winter (Belovsky and Jordan 1981; Ohlson and Staaland 2001). A negative sodium balance can then become acute for Moose in winter when access to forage sources of sodium (e.g., aquatic macrophytes) are difficult to locate (Ohlson and Staaland 2001).

Water samples collected from the lick for a companion project during the first month of this study (January 2002) indicated that water from the lick contained 31.5 times the sodium, 280 times the iron, 11 times the magnesium and 4.5 times the calcium concentrations than that found in a nearby (~ 150 m away) stream that remained open and accessible (but unused as determined by our regular visits to check camera function) to Moose year-round (Rea 2005). Sodium and calcium concentrations in soils from the lick collected at the same time were 19.4 and 2 times higher, respectively, than nearby controls. Soil control samples contained 4 and 0.11 times more iron and magnesium, respectively, than soils from the lick (A. Arocena *et al.*, 2009, University of Northern BC, unpublished data).

Although critical mineral nutrition levels for Moose are unknown (Ohlson and Staaland 2001), mineral elements such as those described above are essential to the nutrition and health of ruminants (Robbins 2001) and must be obtained in both sufficient amounts and physiologically balanced proportions (Ohlson and Staaland 2001). Iron concentrations in lick waters that we sampled were particularly high in winter. Iron is important for blood and muscle function and as a component of many enzyme systems (Robbins 2001). Deficiencies in dietary iron or by blood loss due to winter tick infestation (Fraser *et al.* 1984; Glines and Samuel 1989) could lead to anemia. Alternatively, nutritionally deficient Moose are likely more susceptible to tick infestations (DelGiudice *et al.* 1997) and iron supplementation could potentially act as a prophylactic measure against infestation.

Sodium, calcium and magnesium are all macroelements required by ruminants for the maintenance of acid-base balance, water balance and nerve function (sodium), bone and tooth formation, blood clotting, nerve and muscle function (calcium), as well as enzyme function and ATP synthesis (magnesium; Robbins 2001). Sodium was found to be three times, iron, 14 times, and magnesium and calcium, 400 times lower in winter compared with summer browse in Alaska (Oldemeyer *et al.* 1977) and may help explain why Moose seek mineral supplements from licks in winter, but other reasons such as social gathering may be operative as well (Jones and Hanson 1985; Kreulen 1985).

We observed cow Moose using the lick more frequently than calves and bulls in winter. This difference may be physiologically-based as pregnant cows (84% pregnancy rate reported for cow Moose in North American; Boer 1992) attempt to satisfy nutritional demands during gestation (Weeks and Kirkpatrick 1976; Kennedy *et al.* 1995; but also see requirements for antler growth, Jones and Hanson 1985), but to some extent may also reflect the local population structure (14 bulls/100 cows and 37 calves/100 cows in post-hunt helicopter surveys; Rea 2005). As reported by Couturier and Barrette (1988), however, each sex/age class in our study revealed seasonal patterns of use, confounded, but not explained by the local population structure.

As reported by Kennedy *et al.* (1995) and Jordan *et al.* (1973), we also found that calves were rarely seen accompanying adult females, suggesting they remained outside of the area captured on film or that many of those cows photographed were without calves. When calves were observed, however, they were always accompanied by cows and their visits to the lick peaked during January. We observed no cow-calf pairs at the lick during April to May, prior to calving (Bubenik 1998).

The daily patterns of use that we observed seem to reflect the general activity patterns of Moose (Klassen and Rea 2008) as well as most other terrestrial mammals (Animal Care and Use Committee 1998). Similar to other studies of Moose activity at natural licks (Peterson 1955; Tankersley and Gasaway 1983; Risenhoover and Peterson 1986; Couturier and Barrette 1988), we found that visits occurred most frequently in late evening and, to a lesser extent, in early morning. These patterns of use were similar for cows, bulls and calves, but were most pronounced for cows.

Our observations indicate that in addition to summer use, Moose regularly used the lick during winter, but very little during fall and spring. Proportionately, cows visited and spent more time at the lick than calves and bulls in all seasons except during the spring. Moose generally used the lick more at night and in the early morning hours than during the day. If winter peaks in lick use are wide-spread and as important as summer peaks for Moose, our findings may indicate another mode of mineral supplementation used by Moose during the winter.

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Roy Rea (far right) teaches Introductory Biology, Field Applications in Resource Management and Plant Systems labs at the University of Northern British Columbia (UNBC). Roy also co-teaches Plant-Animal Interactions at UNBC and has been studying various aspects of Moose ecology for the past 17 years.

Dexter Hodder (centre) manages the research program at the John Prince Research Forest which is co-managed by the Tl'azt'en Nation and UNBC. Dexter also co-teaches Field Applications in Resource Management and has active research projects focusing on a wide variety of wildlife species including various meso-carnivores, ungulates and bears.

Ken Child (far left) is now retired. He served as regional wildlife biologist for the British Columbia Ministry of Environment, Lands and Parks (1973-1992) and as a senior environmental co-ordinator for the Northern Region of British Columbia Hydro (1992-2005) in Prince George. When with the Ministry, Ken specialized in Moose management and introduced a selective harvest strategy for Moose in the central interior of the province. Ken was a contributing author to the Wildlife Management Institute Book: Ecology and Management of the North American Moose, published in 1996. Ken continues to maintain his interest in Moose behaviour, ecology and management by collaborating with Roy on shared research interests on Moose.

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