WILD RUMINANT STUDY AT BRENDA MINES

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ABSTRACT

A wild ruminant study was undertaken at the Brenda Mines site in 1999 to determine the numbers of mule deer and whether they showed symptoms of molybdenosis. About 32 mule deer were estimated to utilise the site during the summer. This number included both breeding and non-breeding adults and fawns. Because animals tend to return to familiar summer home ranges, we assume that does using the site successfully reproduce. A variety of age classes were noted including large bucks, indicating animals reach maturity.

Deer were observed feeding on vegetation on the tailings beach area and waste rock piles, as well as surrounding areas. Animals were not limited to these areas and spent time in the surrounding forest. Molybdenum concentrations in forage from revegetated areas, while elevated, remain below levels reported to lead to symptoms of molybdenum toxicity in mule deer. None of the animals exhibited any outward signs of molybdenum toxicity such as weight loss, discolouration of hair or impaired locomotion. No dying or dead animals were encountered. Faecal pellets encountered on the site for the most part were normal in consistency, with little evidence of diarrhoea, one possible symptom of excessive molybdenum intake. These observations combined with the wide-ranging foraging behaviour of deer, indicate that molybdenosis is unlikely to be found in wild ruminants utilizing the mine site.

INTRODUCTION

The Brenda Mines site is located approximately 20 km north west of Peachland in southern British Columbia. The open pit mine operated from 1967 to 1990 and produced copper and molybdenum. Operations were closed in 1990 and extensive reclamation of the tailings dam, rock piles and other disturbed areas has been carried out. The reclamation of the main tailings dam and rock piles began in 1986 and has continued with seeding, planting of trees and shrubs and fertiliser applications. Details about the site are provided in several papers (Jones & Associates, 1990; Morin and Hutt, 1999; and Stroiazzo, 1999).

Ruminants such as cattle and sheep are susceptible to molybdenosis, a condition that leads to an imbalance (deficiency) of copper. In serious cases, symptoms include weight loss, diarrhoea, discoloration of the hair and lameness. Other ruminants such as deer and moose may also be susceptible although the literature indicates that these species are considerably less susceptible to molybdenum induced toxicity than are cattle and sheep (Eisler, 1989; Nagy *et al*., 1975; Osman and Sykes, 1989; Chappell and McKee, 1998).

Mule deer (*Odocoileus hemionus*) and moose (*Alces alces*) have been observed on the mine site for many years. However, as the conditions have changed with revegetation of the tailings pond/beach area and rock piles, there is greater opportunity for wild ruminants to eat forage containing high levels of molybdenum and potentially suffer from molybdenosis. The objective of this study was to determine the degree of use of the Brenda Mine site by deer and moose, particularly grazing on molybdenum-rich forage on the tailings and dam area and the rock piles; to identify any signs of poor health or behavioural abnormalities that could potentially be related to molybdenum toxicity; and to estimate the numbers of wild ruminants using the site relative to the population as a whole.

METHODS

Direct Observations

Four field visits were made to the site by the senior author to observe ungulates in and around the site. They were 12 to 19 June, 03 to 09 August, 20 to 25 September, and 30 October to 03 November 1999.

Trailmaster Monitoring Equipment

Six Trailmaster TM1500 Infra-red Trail monitors[1] were deployed on the Brenda Mine site during the study. Units consist of an infrared emitter that produces a pulsed beam, and a receiver unit that detects an interruption of the beam. The units store the time and date of each event and are designed to work across a gap of up to 30 yards, though problems were encountered using these large distances. A default setting of ¼ second was used for the length of time the beam had to be interrupted for an event to be recorded.

The units were located to monitor animals moving to and from parts of the mine site, in particular the tailings/beach area and the waste rock piles. The receivers were set approximately two feet above the ground so that small animals would not interrupt the beam. Three of the units were equipped with Yashica 35 mm cameras adapted to work with the Trailmaster units. A time delay

[1] Trailmaster is a product of Goodson and Associates Inc. 10614 Widmer, Lenexa, KS 66215

of two minutes between photographs was set so that the camera would not take numerous pictures of the same animal. The cameras have built-in flash units, and the units were programmed to take pictures at any time during the 24-hour day.

Deer Pellet Analysis

Deer pellets were collected for chemical analysis from the beach/tailings area June (Series 1), the beach/tailings area August (Series 2), the north east rock pile August (Series 3), from the trail and road to Brenda Lake, from a reference area approximately 4.0 km from the mine off the Headwaters Lake Road (49^0 52'N 120^0 05' W) and for comparison from the tailings area at another mine in western Canada where the tailings are enriched with molybdenum. Pellets were noted as to their condition and were analysed for copper, molybdenum and total sulphur by PAS, Burlington, Ontario.

Browse Studies

Vegetation was examined throughout the study to determine its use by mule deer. Because of the abundance of choice herbaceous vegetation during the summer months, no attempts were made to quantify the percentage that was browsed. Animals were watched directly with binoculars and telescope to determine what they were eating.

RESULTS

The commonest ungulate on the Brenda Mines site during the summer months is mule deer. Moose are present but in low numbers and were photographed by the Trailmaster units only occasionally (7 moose versus 111 mule deer).

The number of mule deer utilising the Brenda Mine site fluctuates through the year. Mule deer overwinter at lower elevations in the Peachland/Westbank area and move up to the Brenda area in May-June (Guyg, 1999; Simpson *et al.*, 1995). They disperse over the Trepanier Plateau during the summer months and establish summer home ranges of approximately 10 km^2 (Simpson *et al.*, 1995). The numbers of mule deer peaked in July and August and declined through October and November as animals descended to winter range. Mule deer or evidence of their presence was observed over most of the Brenda Mines site. Use of the beach tailings area is greater than use of the waste rock piles.

Visual surveys underestimate actual populations significantly and Gyug (1999) used a sightability correction factor of between 2 and 4 for mule deer on winter range in the central Okanagan Valley. Population estimates for this study are based on the numbers of animals that were seen during any day at different locations. For example, on 7 August, 14 individuals were observed: they were; five males on the northeast rock pile, two does near mine buildings, and three females and four males near the tailings pond. This did not include any fawns of which two were seen on one occasion and they are included. So there was an unduplicated count of 16 animals. Using the minimum sightability correction factor of 2 would provide an estimate of 32 mule deer on site.

The normal number of fawns is two for mature does and several does had one or two fawns with them while others did not. Lactating females may be seen without fawns when they leave them in hiding; thus, the number of fawns on site is probably under-recorded. Because deer tend to return to their summer range year after year, one can deduce that females observed with fawns have used the Brenda Mines site for several years, and are able to conceive and produce young successfully.

The activity patterns of mule deer were determined from direct observations and the use of Trailmaster units. The photographs of moose (7), black bear (3), cougar (2) and coyote (2) compare with deer (128) indicating that the majority of animal activity is mule deer movements.

The Trailmaster activity record indicates the number of times that the infra-red beam has been broken in any 15 minute period during the 24-hour day. The photographs were correlated with the activity records and doe mule deer cause the majority of events, though all age classes triggered the Trailmaster units.

<u>Mule Deer Diet</u>

Mule deer were watched feeding and the species of plants consumed were identified. Plants were also examined for evidence of browsing by deer. The preferred food during the summer is alfalfa (*Medicago sativa*). White clover (*Trifolium repens*), sweet clover (*Meliotus alba*), birdsfoot trefoil (*Lotus corniculatus*), sainfoin (*Onobrychis viciifolia*) and fireweed (*Epilobium* sp.) are also well utilised. The preferred shrub is willow (*Salix* spp.), though during the summer, when there is abundant high quality herbaceous forage, there is not much shrub or tree utilisation.

Samples of forage plants collected in the summer of 1999 from the tailings area and analysed for Cu, Mo and S are summarized (Table 1). The mean value of molybdenum in alfalfa is 130 ppm

(34 - 220 ppm). Concentrations in other vegetation are similar to those in alfalfa, higher in sainfoin and lower in bromegrass and willow (Table 1). Deer move about within a home range that has been estimated to be between 7 km^2 for females to 15 km^2 for males (Simpson *et al*., 1995). Because mule deer were often not present on the tailing/beach area or rock piles, and because the surface area of vegetated tailings and waste rock piles is less than 7 to 15 km^2, it is reasonable to assume that deer often feed elsewhere where the vegetation does not contain elevated levels of molybdenum. Therefore, the composition of their diet is related in part to the proportion of time that mule deer spend in different parts of their range.

As shown in Tables 1, vegetation on the tailings area at the Brenda Mines site has average concentrations of molybdenum of about 130 ppm, with maximum concentrations of 398 ppm. The copper levels are generally low and the copper to molybdenum ratios in forage is generally in the range of about 0.05. Sulphur concentrations are also shown for reference, as dietary sulphur is associated with molybdenum absorption in the digestive tract of ruminants. The sulphur levels in vegetation are similar in range to what is normal for the area (BEAK, 2000).

For most of the summer, there was no diarrhoea observed in any of the pellets. In some cases fresh pellets were greenish and soft reflecting a high proportion of alfalfa consumed. In some cases, the soft pellets tended to stick together and in September, a few faecal piles were found that were completely runny. Pellets observed in October and November were firm and hard. Scientists with Kamloops Range Research Station informed us that mule deer exhibit diarrhoea from time to time without any specific linkage to molybdenum exposure. Based on the scarcity of diarrhoea in deer at Brenda Mines and on the fact that alfalfa contained average molybdenum levels below the apparent no-effect-concentration of 200 ppm for deer in feed (Chappell and McKee, 1998), we considered any linkage between this condition and molybdenum intake to be improbable.

The results of chemical analyses of deer faeces are provided in Table 2. Molybdenum levels in deer faeces at Brenda Mines and the immediate vicinity ranged from 3 ppm to 480 ppm, with an average concentration of about 140 ppm. This range and average level are similar to those levels observed in alfalfa and demonstrate that dietary molybdenum is both ingested and eliminated at similar concentrations.

The ratio of copper to molybdenum in feed has been proposed as being of relevance to copper deficiencies in ruminants. Miltimore and Mason (1971) indicated that a copper deficiency may occur at a ratio below 2:1 in cattle forage. However, Suttle (1991) suggests that there may not be a fixed ratio for risk, and Gardener and Broersma (1999) found that a ratio of 0.44:1 in summer forage did not affect the growth and reproductive performance of cattle over a four-year period. The Cu:Mo ratio in deer faeces from Brenda Mines ranged from 0.1:1 to 4.2:1 although the relevance of this ratio with regard to mule deer is unknown.

In comparing the copper concentrations in vegetation with those in faecal pellets, it is apparent that the elimination rate of copper in faeces is generally greater than could be accounted for by the intake of copper from vegetation from the tailings/beach area. Either the deer are losing copper from their body systems, or they are obtaining copper from other dietary sources. Because the deer show no signs of molybdenum toxicity (copper deficiency), we suggest that copper is obtained from sources other than the tailings vegetation. With copper levels of 132 to 415 ppm in the tailings (Table 2), it is likely that much of the faecal copper is derived from soil ingestion. Deer and many other herbivores consume soil routinely as a means of mineral supplement (Arthur and Gates 1988, Weeks and Kirkpatrick 1976).

The average concentration of copper in tailings is 278 ppm (Table 2). Based on the following rationale, ingestion of copper in tailings by deer is not likely to be deleterious to their health. While dietary copper requirements of mule deer are unknown, it is reasonable and conservative to assume that the safe upper limit for copper ingestion is equivalent to the "No Observed Adverse Effect Level" (NOAEL) identified for mammals known to be copper-sensitive. The lowest published NOAEL for copper appears to be 7.5 mg/kg body weight/day in mink (Aulerich *et al*., 1982). Adjusting for the body weight difference between mink and deer (Sample *et al*., 1996), the NOAEL for deer is about 3.3 mg/kg/day. Assuming a body weight of 110 kg for an adult male mule deer, the NOAEL would be reached only after a daily consumption of 1.3 kg/day of tailings, which would be excessive and unrealistic.

<u>Deer Health</u>

Many hours were spent watching the behaviour of deer. Deer were observed walking, trotting, stotting (a distinctive gait used by several species of ungulate), and jumping and did not show any locomotory problems. None of the photographs showed any abnormalities or stiffness of gait characteristic of molybdenosis. There were no dead deer encountered during searches of the

Brenda Mines property. Except for the occurrence of diarrhoea in a few faecal samples in September, no potential symptoms of molybdenosis were observed during the field season.

CONCLUSIONS

- Mule deer are common on the Brenda Mine Site during summer and early fall months and can often be seen in open areas.
- Moose are less common than mule deer but are present during the summer months.
- Mule deer and moose rear their young of the year at the site indicating that reproductively successful females use the area.
- Female mule deer are commoner than males based on field observations and Trailmaster photo records.
- The preferred forage of mule deer at Brenda Mines is alfalfa, sainfoin, clover and willow. However, these deer feed in molybdenum-rich areas only some of the time, and also occur and feed in adjacent forested habitat during this period.
- Average and maximum molybdenum concentrations in forage from revegetated portions of the Brenda site remained below concentrations known to lead to symptoms of molybdenum toxicity in mule deer, based on the scientific literature.
- The outward appearance of mule deer in summer and fall is excellent with regard to coat colour, antler growth and condition, indicative of no adverse effect from dietary molybdenum
- No gait abnormalities were observed in any of the mule deer or moose observed, as might be expected if dietary molybdenum levels were excessive.
- Overall, the deer at Brenda Mines appear normal and healthy

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TABLES

Table 1: Chemical analyses of alfalfa, sainfoin, birdsfoot trefoil, willow and soils from Brenda Mines site (vegetation data from C. Smithies, soil data from Brenda Mines 1993)

Species	**N**	**Cu (ppm)**	**Mo (ppm)**	**S (ppm)**	**Cu:Mo**
Alfalfa Mean (Min-Max)	12	8 (6-13)	130 (34-220)	1,800 (1300-2500)	0.06
Sainfoin Mean (Min-Max)	9	6 (5-7)	275 (172-398)	1,800 (1300-2200)	0.02
Birdsfoot Trefoil Mean (Min-Max)	7	7 (5-10)	145 (82-199)	1,600 (1400-2000)	0.05
Bromegrass Mean (Min-Max)	16	4 (4-5)	90 (9-182)	800 (600-900)	0.05
Willow Mean (Min-Max)	5	10 (8-11)	61 (10-94)	1,900 (1600-2200)	0.16
Tailings Mean (Min-Max)	4	278 (132-415)	105 (50-140)	-	2.6

Table 2: Mule Deer faecal pellet chemical analysis

	N	**Location**	**Cu**	**Mo**	**Cu:Mo**	**S**
Series 1	8	Tailings beach	65.5 (39-95)	162 (40-270)	0.60:1	2300 (1660-2600)
Series 2	4	Tailings beach	58 (33-89)	180 (61-260)	0.57:1	2047 (790-2600)
Series 3	5	North east rock	46 (28-56)	221 (35-480)	0.48:1	2140 (1700-2800)
Series 4	14	Various	71.1 (12-460)	64.2 (3.0-270)	2.35:1	2047 (960-3000)
Series 5	2	Other mine site	373 (56-690)	185 (130-240)	2.76:1	2000 (1800-2200)
Series 6	2	Various	14.5 (14-15)	135 (120-150)	0.105:1	1950 (1800-2100)