

**Randy G. Hein**, Eastmont Animal Clinic Inc., P.S., 100 Valley Mall Parkway, East Wenatchee, Washington 98802

**Patricia A. Talcott**, Department of Food Science and Toxicology, Holm Research Center, University of Idaho, Moscow, Idaho 83843

**Jack L. Smith**, Washington Department of Wildlife, 48-B Devonshire Road, Montesano, Washington 98563

and

**Woody L. Myers**, Washington Department of Wildlife, N. 8702 Division Street, Spokane, Washington 99218

## Blood Selenium Values of Selected Wildlife Populations in Washington

### Abstract

The object of this study was to determine blood selenium (Se) values in free ranging wild ungulates in Washington state. Blood was obtained from elk (*Cervus elaphus nelsoni*, *C. elaphus roosevelti*) in the Blue, Cascade, and Olympic Mountain Ranges, the Department of Energy's Hanford Site and the Yakama Indian Nation Reservation; California bighorn sheep (*Ovis canadensis californiana*) from the north Cascade Range and northeastern Washington, and moose (*Alces alces shirasi*) from the Mt. Spokane area were sampled. Mule deer (*Odocoileus hemionus hemionus*) from the north shore of Lake Chelan were also sampled. When compared to adequate livestock standard values (Se > 0.1 ppm, wet/weight) Blue Mountain elk, Yakama Indian Nation Reservation elk, bighorn sheep, and mule deer were marginally deficient (Se 0.05-0.09 ppm) whereas the moose sampled were deficient (Se < 0.05 ppm). Elk located on the Olympic Peninsula and Hanford Site exhibited Se values considered adequate. The results suggest blood Se levels vary among elk herds within the state while bighorn sheep, mule deer, and moose have generally low Se values when compared to domestic livestock with adequate values.

### Introduction

Selenium is a trace element that is an integral part of the enzyme, glutathione peroxidase, which acts in conjunction with vitamin E to protect cellular membranes and lipid containing organelles from the destructive effect of fatty acid peroxidation (Blood and Radostits, 1989, The Merck Veterinary Manual, 1991). The primary clinical deficiency disease occurring in domestic ruminants is nutritional muscular dystrophy, commonly called white muscle disease. In affected animals this malady is most significant in young animals during rapid growth. Signs include stiff gait, reluctance or inability to stand and muscle tremors if forced to stand more than a few minutes. Weakened myocardium and diaphragm muscle results in tachycardia and labored abdominal respiration. Death is not an unusual sequela. Other Se deficiency conditions include unthriftiness, chronic diarrhea, decreased growth rate, poor hair coat, impaired immune response, and possibly decreased reproduction (Blood and Radostits, 1989). Domestic cattle blood Se values are considered adequate when > 0.1 ppm, marginal when between 0.05-0.09 ppm, and deficient when < 0.05 ppm (Fielder, 1986).

Normal blood Se levels in nondomestic ruminants are not well known. In red deer, post

capture myopathy is predisposed by Se deficiency and white muscle disease was diagnosed in trapped mountain goats in southeastern British Columbia (Herbet *et al.*, 1971). Farmed red deer exhibiting unthriftiness responded to injectable Se (Knox *et al.*, 1987, Mackintosh *et al.*, 1989). However, captive white-tail deer which were fed a Se deficient diet did not exhibit adverse health effects (Brady *et al.*, 1978).

Soils of the Pacific Northwest are generally low in Se (Blood and Radostits, 1989) and Se deficiency in livestock in the region has been long recognized (Muth and Allaway, 1963). Compared to livestock standards, Se deficiency has been reported in black tail deer herds in California (Flueck, 1991), wild mountain goats in Washington (Robbins *et al.*, 1985, Fielder 1986), and mule deer and Rocky Mountain elk in Washington (Fielder, 1986). Captive mountain goats exhibited normal comparative Se values when fed enriched (0.1 ppm selenium) feed (Robbins *et al.*, 1985).

In California from 1980 through 1988, 1,695 mule deer blood samples were analyzed for Se content (Oliver *et al.*, 1990). In that statewide survey of 15 management groups, mean values ranged from 0.039 mg/L (ppm) to 0.178 mg/L, with the overall mean 0.089 mg/L and the authors report

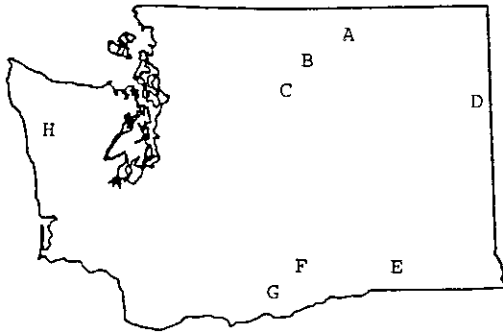


Figure 1. Wildlife populations sampled in Washington. A Vulcan Mountain bighorn sheep, B Sinlahekin Wildlife area bighorn sheep, C Lake Chelan mule deer, D Mt. Spokane moose, E Blue Mountains elk, F Hanford Site elk, G Yakama Indian Nation elk, H Olympic Mountains elk

widespread deficiency based on low first quartile values in two-thirds of the management groups and deficient values ( $<0.04$  ppm Se) in all sample groups. Between 1980 and 1989, 1 Roosevelt and 7 tule elk herds were tested for blood selenium levels in six California counties. Mean Se values of twenty animals from each herd varied from 0.075 ppm to 0.258 ppm (Jessup, 1990). Only one herd exhibited a mean Se value  $<0.1$  ppm.

The object of this study was to determine blood Se values in free ranging wild ungulates from various regions of Washington.

## Materials and Methods

### Description of Study Areas

Individual capture areas are identified in Figure 1. Twenty Roosevelt elk were captured on the southern and western drainages of the Olympic Mountains (OM) outside Olympic National Park. The elk were found in timber clear cuts with elevation generally between 370-1077 meters. Sixty-four Rocky Mountain elk were captured in the Blue Mountains (BM) of southeastern Washington. The elk were located in mountain meadows, timber clear cuts, and shrubsteppe range with elevation varying between 300-1540 meters. Twenty Rocky Mountain elk were captured at the Hanford Site (HS) in southcentral Washington. The animals inhabit shrubsteppe range with elevation ranging between 275-465 meters. Fourteen Rocky Mountain

elk were captured on the Yakama Indian Nation Reservation (YINR) in southcentral Washington. Elevation at the capture sites ranged from 460 to 1385 meters and habitat varied from thin coniferous forest to shrubsteppe. Four California bighorn sheep were captured on the Sinlahekin Wildlife Area (SWA) on the northeastern slopes of the north Cascade Mountains, and 10 from Vulcan Mountain (VM) in northeastern Washington. Elevation at these capture sites was approximately 615 meters. The bighorn sheep were captured on steep hillsides with cliffs and thin timber stands. Two moose were captured on the southern and southeastern slopes of Mt. Spokane (MS) in replanted young growth clearcuts. Elevation at the capture sites ranged from 850 to 1000 meters. Six mule deer were sampled along the north shore of Lake Chelan (LC) at elevations of 340-430 meters on steep, south facing slopes. Vegetation was dominated by Douglas fir, Ponderosa pine, bluebunch wheat grass, and bitterbrush.

### Capture Methods

Two moose were darted from a helicopter using Palmer Cap-Chur<sup>®</sup> darts containing 1.8 mg carfentanil (Wildnil<sup>®</sup>) and 50 mg xylazine (Rompun<sup>®</sup>) in January 1992. Carfentanil was reversed with 200 mg naloxone; one-third given intravenously with the remainder administered subcutaneously. Adult elk and calves over 9 months old were captured in the BM by darting with immobilizing drugs from a helicopter in March of 1990 and 1991. These elk were darted with 1.8-3.6 mg carfentanil and 50-100 mg xylazine. Carfentanil reversal was achieved with 200-250 mg naloxone administered as noted previously. Renarcotization of the elk was not observed during follow up radiotelemetry flights. In June 1992, 13 neonate calves ( $<1$  month old) were captured in the BM by net gunning from a helicopter or physical restraint of calves found hiding in thick cover. In March 1992, 20 Roosevelt elk were captured in the OM by darting from a helicopter with concentrated xylazine (300 mg/ml). Total dosages ranged from 900 to 1,800 mg/elk. Drug reversal was accomplished by intravenous injection of 40-60 mg yohimbine (Yobine<sup>®</sup>)/elk. In March 1992, at the SWA, one bighorn sheep was captured by helicopter darting with a combination of 600 mg ketamine/120 mg xylazine and three were captured in a drive net.

Reversal was with yohimbine. In March of 1992, 7 Rocky Mountain elk on the YINR and 4 on the HS were captured by helicopter darting using a combination of carfentanil (2.1-4.2 mg/elk) and xylazine (50-100 mg/elk). Carfentanil was reversed with naloxone. In March 1993, 7 elk were captured on the YINR and 16 elk were collected at the HS. The elk were darted from a helicopter using carfentanil (2.5-8.0 mg/elk). This drug was reversed with naltrexone (250-800 mg/elk); one-fourth administered intravenously and the remainder subcutaneously. In March 1993, 10 bighorn sheep were caught by drive net at VM and 6 mule deer were sacrificed along the north shore of Lake Chelan.

In all animals except the mule deer, jugular venipuncture was used to collect blood samples which were immediately injected into EDTA blood tubes. Mule deer blood was collected by cardiocentesis. Blood samples were kept cool in the field and stored at 4°C prior to shipment. All samples were submitted for analysis within 7 days of capture. Whole blood selenium was analyzed by inductively coupled plasma (ICP) spectrophotometer atomic emission using hydride generation (Tracy and Moller, 1990) at the Holm Research Center, University of Idaho, Moscow, and values were reported on a wet weight basis.

## Results and Discussion

This survey of selected wildlife in Washington supports a previous study (Fielder, 1986) demonstrat-

ing low comparative selenium values in deer, mountain goats and elk. One-hundred forty wild ungulates were sampled for blood Se values. These animals included 2 moose, 118 elk, 14 bighorn sheep, and 6 mule deer (Table 1). Selenium values ranged from 0.00 ppm to 0.49 ppm with a mean value of  $0.085 \pm 0.06$  for all samples. Individual population mean values ranged from 0.015 to 0.12 ppm. The lowest mean value was noted from two moose near MS while the highest average mean value was found in elk located at the HS.

Although only two adult moose were sampled, their extremely low results would suggest deficiency. Both animals were in excellent physical condition. An adult cow was pregnant (determined by rectal palpation) and accompanied by a yearling when captured. The two California bighorn sheep populations sampled had Se values suggestive of marginal blood Se levels. Low Se values in SWA forage may be a factor resulting in poor lamb recruitment (R. Johnson, personal communication). Elk populations exhibited varied Se values. Elk captured in the OM exhibited significantly higher ( $P < 0.05$ ) Se values than BM elk. Of interest is comparison of the OM elk and Olympic National Park mountain goat mean Se values. Robbins *et al.*, (1985) found 19 mountain goats, captured in 1983 and 1984, had a mean blood Se value of 0.041 ppm  $\pm$  0.032 whereas the 20 elk in this study had respective values of 0.158 ppm  $\pm$  0.108. Difference in these values may be related to time of year when sampled and elevation of home range.

TABLE 1. Blood Selenium values of wildlife in Washington.

Species	Location	Sample Size	Month/Year Sampled	Mean	Range	S.D.
Moose	Mt. Spokane	2	January 1992	0.015	0.01-0.02	
Elk (1)	Blue Mountains	13	June 1992	0.042	0.02-0.07	$\pm 0.014$
Elk (2)	Blue Mountains	51	March 1990 and 1991	0.061	0.00-0.17	$\pm 0.03$
Elk (3)	Yakama Indian Nation	14	March 1992 and 1993	0.069	0.03-0.16	$\pm 0.036$
Elk (3)	Olympic Mountains	20	March 1992	0.158	0.01-0.49	$\pm 0.108$
Elk (3)	Hanford Site	20	March 1992 and March 1993	0.12	0.08-0.16	$\pm 0.021$
Bighorn Sheep	Vulcan Mountain	10	March 1993	0.079	0.04-0.13	$\pm 0.033$
Bighorn Sheep	Sinlahekin Wildlife Area	4	March 1992	0.097	0.07-0.13	$\pm 0.027$
Mule Deer	Lake Chelan	6	March 1993	0.081	0.058-0.15	$\pm 0.03$

(1) Calves less than one month old

(2) Calves nine months or older and adults

(3) Yearlings and adults

Elk captured at the HS displayed values significantly higher ( $P < 0.05$ ) than BM elk. Neonate elk captured in the BM in June 1992 exhibited Se levels lower than adults captured in the same area in March 1990 and 1991. Mule deer from the north shore of LC had Se values similar to bighorn sheep values from the SWA and VM. Topography, local flora, and climate are similar among the areas although the sheep were captured at higher elevations.

In this survey several wildlife populations exhibited mean values considered deficient by livestock standards and two had values thought to be adequate. The majority (6) of the populations exhibited mean values suggestive of marginal blood Se levels. The significance of the marginal and de-

ficient values has not been established in wildlife populations in Washington. Reproduction, growth rate and recruitment are areas of interest for future management study.

### Acknowledgements

The authors wish to express their gratitude to personnel from the Washington Department of Wildlife, Pacific Northwest Laboratory, and the Yakama Indian Nation for field assistance. We thank Dave Jessup, Paul Fielder and Rolf Johnson for their manuscript review comments. Highly skilled helicopter pilots Ray Pleasant, Steve Tolle and Bob Chris are truly appreciated for their flying skill and assistance in planning wildlife captures.

### Literature Cited

- Blood, D. C., and O. M. Radostits. 1989. Veterinary medicine: a textbook of the diseases of cattle, sheep, pigs, goats and horses. 7th ed., Bailliere Tindall. London, England. 1502 pp.
- Brady, P. S., L. J. Brady, P. A. Whetter, D. E. Ullrey, and L. D. Fay. 1978. The effect of dietary selenium and vitamin E on biochemical parameters and survival of young among white-tailed deer (*Odocoileus virginianus*). J. Nutr. 108: 1439-1448.
- Fielder, P. C. 1986. Implications of selenium levels in Washington mountain goats, mule deer and Rocky Mountain elk. Northwest Sci. 60: 15-20.
- Flueck, W. T. 1991. Whole blood selenium levels and glutathione peroxidase activity in erythrocytes of black-tailed deer. J. Wildl. Manage. 55: 26-31.
- Jessup, D. A. 1990. Monitoring Health Parameters in California's Elk Herds. Proceedings of the Western States and Provinces Elk Workshop: 92-97.
- Herbert, D. M. 1971. White muscle disease in the mountain goat. J. Wildl. Manage. 35: 752-756.
- Knox, D. P., H. W. Read, and J. C. Peters. 1987. An outbreak of selenium responsive unthriftiness in farmed red deer (*Cervus elaphus*). Vet. Rec. 120: 91-92.
- Mackintosh, C. G., J. Fill and K. Turner. 1989. Selenium supplementation in young red deer (*Cervus elaphus*). N.Z. Vet. J. 37: 143-145.
- Muth, O. H., and W. H. Allaway. 1963. The relationship of white muscle disease to the distribution of naturally occurring selenium. J. Amer. Vet. Med. Assoc. 142: 1379-1384.
- Oliver, M. N., G. Ros-McGauran, D. Jessup, B. Norman, C. Franti. 1990. Selenium concentrations in blood of free-ranging mule deer in California. Trans. West. Sec. Wildl. Soc. 26: 80-86.
- Robbins, C. T., S. M. Parish, and B. L. Robbins. 1985. Selenium and glutathione peroxidase activity in mountain goats. Can. J. Zool. 63: 1544-1547.
- The Merck Veterinary Manual. 1991. Merck and Co. Inc., 7th ed. Rahway, N.J., 1832 pp.
- Tracy, M. L., and G. Moller. 1990. Continuous flow vapor generation for inductively coupled argon plasma spectrometric analysis. Part I: Selenium. J. Assoc. Off. Anal. Chem. 73(3): 404-410.

Received 28 September 1993

Accepted for publication 31 December 1993