Bienn. Symp. North. Wild Sheep
and Goat Council 6: 330 - 335

SIMPLE METHODS OF COMPARING WINTER SNOW CONDITIONS ON ALPINE AND SUBALPINE RANGES OF DALL'S SHEEP AND MOUNTAIN GOATS IN ALASKA

LYMAN NICHOLS, Cooper Landing, Alaska 99572 (Alaska Dept. Fish and Game, ret.)

Abstract: A simple, inexpensive method was designed whereby 1 person could rapidly estimate winter show depth and relative hardness on accessible Dall's sheep (*Ovis dalli*) winter ranges. The method was repeatable and permitted statistical comparisons between areas and years. It also enabled evaluation of snow conditions relative to sheep's foraging ability. Another method utilizing simple aerial photography was used to estimate percent gross snow cover on winter ranges of both Dall's sheep and mountain goats (*Oreamnos americanus*). Again, statistical comparisons could be made between areas and years. Distribution and density of both species were cor-related with percent snow cover.

In examining winter habitats, it is often useful to be able to compare snow conditions between areas, between winters, or in relation to an animal's ability to obtain food. For example, the relationships between snow cover and caribou (*Rangifer tarandus arcticus*) feeding behavior were studied by Pruitt (1981), and between snow cover and feeding strategies of wild mountain reindeer (*R. tarandus tarandus*) by Skogland (1978), while Lent and Knutson (1971) examined muskox (*Ovibos moschatus*)/ snow relationships. The methods used by these investigators, while depicting accurately the variable pro-files of snow layers, were relatively complicated and used expensive instruments such as the ramsonde penetrometer.

During a study comparing 3 herds of Dall's sheep, I needed a simple, economical method by which to compare gross snow conditions between their alpine winter habitats and between years. Also, I wanted to relate snow conditions to the animals' ability to reach forage. The method I developed enabled 1 person to obtain statistically useful data under harsh conditions with relative ease and speed.

In a later study of mountain goats, I needed to compare snow conditions between winter ranges of sub-herds and between winters, but was unable to use the previous method because of difficult topography. I devised another procedure to assess percent snow cover from aerial photographs.

METHODS

Snow Depth and Hardness

This method was described briefly in a previous paper concerned primarily with Dall's sheep management (Nichols 1976). However, I believe

Average percent snow cover and its standard deviation for each area photographed could then be calculated from the 5 transect lines. These, in turn, could be compared with other areas by standard statistical tests.

DISCUSSION

Snow Depth and Hardness

To test the accuracy of the method, 3 simultaneous surveys were done with the stations for each point set at approximately 1 m apart. Analysis of variance showed no difference in either average depth or hardness ($P > 0.25$) between them. I concluded the method was sufficiently accurate to show real differences between areas or survey dates.

On 1 of my study area, I conducted 4 snow surveys throughout a winter (16 Nov., 11 Dec., 31 Jan., and 10 Mar.) to learn what changes occurred over time and to see whether there was any preferable time period in which to do annual surveys. Snow depth and hardness increased significantly ($P < 0.05$) between the first 2 surveys, and hardness increased ($P < 0.01$) between the second and third. There was no difference found ($P > 0.10$) in either parameter between the last 2 surveys despite several heavy snowfalls. I concluded that in this area, snow accumulated on these exposed ridges until it crusted from wind-packing or thawing and refreezing. After a sufficiently hard crust was formed and colder mid-winter temperatures stabilized, further accumulation was removed from the smooth, crusted surface by wind action. Therefore, snow surveys were conducted annually between late January and early March when I assumed conditions would be sufficiently stable to be representative. Using this technique, I was able to compare successfully and relatively easily snow depth and hardness between areas and years.

One weakness in the method was that with the scale used, I was able to measure snow hardness only to a maximum of 36.4 kg/cm^2 (516 lb/in^2). Any ice layers encountered that could not be penetrated with this pressure were recorded as having a hardness of 36.4 kg/cm^2, thus underestimating average snow hardness. This occurred rarely unless the majority of the snow cover was so hard that sheep could not paw through anyway.

Hardness and depth measurements taken in undisturbed snow around sheep feeding craters that were successfully pawed to forage level ($N = 61$) or were attempted but unsuccessful ($N = 15$) were compared. Indices attained by multiplying mean depth by mean hardness were plotted by frequency of occurrence (Fig. 1) and suggested that below an index of 60, all pawing was successful while above an index of 179, no pawing was successful. Thus, average snow conditions as determined by this method could be used to compare or predict winter severity relative to the animals' ability to reach snow-covered forage.

Average winter snow indices over a period of 5 years were compared with lambing success the following spring on 3 herds of Dall's sheep under study (Fig. 2). A significant negative correlation was found between an increasing index (mean depth x mean hardness) and lambing success ($P = 0.02$).

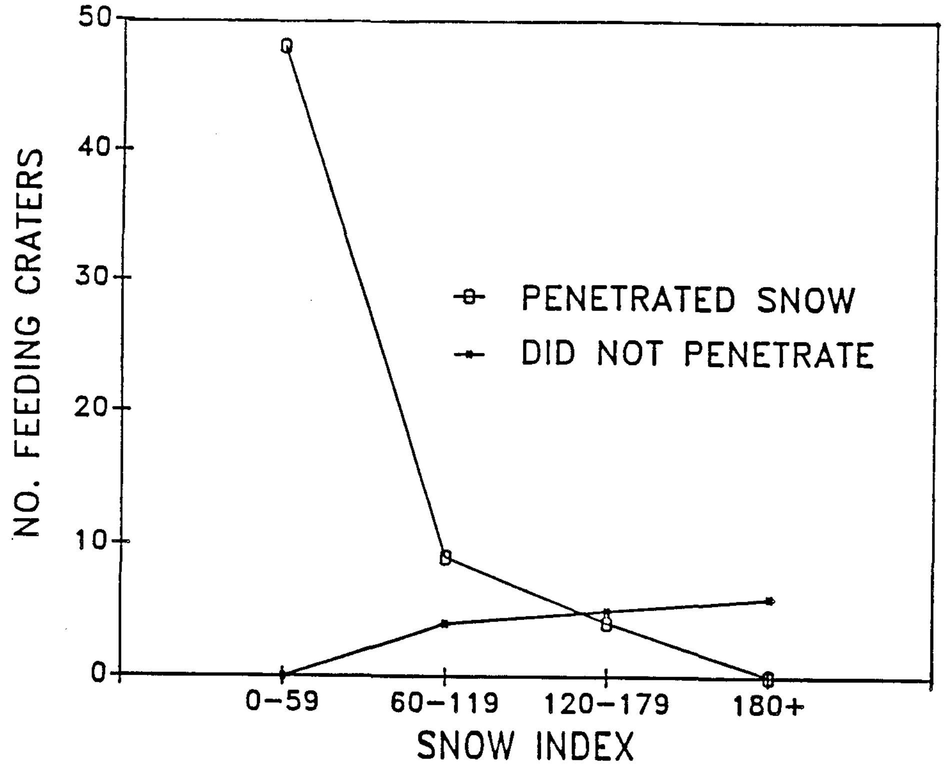

Figure 1. Dall's sheep ability to paw feeding craters through snow as indicated by measurements adjacent to craters. (Snow Index = mean snow depth x mean snow hardness)

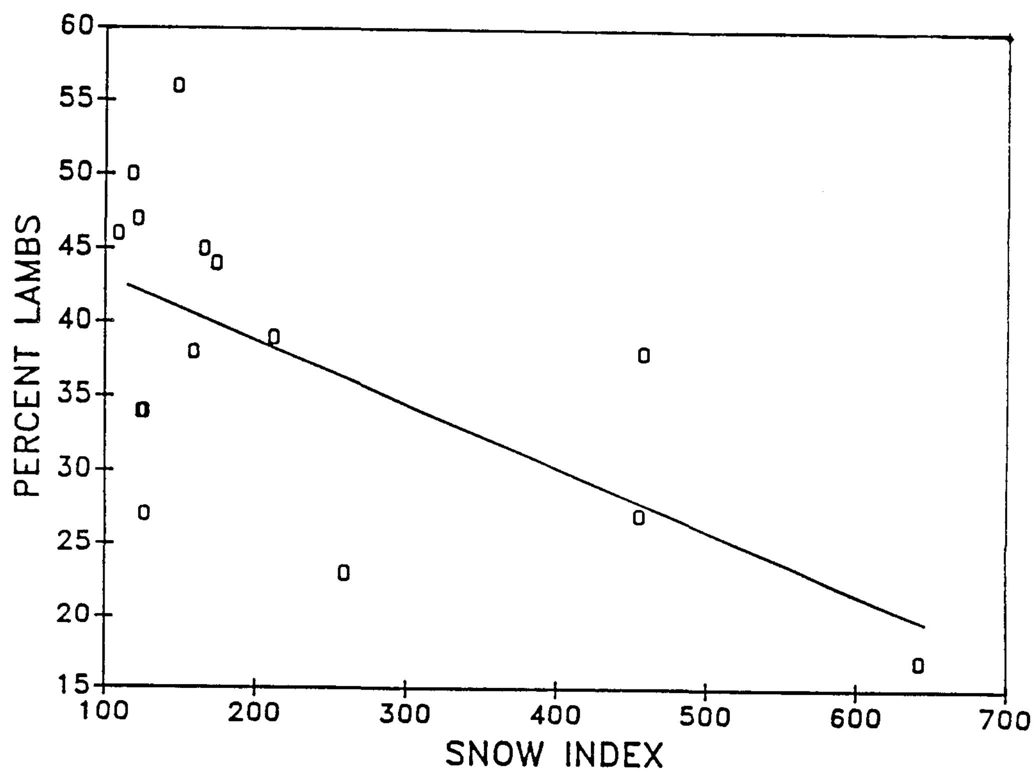

Figure 2. Relationship of snow index (mean snow depth x mean snow hardness) to the ratio of lambs per 100 ewes the following spring. Three Dall's sheep herds over 5 winters (df=13, r=0.6208, P=0.02)

Percent Snow Cover

The 5 transect lines drawn on each photograph proved adequate for estimating percent snow cover on the slope photographed. No improvement in accuracy could be detected by using 10 lines.

Statistical analyses showed that both differences and similarities in snow cover could be demonstrated within and between portions of both sheep and mountain goat winter ranges by this method, and between years. Results appeared to agree closely with observations of winter distribution and abundance and helped explain why most animals used, or did not use certain portions of their habitat.

Average percent snow cover over a 3-year period was examined for the species using each general winter range. Snow cover was higher on ranges used by both sheep and goats than on that used only by sheep ($P < 0.005$), and higher still on ranges used only by goats than on that used by both sheep and goats ($P < 0.001$). Thus, it appears that sheep distribution is limited by average winter snow cover, and that goats can tolerate much higher snow cover than sheep.

Both technique described have been demonstrated to provide useful management and research information about mountain big game in winter. Both are simple to use, fast, and relatively economical; they should be adaptable to other areas and studies.

LITERATURE CITED

Hoefs, M. and I. McT. Cowan. 1979. Ecological investigation of a population of Dall sheep. Syesis 12 (supp. 1):1-81.

Lent, P. C. and D. Knutsen. 1971. Muskox and snow cover on Nunivak Island. Pp. 50-62 in A. D. Haugen, (Ed.), Symposium on snow and ice in relation to wildlife and recreation. Iowa State Univ. Press, Ames. 280 pp.

Nichols, L. 1976. An experiment in Dall sheep management: progress report. Pp. 16-34 in E. Decker, (Ed.), Trans, Second N. Amer. Wild Sheep Conf. Denver, CO. 97 pp.

Pruitt, W. O. 1981. Application of the Varrio Snow Index to overwintering North American Barren-ground Caribou (*Rangifer tarandus arcticus*). Can. Field-Nat. 95:363-365.

Skogland, T. 1978. Characteristics of the snow cover and its relationship to wild mountain reindeer (*Rangifer tarandus tarandus* L.) feeding strategies. Arctic and Alpine Res. 10:569-580.

NORTHERN WILD SHEEP AND GOAT COUNCIL

Proceedings of the Sixth Biennial Symposium

APRIL 11-15, 1988
Banff, Alberta

Edited by W.M. Samuel

Northern Wild Sheep and Goat Council

Attention: Jon Jorgenson
Alberta Fish and Wildlife Division
#200 Sloane Square
5920-1A St. S.W.
Calgary, Alberta T2H 0G1

Price: $20.00
Cheque payable to
Northern Wild Sheep and Goat Council

The Northern Wild Sheep and Goat Council is a nonprofit professional organization that developed in 1978 from the parent organization - The Northern Wild Sheep Council.

Hosted by:

The Alberta Fish and Wildlife Division

Alberta
FORESTRY, LANDS AND WILDLIFE
Fish and Wildlife