SURVEYING SNOW IN ARCTIC ALASKA TO DETERMINE ITS EFFECTS ON REINDEER HERDING 1/

By

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Introduction

Reindeer herding in Western Alaska is being upgraded with the introduction of modern management techniques. Alaskan Eskimos intend to increase their herds to augment subsistence dependency on a dwindling caribou population. The Soil Conservation Service (SCS), is preparing a management plan based on rotation grazing cycles of the winter ranges. Winter range, which is recognized (Preston, et al. 1977) as the limiting factor, is further limited by the overlying snow cover.

Reindeer, Cattle of the Arctic

Reindeer herding in western Alaska has a long and interesting history. Reindeer were introduced from Siberia in the 1890's as part of a federal project to provide a source of meat, milk, clothing, and transportation for Alaskan Eskimos. Reindeer are actually domesticated caribou. Centuries of breeding, however, has produced a noticeably smaller and more compact animal. For some time the industry flourished, and at its peak in the 1930's there were estimated to be more than one-half million reindeer in the Territory of Alaska. Then came a sharp decline brought on, in part, by a change in federal policies, bad weather, overgrazing, and poor market conditions. By 1950 the number had dwindled to a low of approximately 25,000 (Brickley and Brickley 1975).

Herding has always been important in managing reindeer. L. J. Palmer, acknowledged reindeer expert, said, "In the absence of proper herding, suitable management practices are, of course, impossible." (Pegau 1968) Reindeer would simply join wild caribou herds if they were not prevented from doing so. Palmer proposed rotational use of the range as early as 1945.

The Northwest Alaska Native Association (NANA), one of the 12 regional native corporations born out of the Alaska Native Claims Settlement Act of 1971, has recently renewed interest in the industry. NANA would like to manage reindeer scientifically for maximum red meat production. In 1975 NANA requested planning assistance from SCS. With help from the University of Alaska Geophysical Institute, SCS made a range and soil inventory of 1.9 million hectares on the Seward and Baldwin Peninsulas during the 1976 summer season. Landsat imagery and helicopters were used in this joint effort.

Physical Setting

The study area (fig. 1) consists of the major part of four reindeer grazing permits that extend north from the Continental Divide on the Seward Peninsula to Kotzebue Sound, including all of Baldwin Peninsula. The area is approximately 200 km from east to west and 100 km from north to south, and is slightly smaller than the state of New Jersey. The terrain consists of lowlands in the vicinity of Kotzebue Sound, rising to rolling hills and rocky uplands that reach an elevation of 600 m near the divide. Ninety-five percent of the area is barren tundra.

The main population center in the area is Kotzebue, the regional commercial and transportation center, with a population of 2,200 (Arctic Environmental Identification and Data Center 1976). The villages of Deering and Buckland have populations of 95 and 140, respectively; Candle, an active mining community, is not occupied during the winter. Except for occasional single dwellings, the rest of the region is uninhabited.

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Climate

The climate is transitional among Arctic, continental, and maritime. In winter, sea ice restricts the moderating influence of the sea, resulting in cold temperatures characteristic of areas further inland. Still, southwesterly winds have brought maximum temperatures above $0^{o}C$ at times during the winter. Rainfall is not uncommon at these times, which can result in a hard ice layer in the snowpack. In general, however, winters are cold and relatively dry, have much clear weather, and have prolonged periods of high winds and blowing snow (Watson 1959).

Mean monthly temperatures range from $12^{o}C$ in July to $-21^{o}C$ in January (table 1). Precipitation records at Kotzebue indicate an annual moisture fall of about 21 cm, but this is a conservative figure, because the winter records are unreliable. In 1975, snow gages protected by Wyoming wind shields (Rechard and Larson 1971) were introduced to the North Slope. These gages indicate that the region receives three to five times more winter precipitation than the amounts reported by the Barrow and Barter Island weather stations (Francis 1976).

Surveying the Arctic Snowpack

To determine initial stocking rates for reindeer, SCS range scientists wanted to know what percentage of the winter range would be unavailable for foraging because of the depth or hardness of the snow cover. They also wanted to know how long these limiting conditions would persist. Existing data and past research provided few clues, but Benson (1969) showed that wind was the dominant element of the tundra.

In August 1976, the author established three transects in the upper part of the Kugruk River Basin between Imuruk Lake and Independence Mine, an area of approximately 16 km by 16 km. The transects run perpendicular to prominent ridges, traversing them from the valleys on both sides. They avoid obvious drift inducers such as rock outcrops and brush. The distance between end points is about 3 km and the range in elevation is about 150 m. The ridges are oriented in different directions: one extends from north to south; one east to west; and the other northwest to southeast. All three are fairly free of other wind-influencing terrain in their vicinity. This configuration provided slopes facing all directions, so that the various wind-induced effects could be evaluated.

A Wyoming precipitation gage was installed at Independence Mine along with a conventional snow course that was located in a small balsam poplar stand. A snow survey party, consisting of an SCS range scientist, a Bureau of Land Management hydrologist, three reindeer herders, and the author, visited the transects in mid-March Of 1977. The instruments we used were a RAM penetrometer and a federal snow sampler. The RAM delineates the location, thickness, and relative hardness of the layers within the snow profile, in kilograms of resistance. Numerous RAM soundings and snow samples were taken on each aspect along the transects.

Despite the wind blowing hard and often and for lengthy periods, the survey party observed far fewer drifts and scours than they had expected. We observed them at rock outcrops, riverbanks, and areas of low brush and in the villages. The tundra, which covers the rolling, rounded ridges and broad valleys, was free of major drifting. Snow depth along the transects was surprisingly consistent. All RAM and federal sampler measurements were between 30 and 65 cm. (The bottom of the snowpack does not necessarily rest on the ground surface. In many places it is supported by the tops of tussocks, which form a dense and fairly uniform surface.) Even the snowpack water content and average snowpack density readings were fairly consistent (table 2). A dense but thin layer did not seem to add significantly to the overall snowpack density.

The real discrepancy between slope aspects was found in the layers of the snow profile. Extremely hard yet relatively thin layers were found on some aspects. Other aspects typically had internal wind slabs of different hardness and at different depths. Figures 2 through 7 display RAM soundings that are representative of some of the aspects. Although considerable variation occurred at each sample point and at each aspect, the RAM pictures, overall, for each aspect were different from the others.

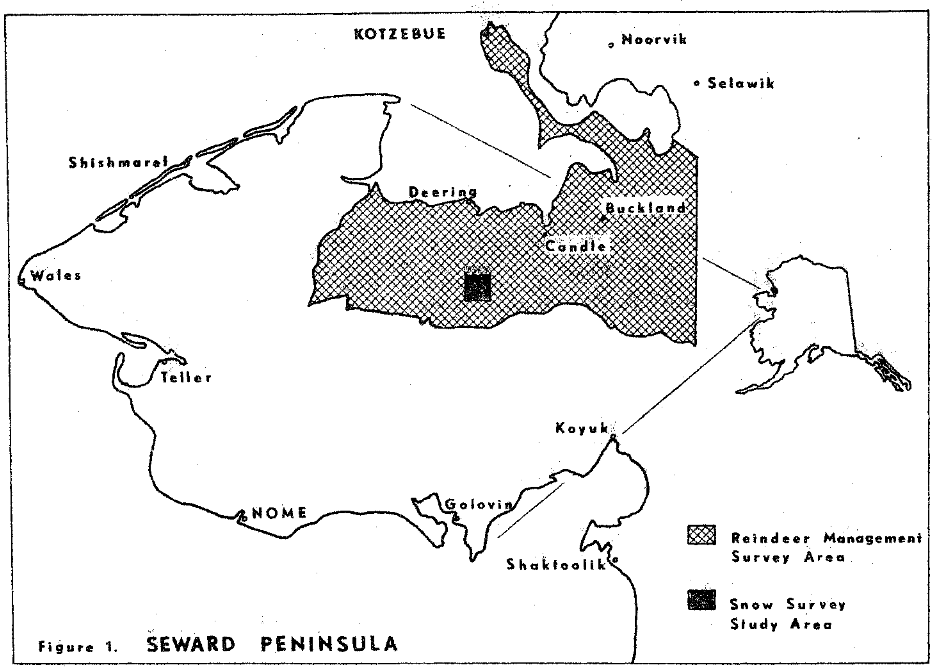

Figure 1. SEWARD PENINSULA

Table 1. Mean monthly temperatures, precipitation, and snowfall, Kotzebue, Alaska. [1943 - 1960 1/]

Month	Average daily temperature Maximum	Minimum	Mean	Precipitation (rain & snow)	Snowfall
	°C			mm	cm
January	-17.0	-24.8	-20.9	9.9	13.7
February	-16.2	-24.5	-20.0	7.6	12.2
March	-13.3	-23.1	-18.9	7.1	13.7
April	- 5.6	-16.2	-10.4	7.9	8.9
May	3.5	- 4.3	- 0.6	8.4	2.5
June	9.8	3.1	6.6	12.4	0.3
July	14.9	8.6	11.5	37.1	T 2/
August	12.8	7.4	10.3	54.8	T
September	7.6	1.8	4.9	31.0	2.8
October	- 1.6	- 7.0	- 4.1	15.0	13.7
November	-10.1	-16.3	-13.7	9.1	19.0
December	-16.6	-23.5	-19.8	7.4	16.0
Mean annual	- 2.6	- 9.9	- 6.3		
Totals				207.8	102.8

Table 2. Summary of federal snow sampler measurements.

Location	Average depth cm	Average water content mm	Average density g/cm^3	Snow characteristics
Valley	59	130	.22	Consistent depth, variable hardness.
North slopes	54	107	.20	Fairly consistent depth, variable hardness.
West slopes	57	142	.25	Fairly consistent depth, variable hardness.
East slopes	34	89	.225	Scoured, highly variable depth and hardness.
South slopes	36	86	.24	Fairly consistent depth, highly variable hardness but consistently very hard.
Ridgetop	43	99	.23	Fairly consistent depth, hardest of all slopes.
Independence Mine snow course	61	137	.225	Snow course and cottonwood stand appear slightly loaded. Drifts present downwind of stand.
Independence Mine Wyoming gage	---	94	---	Precipitation caught between 9/18/76 and 3/16/77.

1/ Data from U.S. Weather Bureau, Anchorage, Alaska

2/ Trace

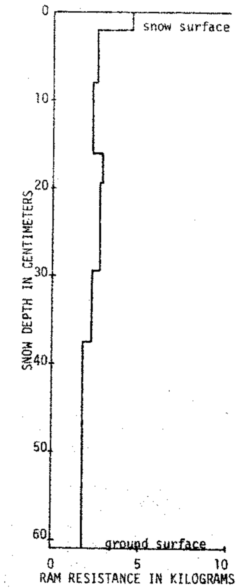

Figure 2. North-facing slope.

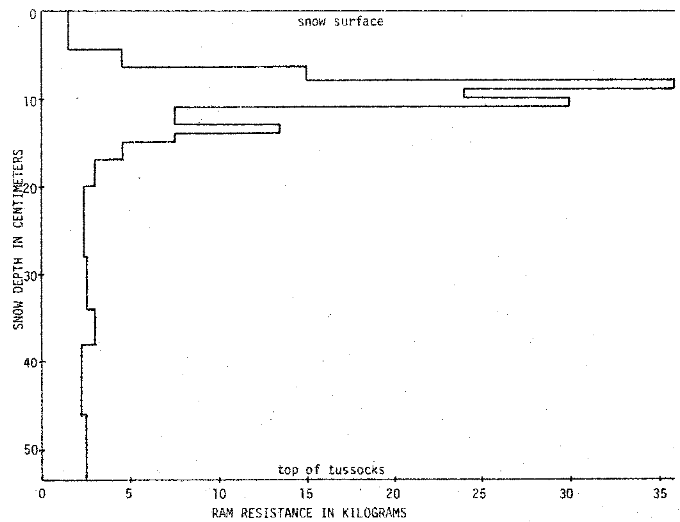

Figure 3. South-facing slope.

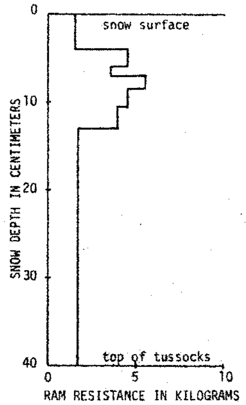

Figure 4. East-facing slope, scoured part.

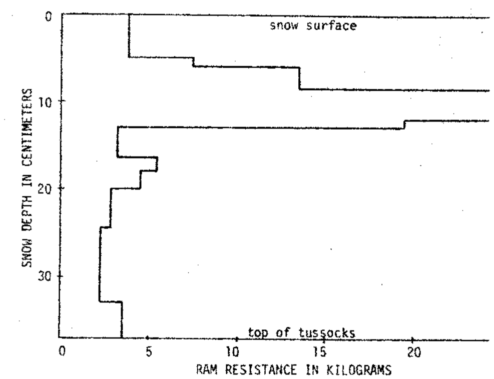

Figure 5. East-facing slope, drifted part.

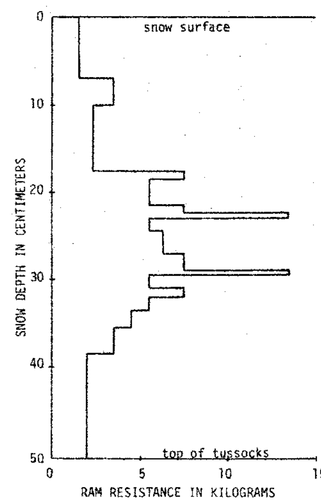

Figure 6. West-facing slope.

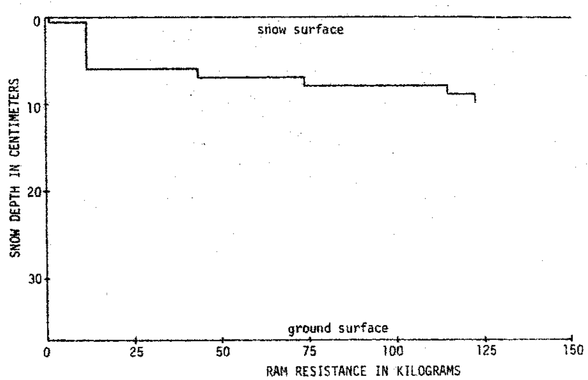

Figure 7. Ridgetop. Sample terminated after 24 hits from a height of 60 cm by 1/2-kg weight produced only 1 cm penetration.

The limited data retrieved so far do not lend themselves to averaging the RAM resistance figures. In fact, not nearly enough data were collected to make any kinds of statistical analyses or come to any solid conclusions. And these data represent only 1 year.

The survey party determined, however, that 5 kg of resistance is about the minimum snow firmness that will support a man's weight without snowshoes. Doug Sheldon, a reindeer herder and member of the survey party, observed that a crust of 5 kg resistance would not restrict a foraging herd. However, he also observed that reindeer would not attempt to forage in an area with a snow crust of about 9-10 kg resistance unless the animals were suffering extreme hunger. Whether they could survive under this condition is unknown. Snow layers with resistance of 15 kg are very hard and represent conditions under which reindeer could certainly not survive even if they could paw through the crust. The energy expended to get to the feed would be far greater than the feed would provide.

The data from the 1977 survey gave a good overall picture of the snowpack in the upper Kugruk Basin. All south-facing slopes and ridgetops had one to several snow layers of at least 15, but more often 25 to 35 kg resistance. Resistance on north-facing slopes was generally no greater than 5 kg. Resistance in the valleys and the east- and west-facing slopes was somewhere in-between.

East slopes were visibly rippled with miniature scours and drifts. The snow surface on other slopes was quite "smooth" in appearance. On the east slopes the tiny drifts were hard, like those on the south slopes, while the troughs or scour areas were soft, like the north slopes. Each condition represented roughly half of the total east slope area.

On the west slopes, the hardest snow layers were deeper, thicker, and less hard than those on south slopes and hard parts of east slopes. It's possible these differences were due to a strong westerly wind that occurred during a storm period earlier in the winter.

Preliminary inferences relating to the whole study area are unmistakable. The windward slopes (south-facing in 1977) and ridgetops represent at least 25 percent (but probably more because of the transition from south to southwest and southeast slopes) of the total hectares. They would probably be unavailable for a large part of every winter. This is offset somewhat by two things: 1) these hectares can be used early in the winter, however, until the crust becomes so hard that reindeer are forced off; and 2) they are also the very first to bare up in late winter due to increasing sublimation rates as temperatures approach $0^{o}C$.

Lee slopes (north-facing in 1977) and valley bottoms, which make up about 25 to 30 percent, are probably available all winter every year. But the other slopes (east- and west-facing in 1977) are a big question mark. Much of this large area may have been unavailable for at lease part of the 1977 winter. Half the area of the east slopes was very hard, and west slopes were in a range of hardness we thought was marginal for utilization.

Conclusion

The 1977 survey is best considered a reconnaissance survey. It provided enormous insight into the problem but presented more questions than it answered. Additional surveys should be made near the foraging herds. It is important to establish the resistance at which the crust becomes too hard for the reindeer. Herders, then, could measure marginal areas and determine whether thay are currently too hard or not. A key to the overall reindeer management plan is the availability of the marginal areas.

A true hardness factor for a certain slope is probably the result of the total area under the curve. A thin hard layer may not pose so great a problem as a thicker but less hard layer. Wind data need to be included in the analysis, for we know that wind correlates with hardness.

The range scientists hope to refine the reindeer management plan over the years to ultimately put the maximum number of reindeer safely and efficiently on the range. In order to accomplish this, more years of snow surveys are needed to determine the average duration of unavailable hectares and the average total hectares unavailable. Averages for total snowfall, wind speed, and direction would be valuable, too. The ultimate plan may address the range carrying capacity and occurrence interval of severe winters with a plan of action to cope with such winters. This would allow the herders to run more animals than a plan based on average conditions would permit.

The reindeer industry has a bright outlook for the future. It will provide a stable and reasonably priced source of red meat for 5,000 residents of the northwest region. In addition, the management plans being prepared on the Seward Peninsula represent only a fraction of the total area devoted to reindeer herding in western Alaska.

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