RECONNAISSANCE SNOW SURVEY OF THE NATIONAL PETROLEUM RESERVE IN ALASKA, APRIL-MAY 1979

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Moderately low snowfall and an early and abrupt spring thaw resulted in removal of most of the snow cover from the National Petroleum Reserve in Alaska before the snow survey of April 30 through May 2, 1979. Logistical problems and lack of snow permitted sampling at only seven sites. The average snow depth (0.263 meter) was approximately 60 percent of that measured in the 1977 and 1978 surveys. Snow density in 1979 averaged 337 kilograms per cubic meter, and water equivalent averaged 0.088 meter. These two values are about 110 percent and 70 percent, respectively, of values for those characteristics in 1977-78. The average temperature of -5.2° Celsius at the base of the snowpack was about 6° Celsius higher than in the previous surveys. Extensive recent slab avalanche activity was noted in the Brooks Range.

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Water Resources Investigations 80-49

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1980

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

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Multiply	By	To obtain
millimeter (mm)	0.03937	inch (in.)
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
cubic meter (m^3)	35.31	cubic foot (ft^3)
kilogram (kg)	2.205	pound (lb)
square kilometer (km^2)	0.3861	square mile (mi^2)

degrees Celsius (C) = [degrees Fahrenheit (F) - 32]/1.8

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ABSTRACT

Moderately low snowfall and an early and abrupt spring thaw resulted in removal of most of the snow cover from the National Petroleum Reserve in Alaska before the snow survey of April 30 through May 2, 1979. Logistical problems and lack of snow permitted sampling at only seven sites. The average snow depth (0.263 meter) was approximately 60 percent of that measured in the 1977 and 1978 surveys. Snow density in 1979 averaged 337 kilograms per cubic meter, and water equivalent averaged 0.088 meter. These two values are about 110 percent and 70 percent, respectively, of values for those characteristics in 1977-78. The average temperature of -5.2° Celsius at the base of the snowpack was about 6° Celsius higher than in the previous surveys. Extensive recent slab avalanche activity was noted in the Brooks Range.

INTRODUCTION

The reconnaissance survey of snow depth, density, and distribution was made to provide information for management of snow resources and to better identify precipitation quantity and distribution in the National Petroleum Reserve in Alaska (NPRA). The location of NPRA and the sampling sites are shown in figure 1. Results from this and earlier surveys (Sloan, Trabant, and Glude, 1979) can be used to identify general snow distribution patterns and pick out areas with significant year-to-year variations.

This third annual snow survey of NPRA was made from April 30 through May 2, 1979. Because much of the snow had melted, the survey was reduced to a brief overview of snow cover. An airplane ski was damaged on the second landing; thereafter ground observations and measurements were limited to places safe for landings on wheels. This prejudiced sample site selection and greatly reduced the number of sites visited.

Methods of measurement at the sites were the same as those used in the 1977 and 1978 snow surveys (Sloan, Trabant, and Glude, 1979). Depth measurements were made by probing about 40 points at each site so that the effects of snow and ground surface irregularities could be minimized. Snow density measurements were made on vertical cores obtained with an Østrem sampling tube in the side of a single snow pit at each site. Observations from the airplane and study of TIROS weather satellite images were used to estimate snow-cover distribution over the areas not sampled.

SNOW DEPTH, DENSITY, WATER EQUIVALENT, AND TEMPERATURE

Measurements at the seven sites (table 1) confirmed the visual observations of thin snow cover. The average snow depth (0.263 m) was approximately 60 percent of that measured in the 1977 and 1978 surveys; the average density (337 kg/m³) was approximately 110 percent, and the average water equivalent (0.088 m) was approximately 70 percent of the two previously measured snow covers. The average temperature of -5.2°C at the base of the snowpack was about 6°C higher than in the previous surveys.

SNOW STRUCTURE

The typical windslab over depth hoar snow structure found throughout NPRA in the previous snow surveys was present in 1979; however, most of the fine-grained windslab had been modified by the refreezing of meltwater to coarse-grained equitemperate snow containing ice layers. Ice layers up to 10 mm thick were present within the windslab at Inigok, Ikpikpuk, and Lookout River (sites 5, 6, and 7). At the Inigok and Lookout River sites, there were two distinct ice layers 40-80 mm apart. The top ice layer was 10-60 mm beneath the snow surface. At the Ikpikpuk site, a single ice layer was found about 40 mm below the surface. Depth hoar was well developed at all sites. Depth hoar crystals were estimated to be 5-15 mm in diameter. The

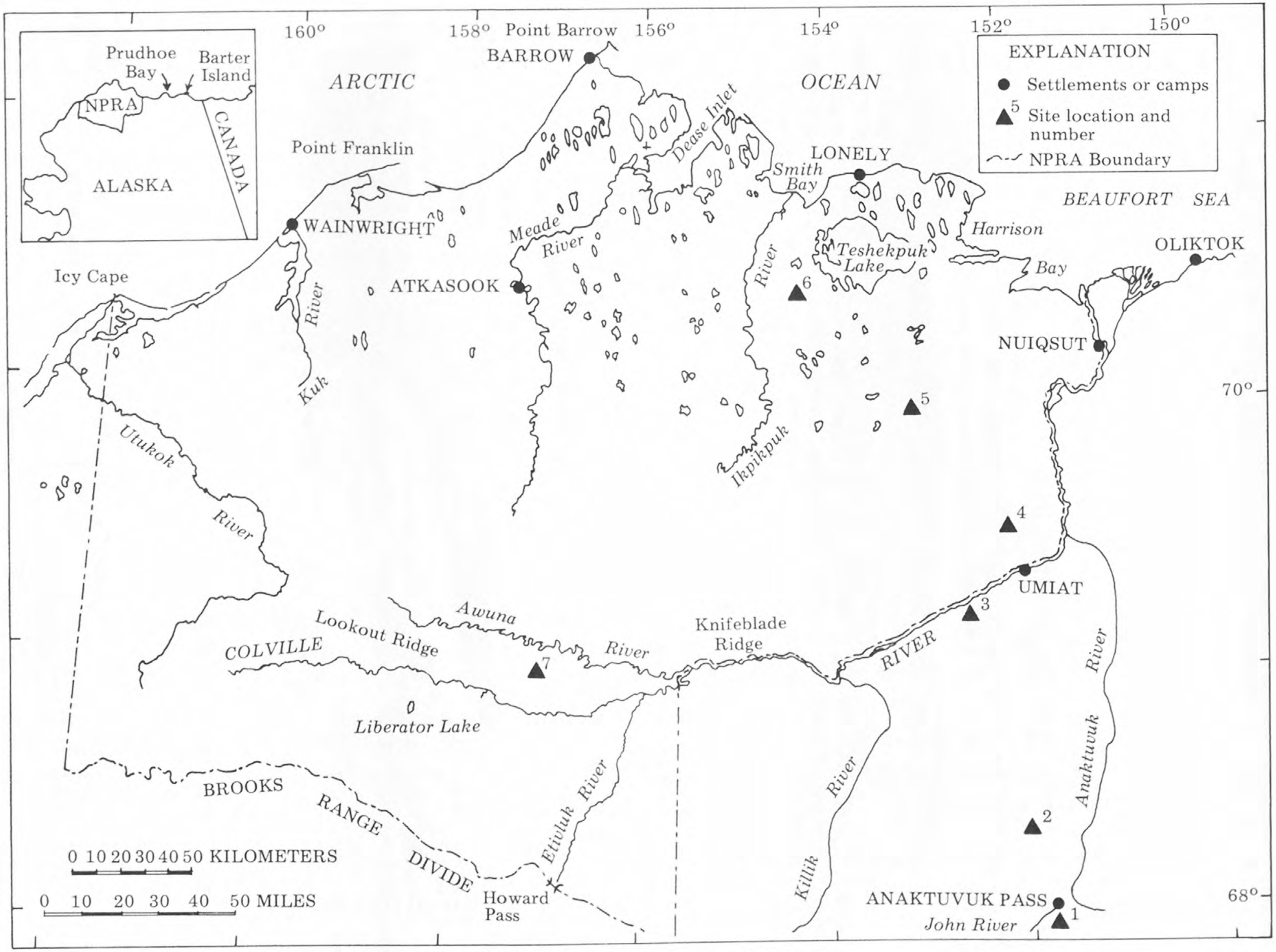

Figure 1.--Location of National Petroleum Reserve in Alaska and the sampling sites.

Table 1.--Reconnaissance snow survey data, NPRA, April-May 1979.

Site No.	Location N lat	Location W long	Name	Approx. altitude (m above NGVD)	Site description	Date	Depth (m)	Density (kg/m³)	Water equiv. (m)	Basal snowpack temp. (deg. C.)
1	68°08'	151°44'	Anaktuvuk Pass (Soil Conservation Service snow course)	640	Willows next to airstrip	4-30	0.341	315	0.107	-1.0
2	68°21'	151°58'	Confusion Creek	825	Rolling upland tundra	4-30	.301	314	.095	-3.0
3	69°14'	152°17'	Nakaktuk Lakes	200	Rolling upland tundra	4-30	.243	335	.081	-1.5
4	69°36'	152°05'	Dogbone Lake	100	Rolling upland tundra	5-2	.188	410	.071	-7.5
5	70°00'	153°06'	Inigok well site	40	Coastal plain tundra	5-2	.261	324	.085	-9.5
6	70°29'	154°21'	Ikpikpuk well site	3	Coastal plain tundra	5-2	.205	326	.067	-6.0
7	69°03'	157°10'	Lookout River	290	Rolling upland tundra	5-2	.300	337	.101	-8.0
					Average		.263	337	.087	-5.2
					Standard deviation		.055	38	.015	3.4

structure of the snowpack was rapidly being obliterated by extensive melting.

SNOW-COVER DISTRIBUTION

The distribution of snow cover in NPRA at the time of the survey is best shown by satellite photo (fig. 2). The areas of most continuous cover were the south side of the Brooks Range divide (fig. 3), the foothills north of the Colville River, the foothills along and east of the middle portion of the Anaktuvuk River, and the coastal area near the mouth of the Utukok River in the west. Snow covered an estimated 80 to 95 percent of the parts of these areas that were flown over during this survey.

Moderate snow cover appeared to be present over most of the coastal plain (figs. 4 and 5). Similar snow cover occurred in a swath 24 to 80 kilometers wide south of the Colville River and west of the Killik River and in the mountains and higher foothills of the north side of the Brooks Range. Our airborne observations indicated large variations in these areas; in some places snow covered 30 percent of the ground, in others, up to 75 percent. Shallow, discontinuous snow cover was seen along the foothills from the middle and upper Utukok River east to the Meade River and in a prominent band along the northern foothills of the Brooks Range, where snow covered an estimated 10 to 25 percent of the ground. The snow cover was almost gone in the larger river valleys on the north side of the Brooks Range (fig. 6). The association of relatively thin and discontinuous snow cover with large river valleys extended well north of the mountain front. Snow cover was estimated to range from less than 5 percent up to 15 percent along the north side of the Brooks Range from the Etivluk River to the Killik River.

Ridges in the northern Brooks Range and foothills, such as those near Howard Pass shown in figure 7, displayed pronounced differences in snow cover between the northern exposures and the southern exposures. This pattern was probably caused by a combination of transport of snow by the prevailing southerly winds over the mountains during the winter and by differential ablation in the spring. A similar pattern was observed in the 1977 and 1978 snow surveys.

AVALANCHE ACTIVITY

Extensive recent slab avalanche activity was evident in the Brooks Range. This was in sharp contrast to observations earlier in the melt season in 1977 and 1978 when virtually no avalanches were detected. Avalanches were particularly common in the deeper snowpack on northeast to northwest exposures on the south side of the Brooks Range (fig. 3), but they were evident throughout the mountains and foothills. Most of the avalanches appeared to be a combined result of warm weather, a fairly recent snowstorm, and strong south winds which caused pronounced drifting and deposition of highly unstable windslabs on north-facing slopes. Snow on slopes that

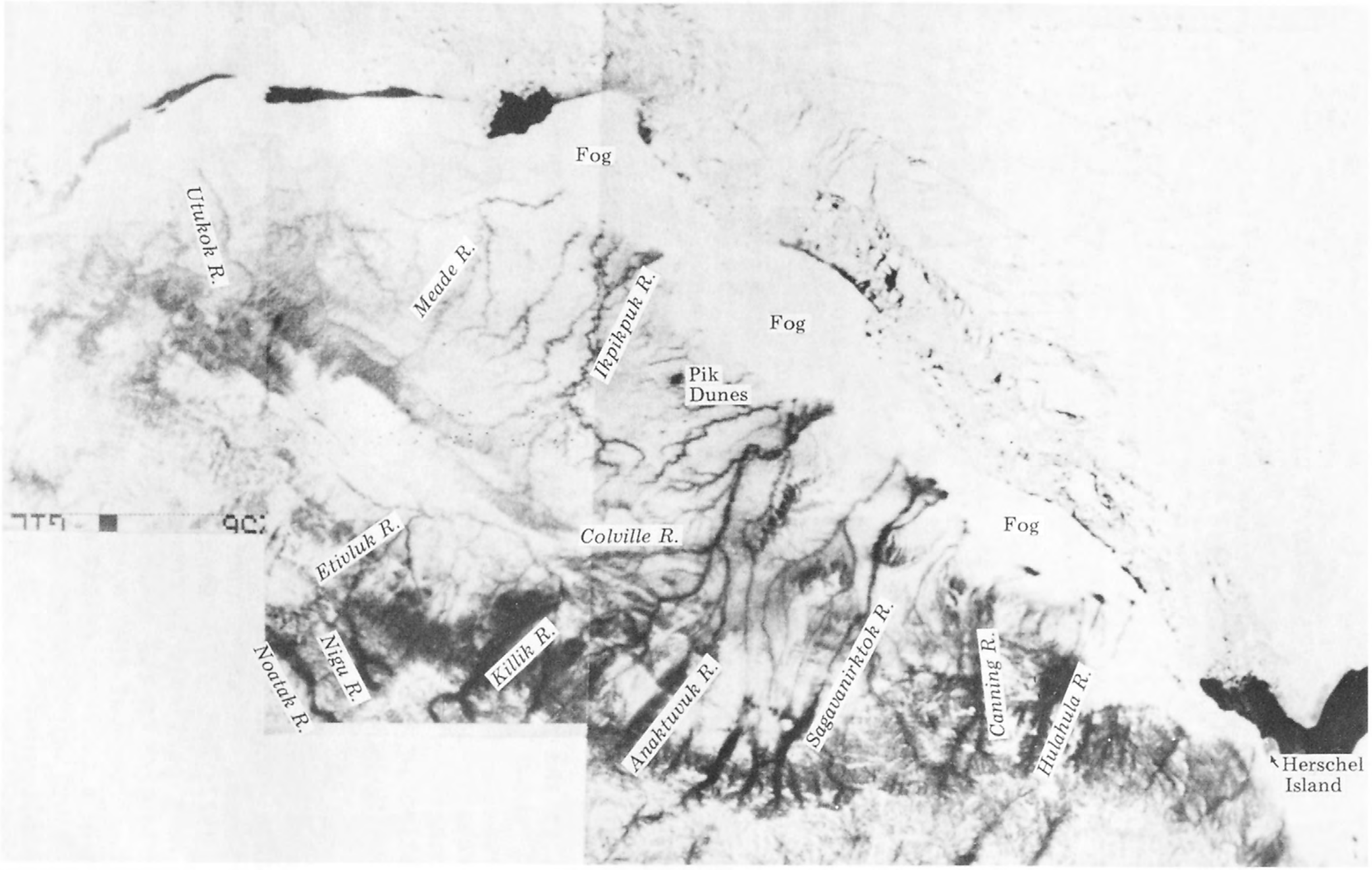

Figure 2.--TIROS weather satellite image showing snow-cover distribution on the Arctic Slope on May 2, 1979 at 2:51 p.m. local time. Scale is approximately one to three million. Image courtesy of National Weather Service.

Figure 3.--Heavy snow cover on the south side of the Brooks Range divide, in the upper Noatak River drainage. A recent slab avalanche is visible in the foreground. Debris from avalanches earlier in the winter is visible on the slopes in the background. Altitude of peaks is about 2,000 meters.

Figure 4.--Moderate snow cover on the Arctic coastal plain north of Umiat, between sample sites 4 and 5. Photo taken May 2, 1979. Small polygons are about 10 meters across.

Figure 5.--River channel on the Arctic coastal plain north of Umiat, between sample sites 4 and 5. Wind erosion of snow and windblown sand from exposed riverbed has produced bare, dark areas that are easily visible on the satellite image (fig.2). Photograph was taken on May 2, 1979. View to the southwest. Dark area of valley in foreground is about 300 meters wide.

Figure 6.--Snow cover is the Nigu River valley. Snow cover was thin in many areas where more snow cover was observed in 1977 and 1978. Photograph taken May 1, 1979. View to southeast. River channel in foreground is about 50 meters wide.

Figure 7.--Pronounced differences in snow cover on ridge near Howard Pass. Thicker snow is on the north-facing slopes (north to left). Photograph taken May 1, 1979.

appeared to be only 15 to 20 degrees had fractured and slid several meters, and avalanches that ran several hundred meters had occurred on slopes that appeared to be in the 20-30 degree range. Although the initial crown (fracture) surface of most of the avalanches was confined to the most recent snow layer, which appeared in many places to be as thin as 0.1-0.2 m, it was common to see slab failure of a succession of underlying layers within several hundred meters downslope. Many avalanches of this type involved the entire snowpack. The relationship of avalanche activity to snowpack structure was unclear because it was not possible to land and observe the structure.

CAUSES OF OBSERVED SNOW-COVER DISTRIBUTION

Records from Wyoming precipitation gages operated by the Soil Conservation Service at eight Arctic Slope locations (Clagett, 1977-79) show average winter precipitation of 11.2 cm in 1976-77, 8.9 cm in 1977-78, and 11.7 cm in 1978-79. The Wyoming gages at Barrow, Meade River, and Prudhoe Bay (fig. 1) show average winter precipitation of 11.4 cm in 1976-77, 8.4 cm in 1977-78, and 9.1 cm in 1978-79.*

Long-term weather records for Barrow (in the files of the Arctic Environmental and Information Data Center in Anchorage) show a 56-year average annual snowfall of 70.4 cm, including summer snowfall. Snowfall was 66.6 cm in 1976-77, 46.2 cm in 1977-78, and 53.3 cm in 1978-79. Annual snowfall at Barrow in 1978-79 was 76 percent of the 56-year average.

Weather records for Barrow, Barter Island, and Umiat (National Weather Service, 1976-79) show average maximum April-May snow depth on the ground of 36.3 cm in 1976-77, 34.8 cm in 1977-78, and 36.3 cm in 1978-79.

The average open-tundra water equivalent measured in U.S. Geological Survey snow surveys for NPRA was 0.12 m in 1977, 0.14 m in 1978 (Sloan, Trabant, and Glude, 1979) and 0.09 m at the seven sites visited in 1979. While not conclusive, the above data tend to support our observation that snowfall in 1978-79 was relatively light.

National Weather Service records for Umiat (National Climate Center, 1976-79) indicate an average daily temperature of -29°C (-23°C average daily high, -36°C average daily low) for the 7-day period of April 12 through 18. On April 18, 1979, the high was -18°C, the low -28°C. On April 19, the high was -8°C; the low -20°C. On April 20, the high was 4°C; the low -18°C.

*National Weather Service climatic records are expressed in inches of precipitation and degrees Fahrenheit. Conversions were made to metric units for consistency in this report.

Daily highs were at least 0°C (up to 9°C) for the remainder of the month, and daily lows did not fall below -12°C. The snow depth was 48 cm on April 20, when the thaw began. By April 29, there was no snow left at Umiat. Other than a trace of snow on April 19 and 20, there was no precipitation recorded during the thaw period.

These figures support our observation of a very abrupt spring thaw in 1979. Oral reports from industrial workers in the area agree with this observation.

We conclude that the lack of snow recorded in the 1979 snow survey was due to a combination of moderately low snowfall and a relatively early and abrupt spring melt. More specific conclusions do not appear to be justified by the available data.

RECOMMENDATIONS

If snow surveys in the Brooks Range and Arctic Slope are scheduled too early, significant late-season snowfall may be missed. Yet, as the 1979 surveys shows, almost all the snow may have melted if the survey is one week too late. We suggest that snow surveys in this area be scheduled no later than April 15 in order to minimize the risk of surveying after an abrupt thaw. Since the timing and intensity of a thaw is unpredictable, weather conditions from the end of March through April and early May should be closely monitored by contact with observers in the survey area and by use of satellite imagery and daily weather reports from the National Weather Service. If an early thaw is detected, the snow survey party will have to leave on very short notice in order to observe snow conditions representative of the late winter accumulation. No snow survey was made in 1980.

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