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Some observations on springtime snow/ice conditions on 10 Canadian high arctic islands—and a preliminary comparison of snow/ice conditions between eastern Prince of Wales Island and western Somerset Island, NWT, 5 May - 2 July 1979

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Abstract
Snow and ice measurements were made between 5 May and 2 July 1979 to gain insight into the timing, duration and extensiveness of springtime accumulations of ground-fast ice and superimposed ice lenses in the snow cover. The study area was on eastern Prince of Wales Island, four of its eastern satellite islands, Somerset Island and four of its western satellite islands. Snowmobiles or a Bell 206B helicopter were used to reach the snow/ice sample sites. Snow/ice measurements were obtained from 1776 sample site holes dug at 92 locations during three periods: premelt, 5 May - 2 June; melt, 8 - 27 June; and run-off, 1 - 2 July. Proportionately more snow-free sites occurred on Prince of Wales Island (65.2%) than on Somerset Island (38.1%) during run-off ($P<0.005$). Average snow depth was significantly greater ($P<0.001$) on Somerset Island than on Prince of Wales (45.2%, 96.4 mm) during run-off. Superimposed ground-fast ice occurred at 36.5% of the sites on Somerset Island and 36.4% of those on Prince of Wales during run-off. Average thickness of ground-fast ice was non-significantly greater on Prince of Wales Island (12.9%, 7.8 mm) than on Somerset during run-off. Superimposed ice lens in the snow cover occurred at 19.2% of the sites on Somerset Island and at only 6.6% on Prince of Wales during run-off. Average thickness of total ice lens found per site was non-significantly greater on Prince of Wales Island (34.7%, 10.2 mm) than on Somerset. Preliminary comparisons suggest that more snow-free range should be available sooner to Peary caribou on eastern Prince of Wales Island than on western Somerset. However, snow-covered ranges on either island would be iced over and unavailable to Peary caribou at that time of the year. Further data are necessary to allow greater insight into the importance of springtime unavailability of range to Peary caribou, especially lactating cows and newborn calves.

Introduction
The Peary caribou (*Rangifer tarandus pearyi*) is found throughout the Canadian arctic archipelago. Its ecology has received only limited investigation, but work by Miller, Russell and Gunn (1977*a*, 1977*b*), Miller and Gunn (1978, 1979) and Miller and Kiliaan (1980) indicates that many Peary caribou move from island to island, apparently seasonally. If they use two or more islands annually and migrate regularly, inter-island movements must be taken into account in planning population surveys and range evaluations, and for estimating harvest levels compatible with stable or increasing populations.

Miller and Gunn (1979) proposed several suppositions to explain the springtime migratory-like movements of Peary caribou between Prince of Wales and Somerset islands. The supposition that offers the best reason for such movements is: "Exposed ground (less than 10 - 15 cm of snow cover) in spring during the period of icing is the key to caribou survival in the Canadian High Arctic . . .". That is, the forage on most areas that have more than several centimetres of snow cover becomes unavailable when the spring period of snowmelt begins and ground-fast ice and ice lenses accumulate under and in the snow cover. In years of prolonged snow-melt, ground-fast ice can remain for the better part of a month or longer. In such years, Peary caribou must forage on the relatively restricted areas of wind-blown beach ridges and snow-free slopes. This phenomenon occurs at the annual nadir of the Peary caribou's physical condition. Also, in some years, ground-fast ice persists into the late June calving period and in extremely harsh years (e.g., 1978 and 1979 on Prince of Wales Island) might remain for a week or more thereafter.

Springtime icing was suggested as the primary factor in the die-off and extensive intra- and inter-island movements of Peary caribou on the western Queen Elizabeth Islands in 1973-74 (Miller *et al.* 1977*a*, 1977*b*). This report gives the results of our efforts in 1979 to obtain a greater insight into the timing, duration and extensiveness of springtime accumulations of ground-fast ice under and ice lenses in the snow cover.

Study area
The area was chosen for study because most of the inter-island movements of Peary caribou were detected there in June 1977 (Miller and Gunn 1978) and in May-June 1978 (Miller and Gunn 1979). It encompassed land areas of (1) eastern Prince of Wales Island; (2) the satellite islands of Prescott, Pandora, Vivian and Lock; (3) western Somerset Island; (4) the satellite island of Wadworth, and the unnamed satellite islands at 72° 49°N/95°42′W, 72°56′N/95°45′W and 72°56′N/95°42′W (Fig. 1). The study area was essentially that

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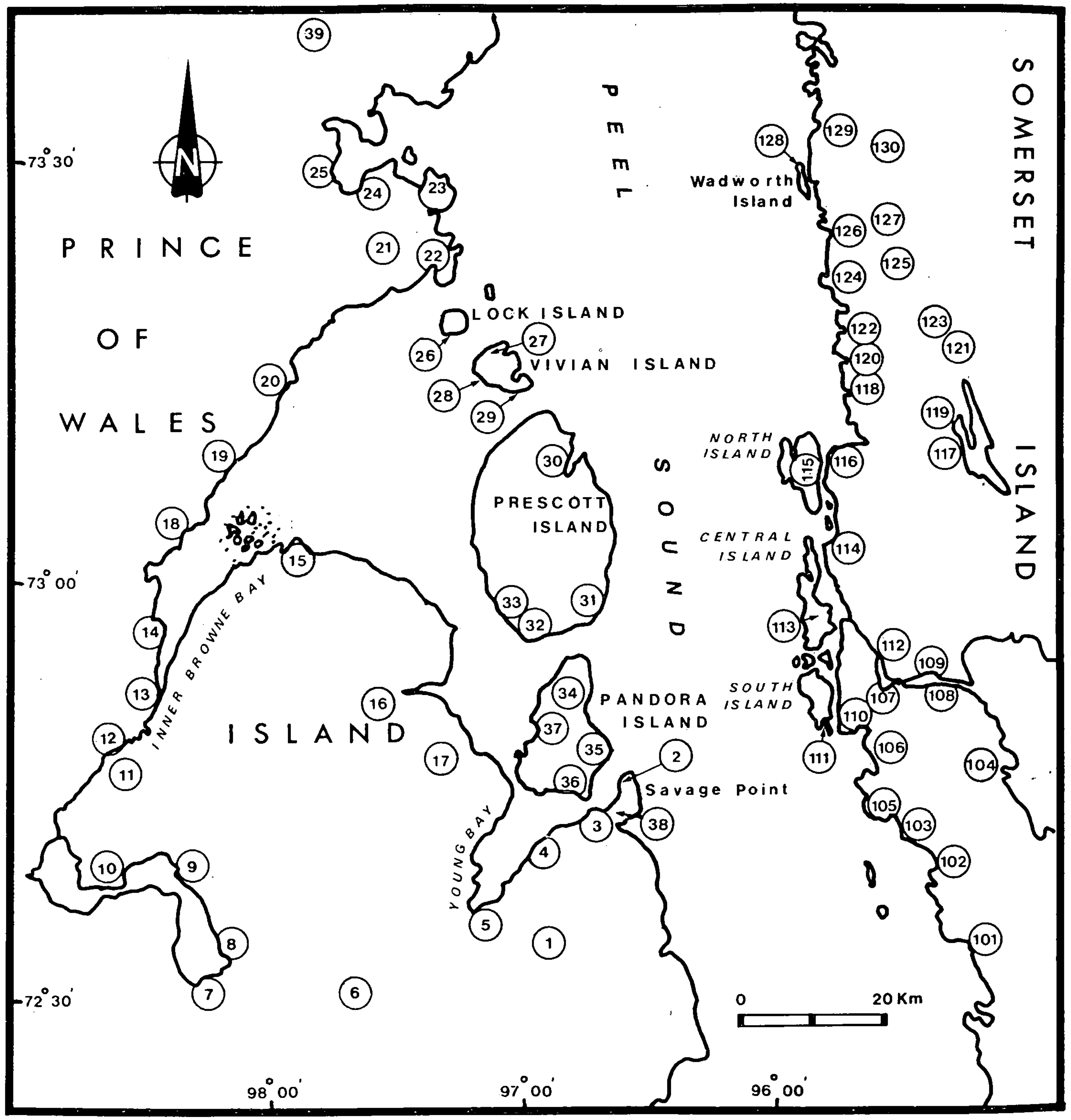
Figure 1
Locations of snow/ice sample areas on eastern Prince of Wales Island and its satellite islands of Prescott, Pandora, Vivian and Lock; and western Somerset Island and its satellite islands of Wadworth, "North", "Central" and "South", NWT, May–July 1979



identified as within latitudinal zones 72°30'–73°00'N and 73°00'–73°30'N, zones 3 and 4 of Miller and Gunn (1978) and zones 6 and 7 of Miller and Gunn (1979). Only one snow/ice sample site (No. 39) on Prince of Wales Island was outside those zones — 73°41'N/97°42'W, within zone 5 of Miller and Gunn (1979).

Methods

Snow/ice sample locations were chosen within pre-selected areas based on empirical knowledge of range use by Peary caribou on Prince of Wales and Somerset islands. A two-man field crew used snowmobiles (Bombardier Scandic model) and Bell 206B helicopters.

Each snow/ice sample location consisted of six site holes dug vertically to ground level at 20 m apart. Digs were numbered in an upslope (ascending) direction 0–100 m with 0-m dig always being the lowest point. We dug with a straight, flat-edged shovel, keeping the diameter of each hole as small as possible, but varied with snow depth.

We decided arbitrarily to take readings from the upslope side of each dig. That side was cut smooth with the shovel and sometimes brushed with a mitten to reveal the layer structure (profile) of the snow cover. All data were recorded on a form designed for this study and diagramatic sketches were made of the snow profile. While making a sample dig, we precooled the thermometer in the snow.

After the hole was dug, the bimetallic dial thermometer (Weston model 2261) was inserted in the snow-cover - ground-surface interface and left for a minimum of 3 min. Next, we measured the thickness of each snow layer in millimetres with an aluminum metre-stick.

A black plastic, graduated plate with etched 1-mm spaces was used to determine snow-grain size within each snow layer. If grains were frozen together in lumps, the lump size was recorded. Two hardness gauges with capacities of 100–1000 g/cm² and 1000 - 10 000 g/cm² were used to measure hardness horizontally in each layer. A minimum of three hardness measurements was made in each snow layer, and the range recorded.

We measured the slope of the sample site in degrees with a hand-held clinometer (Suunto Co., Finland). When possible, one of the workers went 20 m downslope from the 0-m dig. This spacing was maintained between observers as slope measurements were made at successive digs. At the same time, the thermometer was laid flat on the snow to record the surface temperature at each dig. After recording (1) area number, (2) site number, (3) latitude, (4) altitude, (5) longitude, (6) aspect, (7) date and (8) island, we marked the site for relocation by leaving a gravel-filled green garbage bag at one end of the 100-m transect. Subsequent readings were made 30–90 cm from the previous digs to prevent measurement of conditions possibly caused by physical changes in the previous digs.

Standard Pearson Chi-square tests were used to compare sample distributions and Student's tests to compare pairs of sample means. $P<0.05$ was selected as the accepted level of statistical probability.

We made snowmobile treks of several days length to establish and obtain subsequent readings at snow/ice sample sites from a base-camp on the sea-ice along the east side of Pandora Island (72°46'N/96°35'W) between 4 May and 17 June. After that period, we made such treks from a second base-camp on Savage Point (72°42'N/96°35'W), Prince of Wales Island until the end of the work on 2 July.

Two field men travelled by snowmobile, and by Bell 206B helicopter when the snow/ice sample sites were inaccessible by snowmobile (5 May–10 June) or if time limitations necessitated the speed of a helicopter (20–22 June and 1 July).

The work was done essentially in four stages: 1, establishment of snow/ice sample sites and reading of first set of measurements; 2–4, subsequent readings of measurements at snow/ice sample sites. The first and second stages took place during wintery conditions, i.e. premelt (5 May–2 June), the third stage during the beginning of the snow-melt (8–27 June) and the fourth during the beginning of the period of run-off (1–2 July). Because of logistical problems and the use of only one two-man field crew, and with some locations melting off earlier than others, the number of readings at snow/ice sample locations varied from only one to four each on Prince of Wales Island, and from only two to three on Somerset Island (Tables 1 and 2).

Results and discussion

Between 5 May and 2 July 1979, we made 1776 sample digs at 92 locations to obtain snow/ice data that included 41 locations (840 digs) along the east coast of Prince of Wales Island and 26 (438 digs) along the west coast of Somerset Island (Tables 1 and 2, Fig. 1). We also obtained snow/ice data from coastal areas of four small islands adjacent to eastern Prince of Wales Island and four adjacent to western Somerset Island: nine locations (156 digs) on Prescott Island, eight (172 digs) on Pandora Island, three (72 digs) on Vivian Island and one (24 digs) on Lock Island; and one location each (18 digs each) on Wadworth Island and three other satellite islands that are unnamed but referred to herein as "North", "Central" and "South" islands (Tables 1 and 2, Fig. 1).

This preliminary analysis is restricted to a comparison of springtime snow/ice conditions on Prince of Wales Island with those snow/ice conditions on Somerset. The uneven and limited sample sizes obtained from the eight satellite islands did not lend themselves to a meaningful analysis at this time.

Percentage distributions and Observed/Expected (O/E) indices were calculated for the slope classes, aspects, altitude classes and distance from the seacoast classes of snow/ice sample sites in order to evaluate occurrences of those characteristics in the sample

Table 1
Locations, site characteristics and dates of reading measurements at snow/ice sample sites on Prince of Wales Island and its satellite islands of Prescott, Pandora, Vivian and Lock, Northwest Territories, May–July 1979

Snow/ice sample site no.	Lat.*	Long.*	Aspect	Alt. class** of site (m)	Dist. to sea ice† (km)	Dates of readings			
						1st	2nd	3rd	4th
Prince of Wales Island									
1A	7233	9644	N‡	181–210	13.0	7 May	22 June	1 July	
1B	7233	9644	E	181–210	13.0	7	22	1	
1C	7233	9644	S	181–210	13.0	7	22	1	
1D	7233	9644	W	181–210	13.0	7	22	1	
1E	7233	9644	F	181–210	13.0	7	(22 June)§		
2	7246	9636	N	1–30	0.1	10	18 June	22 June	1 July
3	7242	9641	N	91–120	2.0	20	18	24	(1 July)
4	7241	9656	W	31–60	0.8	11	11	22	(1)
5A	7236	9703	N	31–60	3.0	6	11	(22 June)	
5B	7236	9703	E	31–60	3.0		11	22 June	(1)
5C	7236	9703	S	31–60	3.0	6	11	22	(1)
5D	7236	9703	W	31–60	3.0	6	11	22	(1)
5E	7236	9703	F	31–60	3.0	6	11	(22 June)	
6	7231	9727	S	61–90	15.0	11	11	22 June	1 July
7	7232	9814	F	1–30	38.0	11	12	22	1
8	7235	9813	W	31–60	35.0	12	12	22	1
9	7239	9817	S	61–90	30.0	12	12	(22 June)	
10A	7238	9840	W	31–60	33.0	13	12	22 June	1 July
10B	7239	9834	S	1–30	30.0	12	12	22	(1 July)
11	7244	9837	W	31–60	23.0	14	14	22	1 July
12	7248	9839	N	1–30	18.0	15	14	22	1
13	7252	9825	E	1–30	12.0	22	14	22	1
14	7257	9823	F	1–30	0.3	16	14	22	(1 July)
15	7302	9748	N	1–30	0.6	22	22	(1 July)	
16	7248	9735	W	31–60	10.0	22	22	(1)	
17A	7247	9717	N	1–30	5.0	9	22	1 July	
17B	7247	9717	E	1–30	5.0	9	22	1	
17C	7247	9717	S	1–30	5.0	9	(22 June)		
17D	7247	9717	W	1–30	5.0	9	22 June	(1 July)	
17E	7247	9717	F	1–30	5.0	9	(22 June)		
18	7304	9818	E	1–30	1.0	16	15 June	22 June	(1)
19	7310	9807	E	1–30	2.0	16	15	22	(1)
20	7314	9753	F	1–30	0.5	16	15	(22 June)	
21A	7323	9728	W	61–90	5.0	16			
21B	7323	9728	W	61–90	5.0	16 June	22	1 July	
22	7322	9715	S	1–30	0.4	22 May	16	22 June	1 July
23	7328	9713	N	1–30	0.3	22	16	22	1
24	7328	9729	S	1–30	0.4	22	16	22	(1 July)
25	7329	9737	F	1–30	0.3	22	16	22	(1)
38	7242	9635	S	31–60	0.5	19	24	27	2 July
39	7341	9742	F	91–120	15.0	22	8	22	(1 July)

(cont'd)

Table 1 *(cont'd)*

Snow/ice sample site no.	Lat.*	Long.*	Aspect	Alt. class** of site (m)	Dist. to sea-ice† (km)	Dates of readings			
						1st	2nd	3rd	4th
Prescott Island									
30	7307	9645	S	1–30	0.5	22 May	22 June	(1 July)	
31A	7259	9640	E	181–210	1.5	22			
31B	7259	9640	E	181–210	1.5	22 June	1 July		
32A	7256	9653	N	91–120	0.4	8 May	17 June	22 June	1 July
32B	7256	9653	E	91–120	0.4	8	(17 June)		
32C	7256	9653	S	91–120	0.4	8	17 June	22	(1 July)
32D	7256	9653	W	91–120	0.4	8	17	22	(1)
32E	7256	9653	F	91–120	0.4	8	(17 June)		
33	7259	9701	N	31–60	2.0	18	17 June	22	(1)
Pandora Island									
34	7252	9644	F	61–90	2.5	22 May	9 June	22 June	(1 July)
35A	7248	9637	N	31–60	1.0	5	18	24	(1)
35B	7248	9637	E	31–60	1.0	5	18	24	1 July
35C	7248	9637	S	31–60	1.0	5	18	24	(1 July)
35D	7248	9637	W	31–60	1.0	5	18	24	1 July
35E	7248	9637	F	31–60	1.0	5	(18 June)		
36	7244	9645	S	1–30	0.3	19	18 June	(22 June)	
37	7249	9648	E	121–150	2.5	19	9	22 June	(1 July)
Vivian Island									
27	7317	9702	N	1–30	0.4	18 May	17 June	22 June	(1 July)
28	7314	9702	W	1–30	1.0	18	17	22	1 July
29	7314	9657	S	1–30	0.5	18	17	22	1
Lock Island									
26	7318	9713	S	31–60	0.4	18 May	17 June	22 June	(1 July)

*Example, read latitude 7233 and longitude 9644 as 72°33'N and 96°44'W.

**The altitude class was derived from reading the altitude of the position of the snow/ice sample site on a 1:250 000 topographical map by 100-ft (30-m) contours.

†Closest distance to the sea-ice was measured in km on a horizontal plane from a 1:250 000 topographical map for each snow/ice sample site.

‡Aspects: F, flat; N, north; E, east; S, south; and W, west.

§The date given in parentheses indicates no snow left on the snow/ice sample site at the time.

Table 2
Locations, site characteristics and dates of reading measurements at snow/ice sample sites on Somerset Island and its satellite islands of Wadworth and three unnamed islands, NWT, May–June 1979

Snow/ice sample location*	Lat.**	Long.**	Slopes†	Aspects‡	Alt. class§ of site (m)	Dist. to seacoast# (km)	Dates of readings 1st	2nd	3rd
Somerset Island									
101	7232	9512	—	F	1–30	0.3	21 May	(20 June)//	
102	7237	9517	8–9	N	31–60	1.5	23	(20)	
103	7240	9526	4–4	S	1–30	0.3	23	20 June	(1 July)
104	7243	9509	6–6	N	151–180	2.3	23	20	1 July
105	7242	9530	6–8	E	1–30	2.5	28	20	1
106	7246	9533	7–7	W	31–60	1.0	28	(20 June)	
107	7248	9532	—	F	1–30	2.5	28	(20)	
108	7249	9513	6–6	W	121–150	3.5	23	20 June	1
109	7252	9519	9–11	S	31–60	5.0	23	20	1
110	7249	9537	3–4	N	1–30	2.0	28	20	(1 July)
112	7254	9532	4–5	W	121–150	3.5	23	20	1 July
114	7302	9539	5–5	N	31–60	0.5	29	20	1
116	7307	9538	7–8	W	91–120	0.1	29	20	1
117	7307	9519	7–8	E	241–270	11.0	23	20	1
118	7312	9532	—	F	31–60	0.5	29	(20 June)	
119	7309	9511	9–11	S	271–300	10.0	23	20 June	1
120	7314	9532	6–6	W	31–60	1.0	29	20	1
121	7314	9507	7–8	E	241–270	15.0	23	20	1
122	7317	9530	5–6	E	61–90	1.0	30	20	(1 July)
123	7318	9513	5–7	W	391–420	10.0	23	21	1 July
124	7320	9535	8–8	E	31–60	1.0	2 June	20	1
125	7322	9519	6–8	N	241–270	13.0	23 May	20	1
126	7328	9532	8–8	N	31–60	1.0	2 June	20	(1 July)
127	7324	9524	3–5	S	301–330	6.0	23 May	20	1 July
129	7331	9537	—	F	1–30	0.5	2 June	20	1
130	7329	9529	—	F	301–330	11.0	23 May	20	1
"South" island									
111	7249	9546	3–3	S	1–30	0.5	29 May	20 June	1 July
"Central" island									
113	7256	9545	3–4	S	91–120	0.8	29 May	20 June	1 July
"North" island									
115	7306	9542	4–5	E	1–30	0.5	29 May	20 June	(1 July)
Wadworth Island									
128	7328	9543	2–3	N	1–30	0.5	2 June	20 June	1 July

*All A–E locations with the same numeral prefix are located by number only on Fig. 1.
**Example, read latitude 7233 and longitude 9644 as 72°33′N and 96°44′W.
†Slopes equal range of slopes measured at each of the six digs along the 100-m transect at each location: all slopes measured from 20 m distance and always upgrade.
‡Aspects: F, flat; N, north; E, east; S, south; and W, west.
§The altitude class was derived from reading the altitude of the position of the snow/ice sample location from a 1:250 000 topographical map by 100-ft (30-m) contours.
#Closest distance to the seacoast was measured in km on a horizontal plane from a 1:250 000 topographical map for each snow/ice sample location.
//The date given in parentheses indicates no snow left on the snow/ice sample location at that time.

(Tables 3–6). Within-island comparisons of those characteristics of snow/ice sample sites by sampling periods were all non-significant (Tables 3–6). Their O/E indices can still be referred to, however, for some indication of proportional representation of the various classes of the site characteristics. All comparisons between sites on Prince of Wales Island and sites on Somerset were significantly different (Tables 3–6). The O/E indices for the summation of each of those characteristics by island can be used to indicate the direction (over-or under-representation) of the various classes of site characteristics.

Snow Cover

All snow/ice sample sites were established and measured on snow-covered areas during premelt (Table 7). Average snow depth on Somerset Island exceeded that on Prince of Wales by a non-significant 17.4% (44.1 mm) (Table 7).

Snow cover was lost during melt on 35.9% (56) of the sites on Somerset Island and 24.2% (100) of the sites on Prince of Wales. Average snow depth increased 5.6% on Prince of Wales Island and decreased 1.0% on Somerset. But average snow depth remained a non-significant 10.1% (27.0 mm) greater on Somerset Island than on Prince of Wales (Table 7).

During melt, proportionately more snow-free sample sites occurred on Somerset Island (O/E = 1.32, $P<0.005$) than on Prince of Wales (O/E = 0.88, $P<0.005$). Thus relatively more sample sites were snow-covered on Prince of Wales (O/E = 1.05, $P<0.005$) and less were snow-covered on Somerset (O/E = 0.88, $P<0.005$).

The pattern of snow loss on sample areas was reversed during run-off: 65.2% (100) of the dig sites were snow-free on Prince of Wales Island and only 38.1% (48) on Somerset. However, average snow depth remained significantly ($P<0.001$) greater (45.2% = 96.4 mm) on Somerset than on Prince of Wales (Table 7). During run-off, proportionately more snow-free sites occurred on Prince of Wales Island (O/E = 1.19, $P<0.005$) and less than expected on Somerset (O/E = 0.77, $P<0.005$).

Comparisons of the relative number of snow-covered sites with snow-free sites during melt with those during run-off for each island were made to evaluate the acceleration of snow-melt on Prince of Wales Island (Table 7). Relatively more sites were snow-free on Prince of Wales Island during run-off than during melt (O/E = 1.74, $P<0.005$). However, that pattern was not obtained for Somerset Island, where non-significant ($P = 0.9$) values for the snow-covered and snow-free sites occurred at about the expected rates (melt: snow-covered = 1.02, no snow = 0.97; run-off: snow-covered = 0.98, no snow = 1.03).

Maximum hardness of layers within the profiles of snow covers during the premelt varied from 7000 to 10 000 g/cm^2 and minimum hardnesses from 100 to 4000 g/cm^2. Snow hardness was measured only during the premelt sampling period when the work was done by snowmobile. Such measurements were discontinued during melt and run-off, because of the need for rapid sampling over extensive areas and the high cost of helicopter rental.

Snow-layering in the snow-cover profile appeared minimal during the study periods. Ranges and means ± standard deviations for numbers of distinguishable snow layers in the snow cover were as follows: Prince of Wales Island — premelt, 1-5, 2.5±0.9; melt, 1-5, 2.2±0.9; run-off, 1-3, 1.9±0.8; Somerset Island — premelt, 1-4, 2.2±0.9; melt, 1-3, 2.0±0.4; run-off 1-3, 2.0±0.6.

Ranges and means ± standard deviations for centigrade temperatures at the snow-cover - ground surface interface were obtained as follows: Prince of Wales Island, -22 to -7, -15.3±3.3; Somerset Island, -18 to -5, -11.5±2.6; Prescott Island, -21 to -8, -14.1±3.5; Pandora Island, -20 to -7, -14.0±3.4; Vivian Island, -17 to -7, -13.2±3.2; Lock Island, -15 to -10, -12.5±1.6; Wadworth Island, -15 to -11, -13.2±1.3; "North" island, -14 to -7, -11.3±2.4; "Central" island, -15 to -8, -12.2±3.0; and "South" island, -14 to -13, -13.8±0.4. Temperatures were recorded only during the premelt sampling period because of time and cost constraints.

Superimposed ice

Ground-fast ice, most likely formed during autumn prior to snowfall, was found during premelt on only six (2.6%) sites on Prince of Wales Island and no sites on Somerset (Table 8). Whether or not standing water had existed on those six sites on Prince of Wales Island was not determined.

During melt, springtime development of ground-fast ice occurred at 132 (31.9%) sites on Prince of Wales Island and 42 (26.9%) sites on Somerset (Table 8). Average thickness of ground-fast ice was a non-significant 20.7% (11.4 mm) greater on Prince of Wales Island than on Somerset (Table 8).

A comparison of the relative frequency of occurrence of ground-fast ice during melt was made between Prince of Wales and Somerset to evaluate its development on the two islands. The results gave non-significant ($0.5>P>0.1$) relative occurrences that suggested a slightly greater occurrence of sites with ground-fast ice than expected on Prince of Wales Island (O/E = 1.04) and less than expected on Somerset (O/E = 0.88).

Ground-fast ice occurred at 46 (36.5%) sites on Somerset Island and 72 (36.4%) sites on Prince of Wales during run-off (Table 8). Average thickness of ground-fast ice was still non-significantly greater on Prince of Wales (12.9%, 7.8 mm) than on Somerset (Table 8).

A comparison of the relative frequency of occurrence of ground-fast ice on Prince of Wales Island with its occurrence on Somerset was made to evaluate the further spread of ground-fast ice on both islands during run-off. The results gave non-significant ($0.975>P>0.9$) relative occurrences but suggested that the spread of

Table 3
Percentage distributions of and Observed/Expected (O/E) indices* for slope classes of snow/ice sample sites, Prince of Wales Island and Somerset Island, NWT, May–July 1979

Period	n	% slope (O/E index) 1–3°	4–6°	7–11°
Prince of Wales Island				
Premelt	180	52.8 (0.94)	41.1 (1.07)	6.1 (1.19)
Melt	330	59.1 (1.05)	37.0 (0.96)	3.9 (0.77)
Run-off	174	54.6 (0.97)	39.1 (1.01)	6.3 (1.24)
All periods	684	56.3 (1.47)	38.6 (0.95)	5.1 (0.24)
Somerset Island				
Premelt	126	4.8 (0.97)	42.8 (0.97)	52.4 (1.03)
Melt	126	4.8 (0.97)	42.8 (0.97)	52.4 (1.03)
Run-off	114	5.2 (1.15)	47.4 (1.07)	47.4 (0.93)
All periods	366	4.9 (0.13)	44.3 (1.09)	50.8 (2.42)

*O/E indices calculated in two-way contingency table for standard Pearson Chi-square tests: by sample periods. Prince of Wales = $0.9>P>0.5$; Somerset = $0.975>P>0.9$; and by all sampling periods between islands = $P<0.005$.

Table 4
Percentage distributions of and Observed/Expected (O/E) indices* for aspects of snow/ice sample sites, Prince of Wales Island and Somerset Island, NWT, May–July 1979

Period	n	% aspects (O/E index) North	East	South	West	Flat
Prince of Wales Island						
Premelt	228	21.1 (1.05)	13.2 (0.88)	21.1 (0.92)	23.7 (1.00)	21.1 (1.13)
Melt	414	18.8 (0.94)	14.5 (0.97)	24.6 (1.08)	21.7 (0.92)	20.3 (1.09)
Run-off	198	21.2 (1.06)	18.2 (1.21)	21.2 (0.93)	27.3 (1.16)	12.1 (0.65)
All periods	840	20.0 (0.95)	15.0 (0.89)	22.8 (1.11)	23.6 (1.00)	18.6 (1.04)
Somerset Island						
Premelt	156	23.1 (0.99)	19.2 (0.94)	15.4 (0.94)	23.1 (0.99)	19.2 (1.17)
Melt	156	23.1 (0.99)	19.2 (0.94)	15.4 (0.94)	23.1 (0.99)	19.2 (1.17)
Run-off	126	23.8 (1.02)	23.8 (1.16)	19.0 (1.16)	23.8 (1.02)	9.5 (0.58)
All periods	438	23.3 (1.10)	20.6 (1.22)	16.4 (0.80)	23.3 (1.00)	16.4 (0.92)

*O/E indices calculated in two-way contingency table for standard Pearson Chi-square tests: by sampling periods, Prince of Wales = $0.5>P>0.1$; Somerset = $0.9>P>0.5$; and by all sampling periods between islands = $P<0.05$.

Table 5
Percentage distributions of and Observed/Expected (O/E) indices* for altitude classes of snow/ice sample sites, Prince of Wales Island and Somerset Island, NWT, May–July 1979

Period	n	% alt. class, masl (O/E index) 1–30	31–90	91–180	181–420
Prince of Wales Island					
Premelt	228	50.0 (1.04)	31.5 (0.87)	5.3 (0.92)	13.2 (1.32)
Melt	414	46.4 (0.97)	40.6 (1.11)	5.8 (1.01)	7.2 (0.72)
Run-off	198	48.4 (1.01)	33.4 (0.92)	6.1 (1.06)	12.1 (1.21)
All periods	840	47.9 (1.23)	36.4 (1.03)	5.7 (0.61)	10.0 (0.61)
Somerset Island					
Premelt	156	23.1 (1.05)	34.6 (1.05)	15.4 (0.94)	26.9 (0.94)
Melt	156	23.1 (1.05)	34.6 (1.05)	15.4 (0.94)	26.9 (0.94)
Run-off	126	19.1 (0.87)	28.5 (0.87)	19.1 (1.16)	33.3 (1.16)
All periods	438	21.9 (0.56)	32.9 (0.93)	16.4 (1.75)	28.8 (1.75)

*O/E indices calculated in two-way contingency table for standard Pearson Chi-square tests: by sampling periods, Prince of Wales = $0.5>P>0.1$; Somerset = $0.9>P>0.5$; and by all sampling periods between islands = $P<0.05$.

Table 6
Percentage distributions of and Observed/Expected (O/E) indices* for distance from the seacoast classes of snow/ice sample sites, Prince of Wales Island and Somerset Island, NWT, May–July 1979

Period	n	% distance from the seacoast, km (O/E index) 0.1–0.9	1–4	5–9	10–14	15–38
Prince of Wales Island						
Premelt	228	23.7 (0.87)	18.4 (0.89)	15.8 (1.30)	18.4 (1.23)	23.7 (0.95)
Melt	414	29.0 (1.07)	23.2 (1.12)	10.1 (0.84)	11.7 (0.77)	26.0 (1.04)
Run-off	198	27.3 (1.00)	18.2 (0.88)	12.1 (1.00)	18.2 (1.21)	21.0 (0.97)
All periods	840	27.1 (1.07)	20.7 (0.71)	12.1 (1.12)	15.0 (0.89)	25.0 (1.40)
Somerset Island						
Premelt	156	23.1 (1.05)	46.2 (1.02)	7.7 (0.94)	19.2 (0.94)	3.8 (0.94)
Melt	156	23.1 (1.05)	46.2 (1.02)	7.7 (0.94)	19.2 (0.94)	3.8 (0.94)
Run-off	126	19.0 (0.87)	42.9 (0.95)	9.5 (1.16)	23.8 (1.16)	4.8 (1.16)
All periods	438	21.9 (0.86)	45.2 (1.55)	8.2 (0.76)	20.6 (1.22)	4.1 (0.23)

*O/E indices calculated in two-way contingency table for standard Pearson Chi-square tests: by sampling periods, Prince of Wales = $0.1<P<0.05$; Somerset = $0.975>P>0.9$; and by all sampling periods between islands = $P<0.005$.

Table 7
Snow depth measurements in mm obtained on 10 Canadian high arctic islands, NWT, 5 May–2 July 1979

Islands	Premelt n	$\bar{X} \pm SD$	Range	Melt n	$\bar{X} \pm SD$	Range	Run-off n	$\bar{X} \pm SD$	Range
Prince of Wales	228	252.7±187.9	15–1070	314	266.9±196.7	20–1135	69	213.3±142.3	30–670
Somerset	156	296.8±214.5	20–1300	100	293.9±205.3	30–1090	78	309.7±196.4	20–1070
Prescott	48	230.1±203.1	15–790	29	235.2±169.3	30–635	7	179.3±123.2	15–350
Pandora	48	162.5±133.9	10–585	52	159.5±134.1	20–680	5	66.0± 94.0	10–230
Vivian	18	311.9±195.4	70–705	35	259.7±174.8	50–755	9	238.3±120.1	40–550
Lock	6	249.2± 97.7	120–375	3	30.0± 10.0	20–40	0	—	—
"South"	6	315.0± 83.1	200–430	6	310.0± 95.0	215–460	6	171.7± 31.7	140–225
"Central"	6	164.2± 62.7	50–215	3	141.7± 37.5	105–180	0	—	—
"North"	6	333.3±318.2	40–890	4	380.0±273.1	150–750	2	155.0± 7.1	150–160
Wadworth	6	409.2±262.9	135–735	6	311.7±243.0	80–655	3	233.3±115.0	120–350

Table 8
Ground-fast ice thickness measurements in mm obtained on 10 Canadian high arctic islands, NWT, 5 May–2 July 1979

Islands	Premelt n	$\bar{X} \pm SD$	Range	Melt n	$\bar{X} \pm SD$	Range	Run-off n	$\bar{X} \pm SD$	Range
Prince of Wales Island	6	13.2±14.7	1–34	132	66.5±48.1	5–270	72	68.5±45.5	5–280
Somerset	2	38.5±23.3	22–55	42	55.0±40.9	2–180	46	60.7±42.1	4–220
Prescott	3	17.7±15.0	8–35	16	74.1±41.7	25–170	7	85.7±54.7	35–160
Pandora	0	—	—	34	65.4±39.6	10–170	6	128.3±40.6	80–200
Vivian	0	—	—	15	34.8±29.9	5–100	7	37.2±17.5	10–60
Lock	3	73.3±40.1	35–115	3	135.0±85.0	50–220	0	—	—
"South"	0	—	—	4	73.8±38.8	35–125	3	66.7±41.6	20–100
"Central"	0	—	—	2	85.0± 7.1	80–90	2	100.0	100–100
"North"	0	—	—	3	88.3±38.8	45–120	0	—	—
Wadworth	0	—	—	1	15.0	15–15	5	26.8±15.2	4–45

Table 9
Measurements of combined thicknesses in mm of superimposed ice lens in the snow cover at each site where they occurred on 10 Canadian high arctic islands, NWT, 5 May - 2 July 1979

	Premelt			Melt			Run-off		
Islands	n	$\bar{X} \pm SD$	Range	n	$\bar{X} \pm SD$	Range	n	$\bar{X} \pm SD$	Range
Prince of Wales	2	1.0	1-1	65	37.4±39.1	2-220	13	39.6±36.4	15-155
Somerset	0	—	—	31	27.3±26.7	3-110	24	29.4±27.8	4-110
Prescott	0	—	—	3	90.0±87.2	30-190	0	—	—
Pandora	0	—	—	7	51.9±41.7	18-120	0	—	—
Vivian	0	—	—	8	18.5±17.3	5-60	1	20.0	20-20
Lock	2	1.5±0.7	1-2	0	—	—	0	—	—
"South"	0	—	—	2	27.5± 3.5	25-30	0	—	—
"Central"	0	—	—	1	70.0	70-70	0	—	—
"North"	0	—	—	0	—	—	0	—	—
Wadworth	0	—	—	2	30.0± 7.1	25-35	2	17.5± 3.5	15-20

ground-fast ice was proportionally as expected (O/E = 1.00).

Comparisons of the relative occurrence of sites with ground-fast ice during melt with those during run-off for each island were made to evaluate temporal development of ground-fast ice on both islands. The two comparisons gave non-significantly acceptable results: on both islands the rates suggested relatively more sites with ice during run-off (Prince of Wales, O/E = 1.09, $0.5>P>0.1$; Somerset, O/E = 1.17, $0.1>P>0.05$).

Superimposed single ice lenses occurred in the snow cover during premelt on only two (0.9%) sites on Prince of Wales Island and none were found on Somerset (Table 9). We later determined that those two sites on Prince of Wales were associated with stream courses and overflow (run-off) channels.

During melt, superimposed ice lenses occurred in the snow cover on 31 (19.9%) sites on Somerset Island and on 65 (15.7%) sites on Prince of Wales (Table 9). Average thickness of total ice lenses found per site was a non-significant 37.0% (10.1 mm) greater on Prince of Wales Island than on Somerset (Table 9).

Superimposed ice lenses occurred during run-off at 24 (19.0%) sites on Somerset Island and only 13 (6.6%) sites on Prince of Wales (Table 9). Average thickness of total ice lenses found per site was still non-significantly greater on Prince of Wales Island (34.7%, 10.2 mm) than on Somerset (Table 9).

Comparisons of the relative number of sites where superimposed ice lenses had and had not occurred were made between islands and by island between melt and run-off. The comparisons allowed cursory evaluations of the relative frequencies of occurrences of ice lenses in the snow covers on Prince of Wales and Somerset islands. The obtained non-significant values ($0.5>P>0.1$) suggested that there was a proportionately greater than expected rate (O/E = 1.18) of occurrence of ice lenses at sites on Somerset Island and a lower than expected rate (O/E = 0.93) on Prince of Wales Island during melt. During run-off, ice lenses in the snow cover occurred at a relatively greater than expected rate (O/E = 1.67, $P<0.005$) on Somerset Island and at a less than expected rate (O/E = 0.58, $P<0.005$) on Prince of Wales. Ice lenses occurred on Prince of Wales Island at a relatively greater than expected rate (O/E = 1.23, $P<0.01$) during melt and at a less than expected rate (O/E = 0.52, $P<0.01$) during run-off. On Somerset Island the non-significant results ($0.9>P>0.5$) gave values for relative occurrences of ice lenses at about the expected rate (melt, O/E = 1.02; and run-off, O/E = 0.98).

We cannot evaluate the relative representation of different site characteristic classes in the sample by each sampling period or by all sampling periods until we further analyze the data. The major differences in proportional over- or under-representation of site characteristic classes for the entire sample appear to be as follows: (1) slope class 1-3° over-represented on Prince of Wales Island and under-represented on Somerset; (2) slope class 7-11° under-represented on Prince of Wales Island and over-represented on Somerset; (3) south-facing sites and flat sites over-represented on Prince of Wales Island and under-represented on Somerset; (4) east-facing and north-facing sites under-represented on Prince of Wales Island and over-represented on Somerset; (5) altitude class 1-30 m over-represented on Prince of Wales Island and under-represented on Somerset; (6) altitude classes 91-180 m and 181-420 m under-represented on Prince of Wales Island and over-represented on Somerset; (7) distance from the seacoast classes 15-38 km, 5-9 km and 0.1-0.9 km over-represented on Prince of Wales Island and under-represented on Somerset; and (8) distance from the seacoast classes 1-4 km and 10-14 km under-represented on Prince of Wales Island and over-represented on Somerset.

Empirical knowledge of the study area suggests that the above conditions, with the possible exceptions of over-representations of distance from the seacoast classes 15-38 km and 5-9 km and under-representation of 1-4 km on Prince of Wales Island, would favour more rapid loss of snow and thus earlier accumulations of superimposed ground-fast ice and ice lens on sites on Prince of Wales Island than on sites on Somerset Island.

The initial comparisons that we made between Prince of Wales and Somerset islands of snow depths (Table 7), thicknesses of ground-fast ice (Table 8) and thicknesses of superimposed ice lens in the snow cover (Table 9) also tend to support the above empirically based supposition of more rapid snow loss and ice accumulation on Prince of Wales Island than on Somerset.

The greater number of snow-free sites on Prince of Wales Island than on Somerset during run-off suggests that more range would become snow-free and available for foraging sooner on Prince of Wales. Thus there should be relatively more range available for foraging by Peary caribou at that time of the year on Prince of Wales Island than on Somerset. However, the comparison that we made for superimposed ground-fast ice suggests that any snow-covered range on either island would be iced over at that time and unavailable to Peary caribou during most of the melt and throughout the run-off.

In 1979, ground-fast ice persisted from, at least, mid June into the first week of July. The peak of calving for Peary caribou on Prince of Wales Island appeared to be during the third week of June in 1979, which agrees with the timing for calving in 1977 and 1978 (Miller and Gunn 1978, 1979). This means that in years when ground-fast ice persists into July, maternal cows must forage on greatly restricted and relatively poorly vegetated portions of their ranges during the energy-demanding initial stage of lactation.

The consequences of this additional stress, if any, are not known. But, in years when Peary caribou have suffered severe winter conditions and extreme unavailability of forage, additional springtime nutritional stress on maternal cows likely would have a marked impact. In such years mortality of newborn calves would most likely be high and maternal cows would experience greater physical deterioration; that, in extreme cases, could lead to their subsequent failure to conceive in the following autumn (Thomas *et al.* 1976, 1977, Thomas and Broughton 1978). Further springtime data on snow and ice conditions, forage used by Peary caribou, and their feeding strategies and behaviour will be necessary to allow greater insight into the importance of springtime range availability to Peary caribou.

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References
Miller, F.L.; Gunn, A. 1978. Inter-island movements of Peary caribou south of Viscount Melville Sound, Northwest Territories. Can. Field-Nat. 92(4):327-333.

Miller, F.L.; Gunn, A. (1979). In press. Inter-island movements of Peary caribou (*Rangifer tarandus pearyi*) south of Viscount Melville Sound and Barrow Strait, Northwest Territories, Canada. Proc. 2nd. Int. Reindeer-Caribou Symp. Røros, Norway.
(or Miller, F.L.; Gunn, A. 1979. Inter-island movements of Peary caribou south of Viscount Melville Sound and Barrow Strait, Northwest Territories, May-July 1978. Unpubl. Rep. Can. Wildl. Serv. Edmonton, Alta. CWSC-2760. 74pp.)

Miller, F.L.; Kiliaan, H. 1980. Inter-island movements of Peary caribou in the Prince of Wales - Somerset Island - Boothia Peninsula complex, Northwest Territories, May-July 1979. Can. Wildl. Serv. Prog. Notes No. 107. 7pp.

Miller, F.L.; Russell, R.H.; Gunn, A. 1977*a*. Distribution, movements and numbers of Peary Caribou and muskoxen on western Queen Elizabeth Islands, Northwest Territories, 1972-74. Can. Wildl. Serv. Rep. Ser. No. 40. 55pp.

Miller, F.L.; Russell, R.H.; Gunn, A. 1977*b*. Inter-island movements of Peary caribou (*Rangifer tarandus pearyi*) on western Queen Elizabeth Islands, Arctic Canada. Can. J. Zool. 55(6):1029-1037.

Thomas, D.C.; Russell, R.H.; Broughton, E.; Madore, P. 1976. Investigations of Peary caribou populations on some Canadian Arctic Islands, March 1975. Can. Wildl. Serv. Prog. Notes No. 64, 13pp.

Thomas, D.C.; Russell, R.H.; Broughton, E.; Edmonds, E.J.; Gunn, A. 1977. Further studies of two populations of Peary caribou in the Canadian Arctic. Can. Wildl. Serv. Prog. Notes No. 80. 14pp.

Thomas, D.C.; Broughton, E. 1978. Status of three Canadian caribou populations north of 70° in winter 1977. Can. Wildl. Serv. Prog. Notes No. 85. 12pp.