ICE CONDITIONS SURVEY, BANKS ISLAND

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ABSTRACT

Between 26 October and 5 November, 1993 aerial and ground surveys were conducted on southern Banks Island to determine the extent and severity of early winter icing conditions. Twenty-one randomly located sites were visited. Snowpack conditions were assessed by measuring the different layers of snow and ice present, and by estimating snowpack hardness with a Rammsonde penetrometer. At 8 sites ice conditions were deemed severe. Based on the distribution of severely iced and relatively ice-free sites, approximately 50% of the traditional caribou wintering ground had severe icing conditions. Snowpack hardness was measured at caribou and muskox feeding sites in order to assess what conditions the animals were capable of cratering through.

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INTRODUCTION

During September and October, 1993, high temperatures and freezing rains occurred in the vicinity of Sachs Harbour. There was local concern that this unseasonable weather had resulted in a snowpack with a significant ice component. If this was the case, the availability of winter forage for Peary caribou would be reduced because the ice would prevent animals from reaching food, and there would be the potential for a winter die-off. Winter die-offs have previously been recorded on Banks Island during 1987-88, 1988-89, and 1990-91, with reported total losses of 490 animals (Nagy *et al.* 1994). At the request of the Sachs Harbour Hunters' and Trappers' Committee (SHHTC), we surveyed the southern third of Banks Island to determine the severity and extent of icing conditions caused by freezing rains. Additionally, whenever recent crater sites were located, we measured the snow conditions adjacent to the craters in order to determine the range of snow conditions that animals were capable of removing in order to access forage.

METHODS

The southern third of Banks Island was delineated into 238, 100 km^2 blocks. Thirty-six blocks (representing 15% coverage of this portion of island) were selected at random as survey sites. A random latitude and longitude located within the selected 100 km^2 block was chosen as the actual survey site. All sites were entered into a Global Position System (Trimble Transpack II) (GPS). Seventeen sites were visited by helicopter, and 4 were visited by snowmobile. Adverse weather conditions and mechanical failures prevented us from visiting all 36 sites; the resultant coverage was approximately 9% of the southern third of the island. At each site snow measurements were taken at 5 sample points: the original central location, and 4 points located 150 m due north, south, east, and west of the centre location.

Snowpack conditions were assessed at each site by: 1) excavating a snow pit and measuring the different layers of snow and ice present in the snowpack and, 2) estimating snowpack hardness with a Rammsonde penetrometer (Raillard 1992). Snowpack hardness was estimated by recording the mean number (n=2) of times, at each of the 5 sample points, a 1 kg weight had to be dropped, from a height of 30 cm, in order for the penetrometer to break through the snowpack and reach the ground. Because snow hardness varies with temperature, the estimations were standardized using the following equation adapted from Raillard (1992):

$$\text{Number of Drops} = \text{absolute value } (0.3\,(\text{temperature}) - 3.14)$$

We then converted the standardized value to the number of drops required to penetrate the snowpack if the temperature had been -35° C. We chose -35° C because it represents the average low temperature for Sachs Harbour during November to March (A. R. Maarouf unpubl.), and therefore represents the hardest the present snow conditions would be if projected across the November to March period.

The snow depth and hardness were measured beside caribou and muskox craters to see what conditions the animals were able to crater through. Snow and icing conditions were also noted while travelling on the ground between sites.

Snow sites were deemed to be relatively ice free if no more than two of the five points sampled had an ice layer present in the snowpack. Sites with three or more of the five points sampled having ice layers present were deemed as heavily iced.

Snow depth and standardized snow hardness were compared between relatively ice free and heavily iced zones using the Student's t-test. Snow depth and standardized hardness were compared between cratered and non-cratered areas, in both relatively ice free and heavily iced zones, for Peary caribou and muskox, also using the Student's t-test.

RESULTS

Solid ice layers were incorporated into the snowpack at 15 of the 21 sites, and a total of 44 of the 105 sample points (Figure 1, Appendix 1). Ice layers up to 5 centimetres thick were present at all 5 sampling points at sites 4, 6, 97, 116, and 117 (Figure 1). Ground fast ice was evident at only 2 of the 105 sampling points. Both of those points were located on south facing snow free slopes.

A heavily iced zone was found covering a 100 km wide swath east of Sachs Harbour running northeast through the Saningayualuk and Egg river drainages and northwest to Storkerson Bay, and a small area around Capron Lake (Figure 3). In this area, ice was present at 35 of 40 or 87.5% of points sampled. Layers of ice and hard snow, formed by a number of freezing and thawing events, were located above layers of softer or coarser granulated snow crystals (sugar snow) at all sites.

A relatively ice free zone was found on the southeastern half of Banks Island from De Salis Bay and north through the headwaters of the Bernard and Big rivers (Figure 3.). In this area, ice was present at 9 of 65 or 14% of points sampled. At eight sites the ice layer was 0.5 cm thick; at one site it was 1 cm thick. Layers of ice and hard snow, formed by a number of freezing and thawing events, were also located above layers of softer or coarser granulated snow crystals (sugar snow) at all other sites.

Heavily Iced Zone

In this zone the mean number of drops (standardized to -35° C) required to penetrate to ground level was 16.9 (n=40). This was significantly greater than the 10 drops (n=65) required in the relatively ice free zone (one-tailed t-test, p<0.025). The mean depth of the snowpack was 20.0 cm (n=40) in the iced zone compared with 16.3 cm (n=65) in the ice free zone. This difference was significant (one-tailed t-test, p<0.045). In general the snowpack was harder and deeper in the iced zone.

Caribou cratered in sites with significantly less (mean 12.5 cm, n=11, one-tailed t-test, p<0.004) than the mean snow depth (20.0 cm). The hardest snowpack that caribou were observed cratering through required 5 drops to penetrate at an ambient temperature of -22° C. If we assume that 5 drops is the threshold hardness at -35° C, then caribou would have been unable to crater through the snowpack at 80% (32 of 40) of the sites sampled.

Muskox cratered through snowpacks of similar snow depth (mean 22.1 cm, n=30, two-tailed t-test, p=0.32) to the mean snow depth (20.0 cm, n=40). The hardest snowpack that muskox were observed cratering through required 30 drops to penetrate at an ambient temperature of -27° C. If we assume that 30 drops is the threshold hardness at -35° C, then muskox would have been unable to crater through the snowpack in 15% (6 of 40) of the sites sampled.

<u>Relatively Ice Free Zone</u>

In this zone caribou cratered through snowpacks of similar depth (mean 20.2 cm, n=10, p=0.84) to the mean snow depth (16.3 cm, n=65). The hardest snowpack that caribou were observed cratering through required 19 drops to penetrate at an ambient temperature of -27° C. If we assume that 19 drops is the threshold hardness at -35° C, then caribou should be able to successfully crater through the snowpack in 87.7% (57 of 65) of the sites sampled.

Muskox cratered in sites with significantly more snow (mean 25.7 cm, n=5, two-tailed t-test, $p<0.0025$) than the mean snow depth (16.3 cm, n=65). The hardest snowpack that muskox were observed cratering through required 10 drops to penetrate at an ambient temperature of -23° C. If we assume that 10 drops is the threshold hardness at -35° C, then muskox should be able to successfully crater through the snowpack in 75.4% (49 of 65) of the sites sampled.

During the course of the aerial part of the survey we observed 28 caribou in 6 groups: 16 were adult females and 5 were calves. We also observed 2411 muskox in 205 groups. Twenty-eight caribou in 8 groups were observed during the ground work: 16 adult females, 7 calves, 2 yearlings, and 3 adult males.

DISCUSSION

Based upon the results of this survey, caribou can crater through the snowpack on a majority of their traditional wintering range even at temperatures of -35° C. Ground fast ice was uncommon at sites surveyed. However, more detailed snow measurements were subsequently taken at locations in the heavily iced zone, as part of an ongoing range study, and they indicated that the majority of more exposed uplands and ridgetops had ground fast ice of up to 2.5 cm (N.C. Larter unpubl.). Ground fast ice effectively prevents access to forage and was present in previous winters when die-offs had occurred.

We found that caribou cratered in areas with more shallow snow than average snow cover, a finding similar to that found for caribou and reindeer in Alaska (LaPerriere and Lent 1977, Collins and Smith 1991), Finland (Pruitt 1992), and the Yukon (Duquette 1988). Unfortunately we lack comparative snow measurements from more "normal" winters on Banks Island, in order to determine whether or not the shallower levels caribou were cratering through were comparable with levels normally found at this time of year.

RECOMMENDATIONS

1) The health and condition of caribou, specifically calves and older adult males, should be carefully monitored on a monthly basis from November through March.

2) Because of the lack of baseline urineanalysis data, a limited sample of adult male and calf caribou should be collected in order to demonstrate the current health and condition of animals to residents of Sachs Harbour, and correlate urine data with animals of known condition.

3) To work with the community of Sachs Harbour and the SHHTC to assess the potential for over winter survival of calf and adult male caribou and to work together to produce management recommendations for the conservation and management of caribou on Banks Island.

4) Continue measuring and assessing snow conditions in various habitats and at animal crater sites throughout the winter.

ACKNOWLEDGEMENTS

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APPENDIX 1.

Site Number [1]	Snow Depth (cm)	Snow Hardness (number drops)	Temperature (°C Ambient)	Ice Layer (cm)
4C	13.0	6.0	-17	`1.0
4N	11.0	18.0	-17	2.0
4S	12.0	6.0	-17	2.5
4E	13.0	4.5	-17	3.0
4W	17.0	9.0	-17	2.5
6C	11.0	4.0	-12	0.2
6N	16.0	1.5	-12	0.5
6S	10.0	15.5	-12	5.0
6E	15.0	4.0	-12	0.5
6W	29.0	5.0	-12	0.5
11C	18.0	8.0	-17	2.0
11N	7.0	5.5	-17	0.5
11S	16.0	9.0	-17	none
11E	21.0	4.0	-17	none
11W	10.0	4.0	-17	none
19C	45.0	4.0	-12	none
19N	5.0	2.0	-12	none
19S	4.0	1.0	-12	none
19E	11.0	2.0	-12	1.0
19W	4.0	0.5	-12	none
54C	13.0	2.5	-9	none
54N	10.0	2.0	-9	none
54S	20.0	3.5	-9	none
54E	12.0	8.0	-9	none

Site Number [1]	Snow Depth (cm)	Snow Hardness (number drops)	Temperature (°C Ambient)	Ice Layer (cm)
54W	10.0	4.0	-9	none
74C	20.0	5.0	-15	0.5
74N	15.0	3.5	-15	none
74S	25.0	6.5	-15	none
74E	15.0	8.5	-15	1.5
74W	29.0	6.0	-15	1.0
94C	14.0	7.0	-15	2.0
94N	20.0	6.5	-15	none
94S	14.0	3.0	-15	0.5
94E	11.0	3.5	-15	none
94W	20.0	2.0	-15	0.5
97C	27.0	17.0	-22	0.5
97N	24.0	5.0	-22	2.0
97S	24.0	3.0	-22	2.0
97E	47.0	17.0	-22	0.5
97W	36.0	4.0	-22	1.0
106C	15.0	16.0	-9	none
106N	20.0	11.0	-9	2.5
106S	18.0	3.0	-9	4.0
106E	10.5	2.5	-9	none
106W	7.0	2.0	-9	none
116C	12.0	31.0	-10	0.5
116N	50.0	42.0	-10	0.5
116S	8.0	2.0	-10	0.5
116E	11.0	3.0	-10	1.0
116W	16.0	6.0	-10	0.5

Site Number [1]	Snow Depth (cm)	Snow Hardness (number drops)	Temperature (°C Ambient)	Ice Layer (cm)
117C	22.0	4.0	-9	1.5
117N	14.0	2.0	-9	0.5
117S	26.0	23.0	-9	0.5
117E	15.0	5.0	-9	0.5
117W	16.0	14.0	-9	0.5
134C	14.0	2.0	-11	0.5
134N	16.0	2.0	-11	0.5
134S	62.0	27.0	-11	0.5
134E	8.0	9.0	-11	none
134W	21.0	1.0	-11	0.5
138C	15.0	8.0	-19	none
138N	26.0	41.5	-19	none
138S	25.0	20.0	-19	none
138E	19.0	2.0	-19	none
138W	9.0	5.0	-19	none
158C	37.0	2.0	-26	none
158N	22.0	4.0	-26	none
158S	23.0	4.5	-26	none
158E	28.0	5.5	-26	none
158W	22.0	3.5	-26	none
162C	17.0	1.5	-10	none
162N	9.0	1.0	-10	none
162S	17.0	2.0	-10	none
162E	6.0	1.0	-10	none
162W	16.0	4.5	-10	none
173C	9.0	26.0	-23	none

Site Number [1]	Snow Depth (cm)	Snow Hardness (number drops)	Temperature (°C Ambient)	Ice Layer (cm)
173N	34.0	13.5	-23	none
173S	21.0	5.5	-23	none
173E	7.0	2.0	-23	0.5
173W	5.5	2.5	-23	0.5
192C	17.0	4.0	-20	none
192N	20.0	5.0	-20	none
192S	13.0	3.0	-20	none
192E	19.0	7.0	-20	none
192W	21.0	4.5	-20	none
202C	10.0	4.0	-22	none
202N	32.0	2.5	-22	none
202S	23.0	10.0	-22	none
202E	31.0	4.0	-22	none
202W	34.0	4.5	-22	none
205C	11.0	4.5	-20	none
205N	4.0	2.0	-20	1.5
205S	20.0	16.0	-20	none
205E	22.0	15.0	-20	none
205W	9.0	3.0	-20	none
208C	10.0	4.0	-20	none
208N	4.0	0.5	-20	none
208S	6.0	3.0	-20	none
208E	14.0	5.0	-20	1.0
208W	20.0	23.0	-20	none
232C	17.0	4.5	-23	none
232N	13.0	3.0	-23	none

Site Number [1]	Snow Depth (cm)	Snow Hardness (number drops)	Temperature (°C Ambient)	Ice Layer (cm)
232S	20.0	9.0	-23	none
232E	11.0	5.0	-23	none
232W	14.0	4.5	-23	none

[1] Letters indicate plot location; C = centre. N = north, S = south, E = east, W=west.

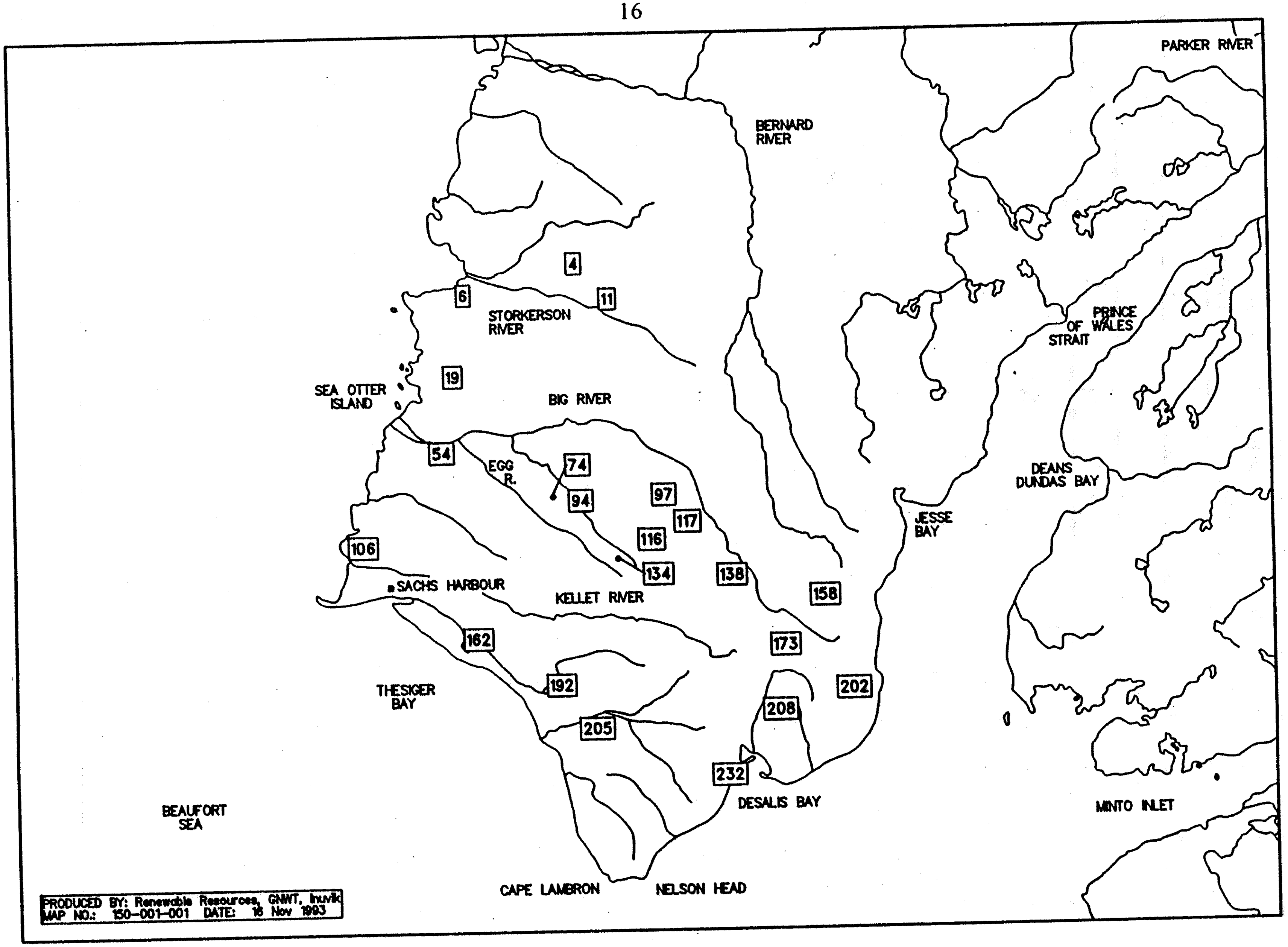

Figure 1. The location of the sites where snow and ice conditions were recorded.

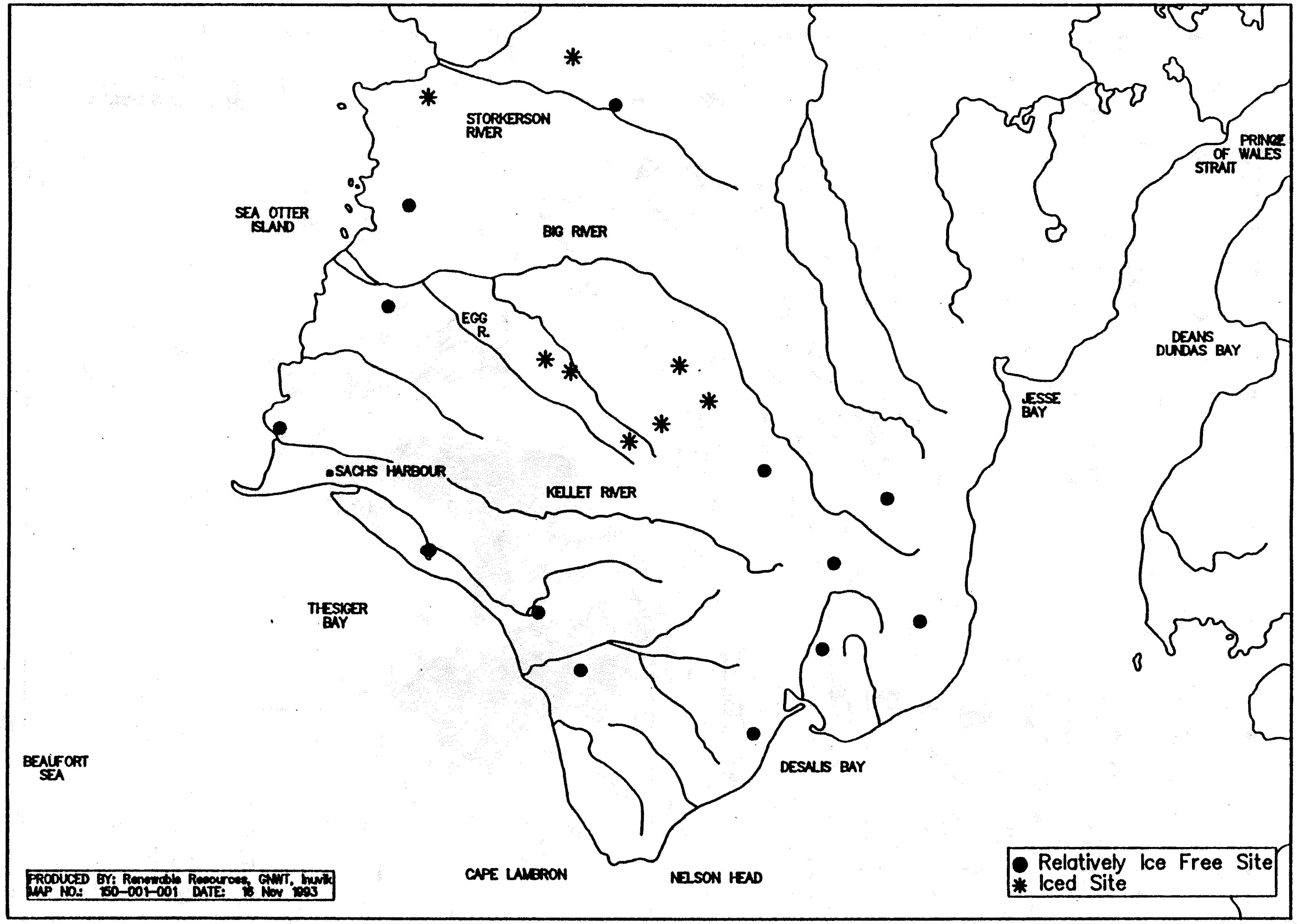

Figure 2. The distribution of iced (✱), and relatively ice free (●) sites.

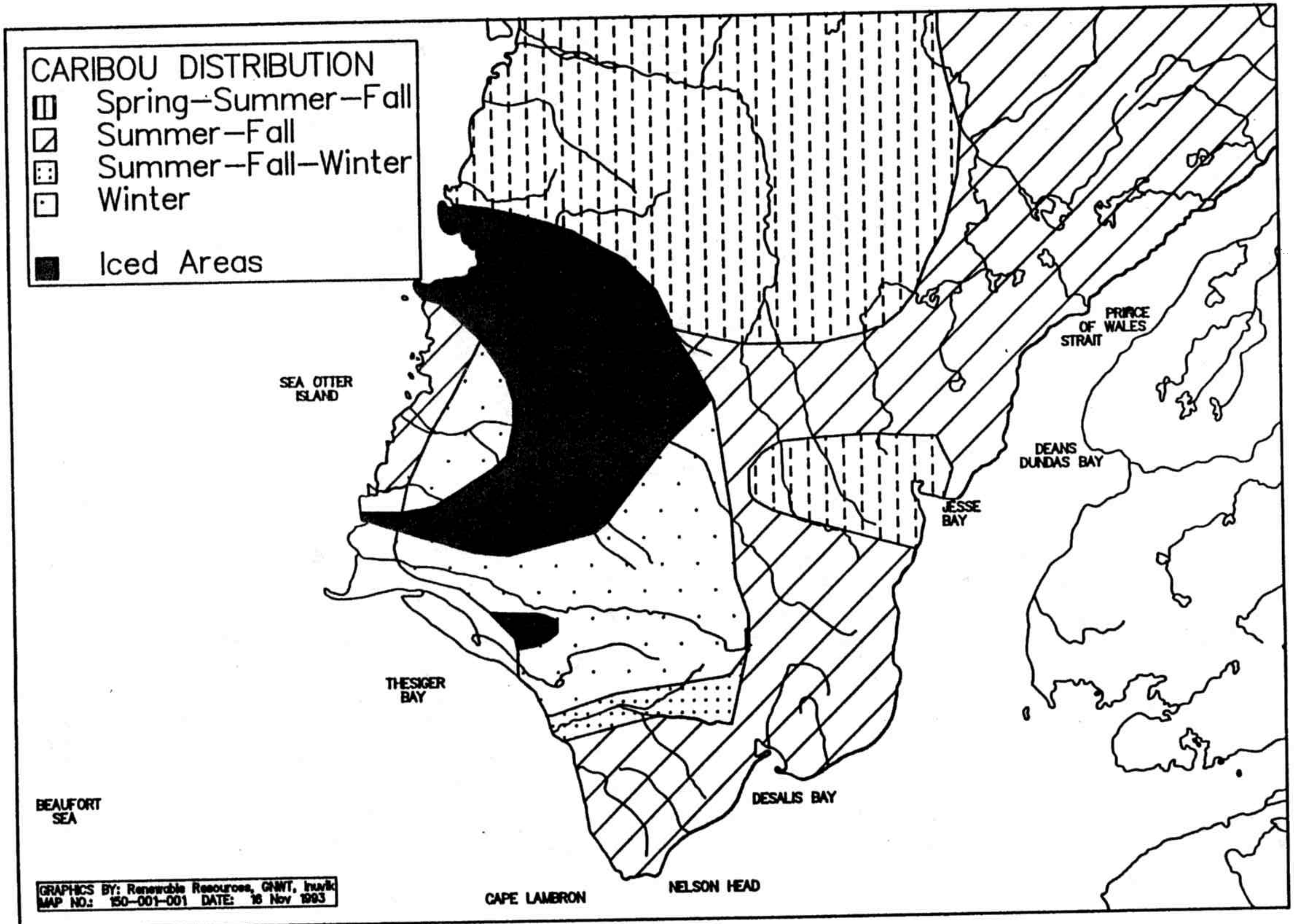

Figure 3. The distribution of the iced zone in relation to the seasonal distribution of caribou range. Seasonal distribution map is adapted from the Sachs Harbour Community Conservation Plan.