

The Distribution and Numbers
of caribou in the Central Arctic
Region of Alaska
1985-1986

by
L.G. Sopuck and R.D. Jakimchuk

Prepared for
Alyeska Pipeline Service Company
ARCO Alaska, Inc.
Conoco, Inc.
Exxon Company, U.S.A.
Sohio Alaska Petroleum Company
Amerada Hess Corporation

May 1986

EXECUTIVE SUMMARY

The seasonal distribution, numbers and movements of caribou in the Central Arctic region were monitored from May 1985 to April 1986. The calving distribution of caribou in the region was similar to that recorded for the period 1981-1984, with concentrations south of Bullen, Milne/Oliktok and Atigaru Points and east of Franklin Bluffs. Calving distributions were characterized by their extreme distances from rivers which confirms the results of previous surveys. Males were found closer to rivers than were females during calving and used riparian habitats much more than did females.

Results of the 1985-86 monitoring program confirm our previous findings that the population of caribou in the Central Arctic region can undergo wide seasonal fluctuations in numbers. We recorded an egress of caribou during the late winter/early spring period and a subsequent increase between 30 May and 7 June, immediately prior to calving. However, the major influxes of caribou into the region recorded during the fall and winter 1982-1985 were not observed in 1985-86. Our long-term monitoring data indicate that the major changes in numbers tend to occur during spring and fall, but that such changes are not always predictable.

The fall and winter distribution of Central Arctic caribou in 1985-86 was similar to previous years, except that densities were lower. The south-central portion of the study area centred on the pipeline supported the highest densities of wintering caribou.

The population of caribou in the Central Arctic region continues to increase rapidly despite expanding hydrocarbon development. The mid-June estimate for 1985 was 17,038 which represents an average annual rate of increase of $r = 0.31$ since 1981. In addition, yearling recruitment and calf productivity continue to be high. However, a doubling of the 1984-85 hunter harvest and possible increased levels of illegal hunting may reduce the rate of growth of Central Arctic caribou. Any assessment of the potential effects of hydrocarbon development on caribou must take into account and differentiate between developmental influences and the distribution and demographic factors which characterize caribou in the region.

TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY.....	i
TABLE OF CONTENTS.....	iii
LIST OF TABLES.....	iv
LIST OF FIGURES.....	v
INTRODUCTION.....	1
STUDY AREA AND METHODS.....	2
RESULTS.....	4
DISTRIBUTION AND ABUNDANCE.....	4
Late May.....	4
Early June.....	7
Mid-June.....	10
November 1985.....	10
March 1986.....	13
April 1986.....	14
Habitat Use.....	17
Population Dynamics.....	20
DISCUSSION.....	22
LITERATURE CITED.....	29

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1.	Number and density of caribou observed during aerial surveys, May to April 1985-86.....	6
2.	Seasonal habitat use by caribou in the study area, 1985-86.....	18
3.	Age and sex composition of all caribou observed during aerial surveys, May to April 1985-86.....	21

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1.	The study area.....	3
2.	Distribution of caribou in late May 1985.....	5
3.	Seasonal changes in mean (\pm S.E.) distance to the coast for individual male and female caribou, 1985-86.....	8
4.	Distribution of caribou in early June 1985.....	9
5.	Distribution of caribou in mid-June 1985.....	11
6.	Distribution of caribou in November 1985.....	12
7.	Distribution of caribou in March 1986.....	15
8.	Distribution of caibou in April 1986.....	16
9.	Seasonal changes in mean (\pm S.E.) distance to riparian habitat for individual male and female caribou, 1985-86.....	19

INTRODUCTION

The results of our monitoring study from 1981-1985 have shown that the numbers of caribou in the Central Arctic region can undergo dramatic seasonal changes. In 1983 and 1985, large numbers of caribou were found in the region in fall and winter (Carruthers 1983; Carruthers et al. 1984; Carruthers and Jakimchuk 1985a,b). In addition, during all years from 1982-1985, there appeared to be an egress of animals from the region in late winter or early spring, with a sudden ingress occurring some time before mid-June. Late fall influxes are the result of intermittent use of the Central Arctic region by the adjacent Western Arctic herd and possibly the Porcupine herd, both of which have increased in recent years (Davis et al. 1980; Barnett 1984; Townsend 1986). The origin of additional caribou entering coastal areas prior to calving is not known at this time. This dynamic situation in fall and early spring may eventually lead to pronounced changes in distribution and movements in the Central Arctic Region (Bergerud et al. 1984). The underlying causes for such changes must be understood so that the effects of oil development on caribou can be accurately assessed.

Our 1985-86 program was designed to continue systematic monitoring of the seasonal distribution, numbers and movements of caribou in the Central Arctic region. Spring,

fall and winter surveys were conducted to determine egress and ingress of caribou. As an additional effort in 1985-86, three consecutive aerial surveys were conducted from late May to mid-June 1985. These surveys were designed to more accurately determine the nature and timing of the ingress of caribou into the region prior to calving and to more accurately delineate the calving distribution along the coast.

STUDY AREA AND METHODS

The 46,000 km² study area is on the North Slope of Alaska and extends slightly west of the lower Colville River and east of the Canning River (Figure 1). The area is described in detail by Carruthers et al. (1984) and Carruthers and Jakimchuk (1985a).

Systematic aerial surveys of the study area were conducted from May 1985 to April 1986. Parallel north-south strip transects 2.0 km wide were surveyed without replacement from 50 km west of the Colville River to the Sadlerochit River. Transect locations were identical to those in use during 1981-1985. Surveys with 10% coverage were conducted in November, March and April. During the 30 May and 15 June surveys, the region was surveyed at 20% coverage within 70 km of the coast, and at 10% beyond 70 km. The 7 June survey was

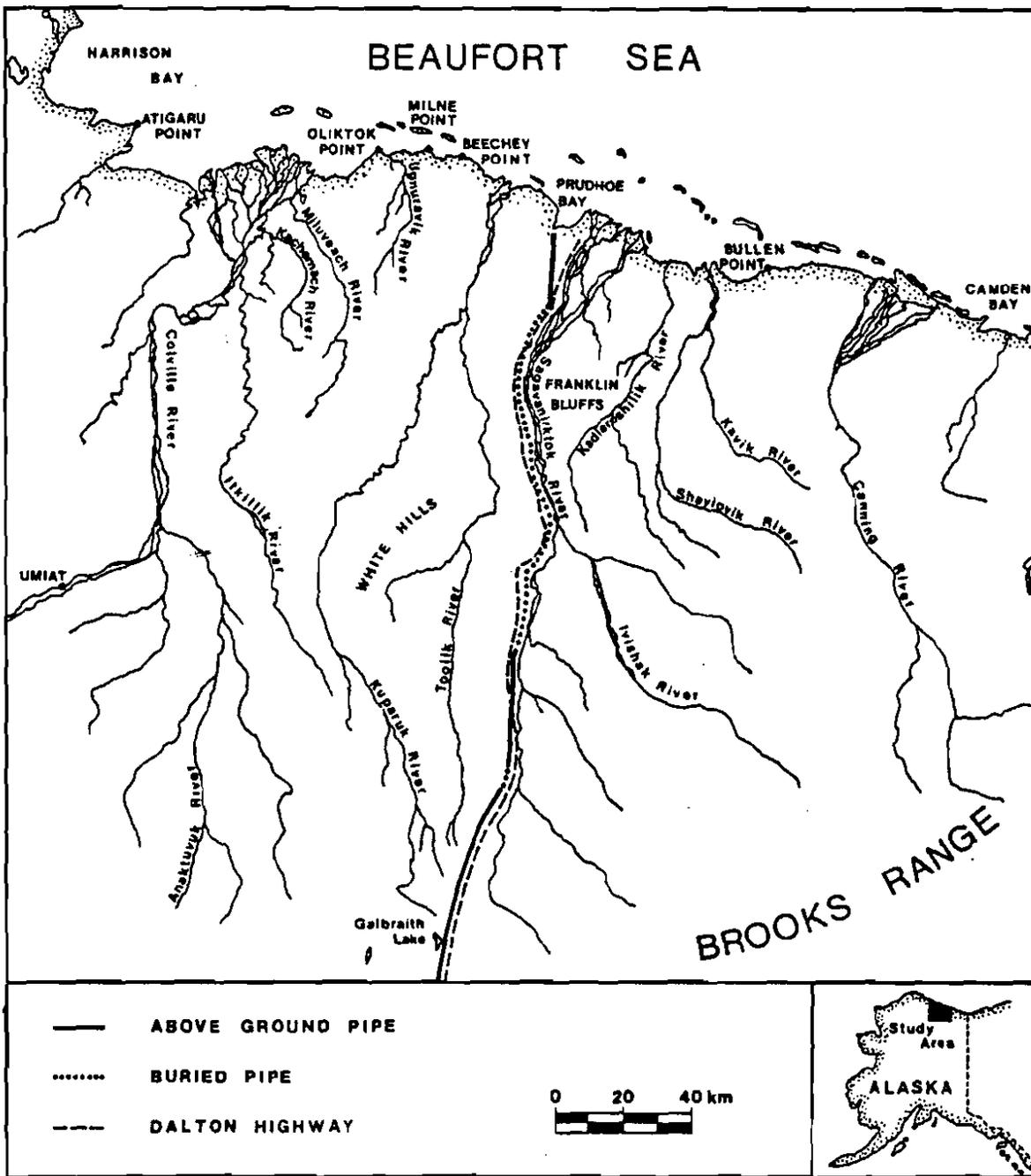


Figure 1. The study area.

conducted at 20% coverage and restricted to the area within 70 km of the coast.

A detailed description of methods is presented in Carruthers and Jakimchuk (1985a).

RESULTS

DISTRIBUTION AND ABUNDANCE

Late May (30 May - 2 June)

As in previous years, caribou were widely dispersed in late May and relatively few animals were seen (Figure 2). About five times as many caribou were seen in February 1985 and twice as many in early and mid-June 1985 (Table 1) as in late May (Table 1; Carruthers and Jakimchuk 1985b). The low population estimate in late May may be due, in part, to the mottled snow conditions at this time of year which result in poor sightability of caribou. However, because of the magnitude of differences in our seasonal estimates and the consistency in our estimates during late May 1982-1985, we believe that our most recent May estimate truly represents a seasonal low in numbers.

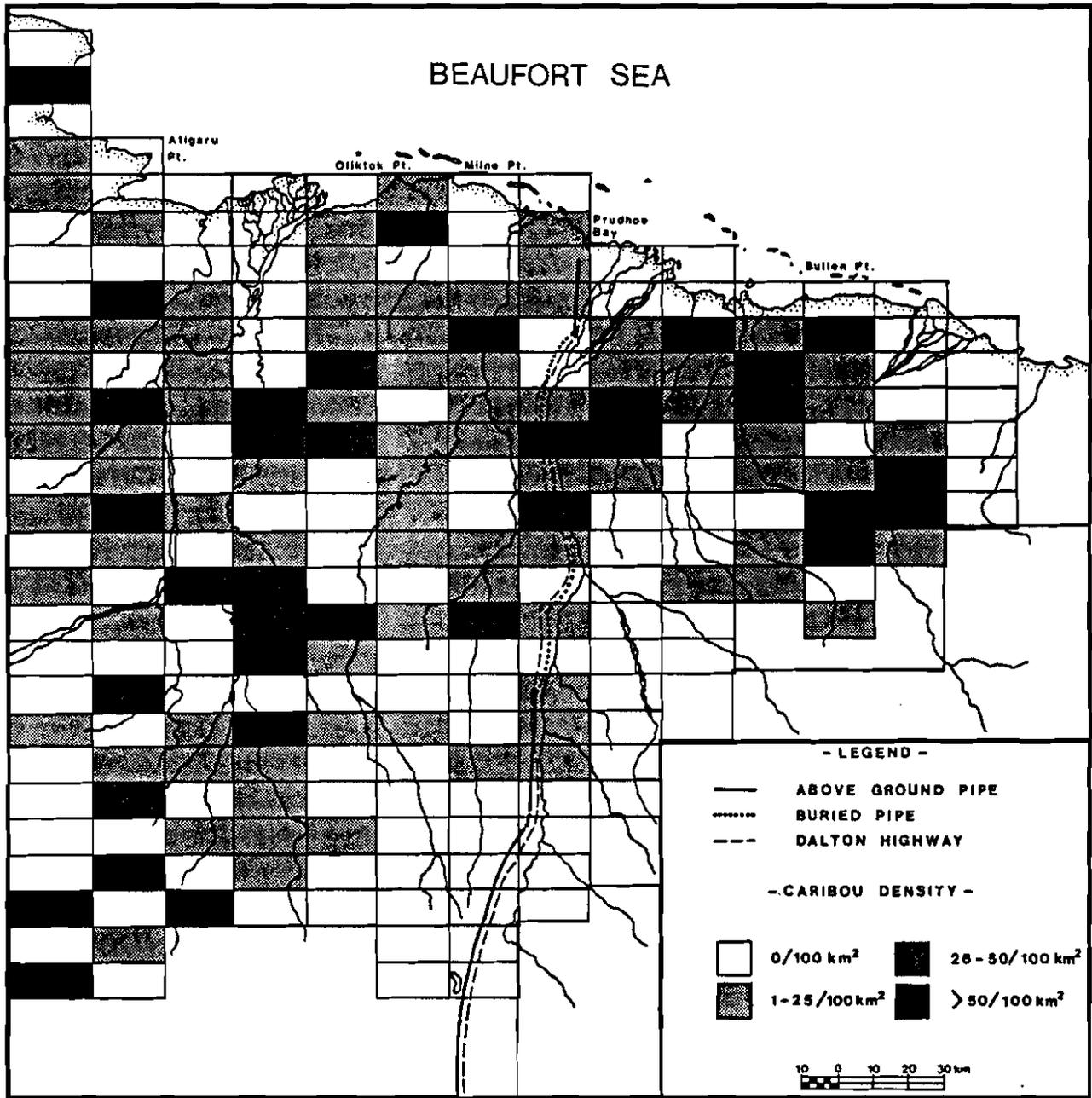


Figure 2. Distribution of caribou in late May 1985.

Table 1. Number and density of caribou observed during aerial surveys, May to April 1985-86.

Date	Stratum ^a	Survey Coverage %	Number of Caribou	Transect Area (km ²)	Density: caribou per 100 km ²	Population Size Est ± S.E.	Population Size Est ± S.E.	Population Size Est ± S.E.	
30 May- 2 June 1985		10%	511	4,310	11.9	5110	771	6388	964
	A	20%	589	4,080	14.4	2945	367	3681	458
	B	10%	261	2,280	11.4	2610	532	3262	665
	A & B		<u>850</u>	<u>6,360</u>	13.4	<u>5555</u>	646	<u>6943</u>	808
7-10 June 1985		10%	615	1,980	31.1	6150	1156	7688	1445
		20%	2,280	3,790	60.2	11400	4436	14250	5545
15-18 June 1985		10%	1,363	3,914	34.8	13630	2238	17038	2923
	A	20%	1,644	3,600	45.7	8220	1236	10275	1545
	B	10%	364	2,114	17.2	3640	497	4550	621
	A & B		<u>2,008</u>	<u>5,714</u>	35.1	<u>11860</u>	1332	<u>14825</u>	1665
November 1985		10%	357	3,370	10.6	4534 ^c	1478 ^c	5668 ^c	1848 ^c
March 1986		10%	910	4,650	19.6	9100	1478	11375	1847
April 1986		10%	957	4,764	20.1	9570	1779	11963	2224

^a Stratum A is within 70 km of coast; Stratum B is greater than 70 km of coast.

^b Corrected for sightability using a factor of 1.25x.

^c Corrected for incomplete survey of transects 8, 11-15, using a factor of 1.27x.

In late May, pregnant females were arriving on calving areas near the coast, whereas males were drifting slowly northward from winter to summer range. Females were, on average, closer to the coast than were males (57 km vs 122 km, Figure 3). Although densities of caribou along the coast were relatively low (Table 1), the areas south of Bullen, Milne/Oliktok and Atigaru Points and east of Franklin Bluffs supported concentrations of calving caribou.

Early June (7-10 June)

The early June survey, conducted within 70 km of the coast, indicated that there is an east-west continuum of calving caribou along the coast (Figure 4). As in late May, the highest densities of caribou occurred south of Bullen, Milne/Oliktok and Atigaru Points and east of Franklin Bluffs. Caribou densities near the coast were much higher than in late May (60.2 vs 14.4 caribou/100 km²). The high population estimate in early June indicated that an influx of calving caribou entered the coastal regions of the study area sometime between 30 May and 7 June 1985 (Table 1).

The high proportion of calves:100 females in early June compared to late May (93:100 vs 37:100) indicated that this survey was conducted near the peak of calving.

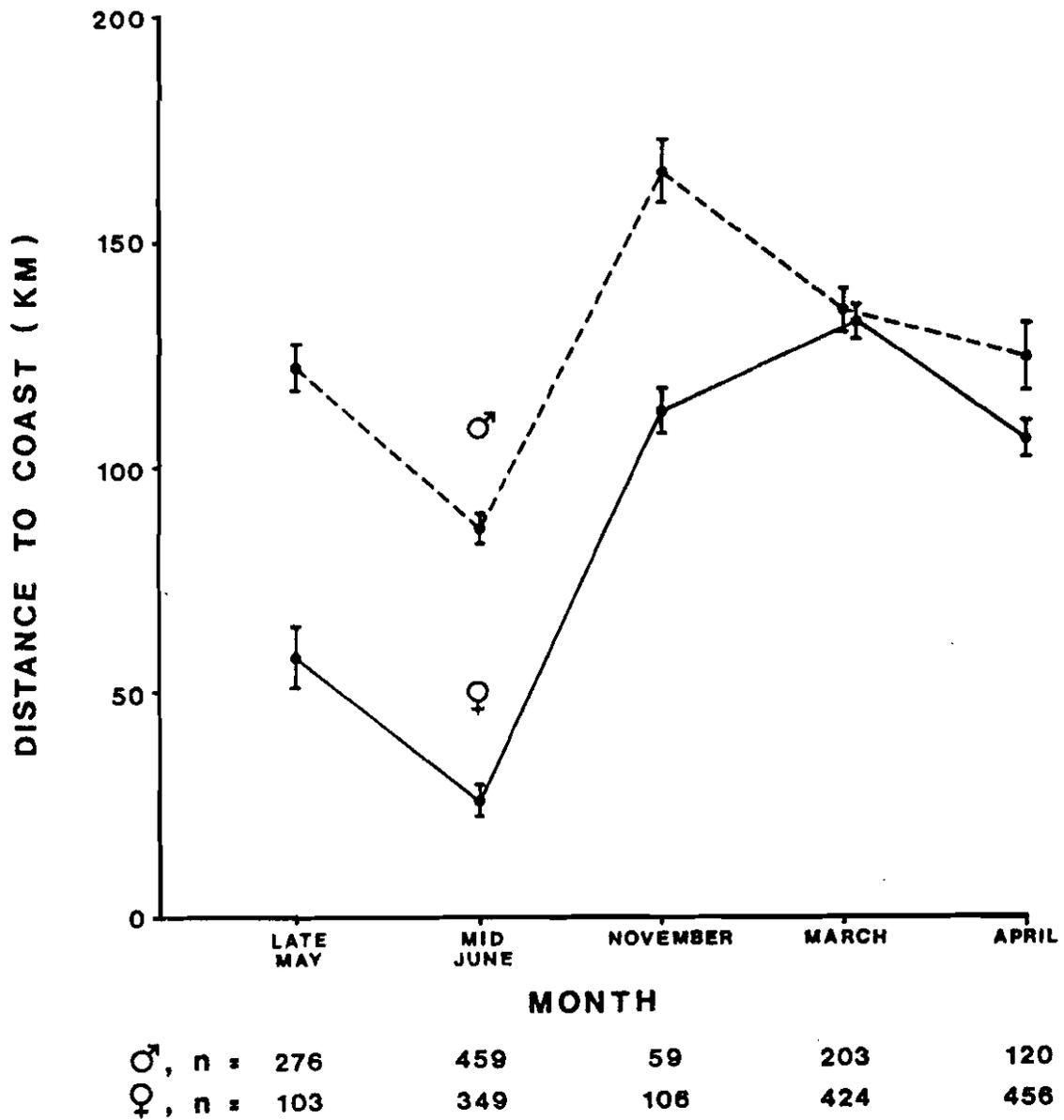


Figure 3. Seasonal changes in mean (\pm S.E.) distance to the coast for individual male and female caribou, 1985-1986.

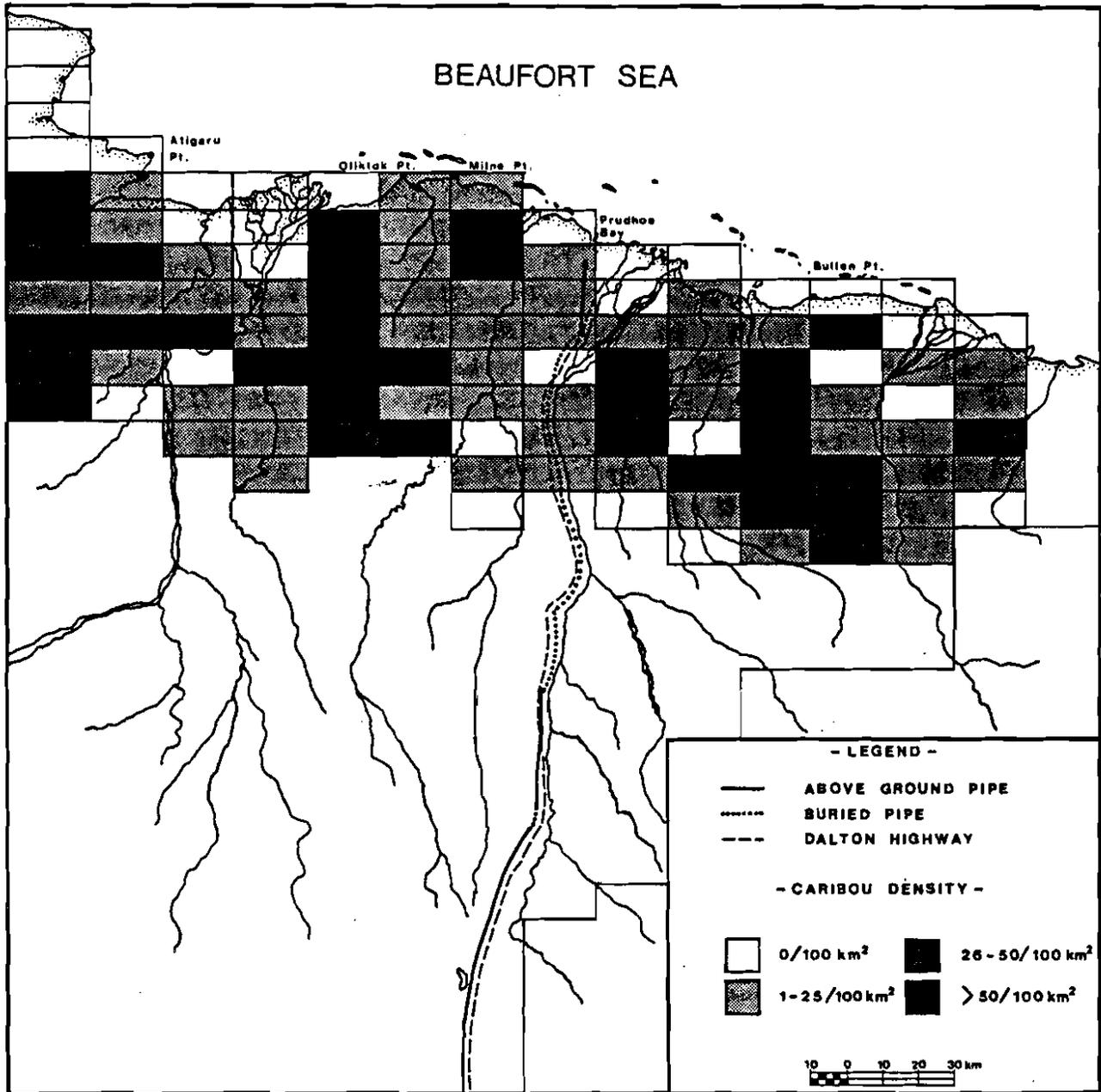


Figure 4. Distribution of caribou in early June 1985.

Mid-June (15-18 June)

As in May and early June, the mid-June survey showed a continuum of calving along the coast, with the areas south of Bullen, Milne/Oliktok and Atigaru Points and east of Franklin Bluffs still supporting the highest densities (Figure 5). The estimated population size and density of caribou for mid-June was at least twice that of late May and similar to that obtained for early June (Table 1). These data indicate that the influx of females onto calving areas in the study area was complete by 7 June.

In mid-June females were, on average, closer to the coast than at any other season and were significantly closer to the coast than were males (28 vs 87 km, Figure 3).

November 1985

Relatively few caribou were observed in the study area during November (Figure 6). This contrasts with the results of surveys from 1982-1984 which indicated population levels 5-6 times that of 1985 (Carruthers and Jakimchuk (1985b)). The November estimate was also about three times lower than the mid-June estimate, suggesting an egress of caribou from the study area during summer or fall (Table 1).

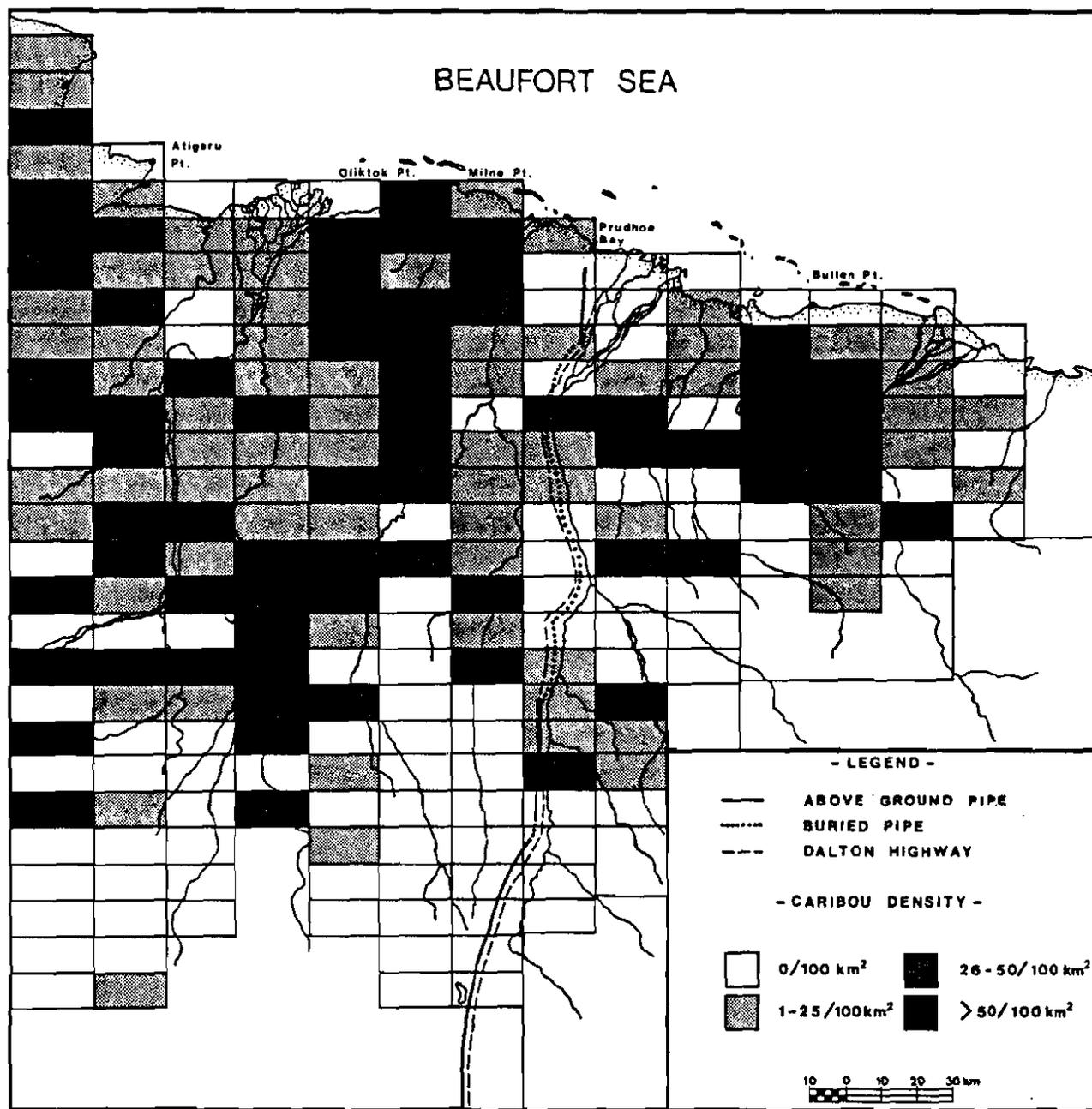


Figure 5. Distribution of caribou in mid-June 1985.

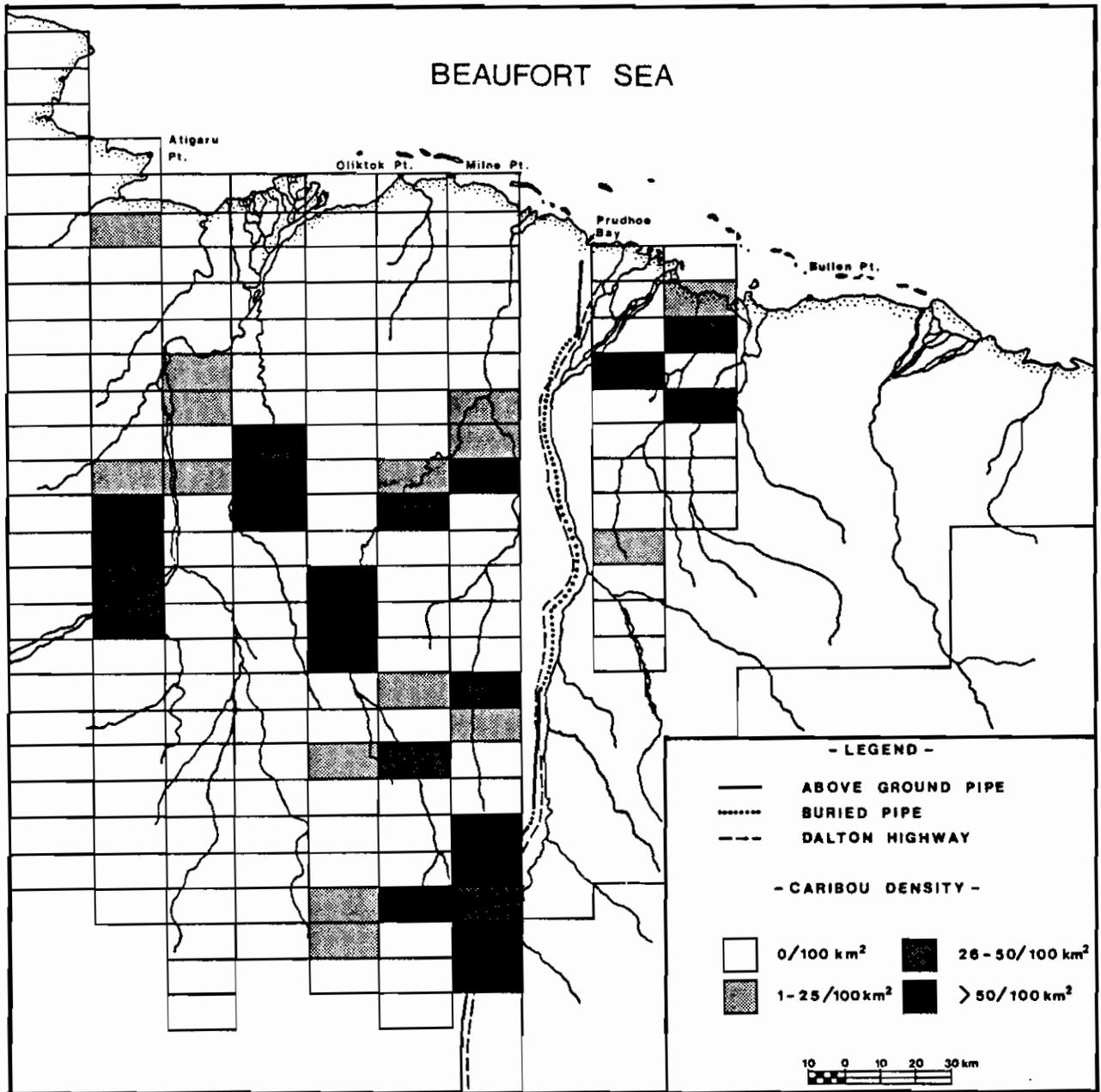


Figure 6. Distribution of caribou in November 1985. Transects 8 and 11-15 could not be surveyed due to poor weather.

However, the low November estimate may be due, in part, to the incomplete survey coverage. Although the estimate was corrected for incompleteness by extrapolation of caribou densities from surveyed areas, densities in the southwestern portion of the study area were probably much higher given the results of past surveys (Carruthers and Jakimchuk 1985a; Carruthers et al. 1984).

In November, caribou distribution had shifted south, although females were still closer to the coast than were males (122 vs 166 km, Figure 3). Relatively high densities of caribou occurred in the south-central and west-central portions of the study area near the Trans-Alaska pipeline and between Umiat and the White Hills (Figure 6).

March 1986

In March, caribou numbers increased to a level slightly lower than that obtained during mid-June (Table 1). However, the population estimate was well below that obtained in late winter 1985 (Carruthers and Jakimchuk 1985b) and no major influx of caribou into the region was detected. The March estimate was twice that obtained in November. Although this difference may be due, in part, to the incomplete coverage during November, the magnitude of the difference suggests that

a minor influx of caribou may have occurred between November and March.

In November caribou were located mainly within the foothills of the Brooks Range (Figure 7). The highest densities occurred in the south-central portion of the study area near the Trans-Alaska pipeline. A smaller concentration was located in the northwestern portion of the study area. On average, male and female caribou were located at a similar distance from the coast (Figure 3).

April 1986

As in March 1986, no major influx of caribou into the study area was detected and hence the population estimate was much lower than that recorded in February 1985. Estimated numbers were virtually unchanged from the March estimate (Table 1). The distribution of caribou in April was very similar to that recorded in March with the south-central and northwest portions of the study area again supporting the highest densities (Figure 8). In contrast to March, females were, on average, slightly closer to the coast than were males (107 vs 125 km), suggesting that females were gradually drifting towards their calving areas near the coast (Figure 3).

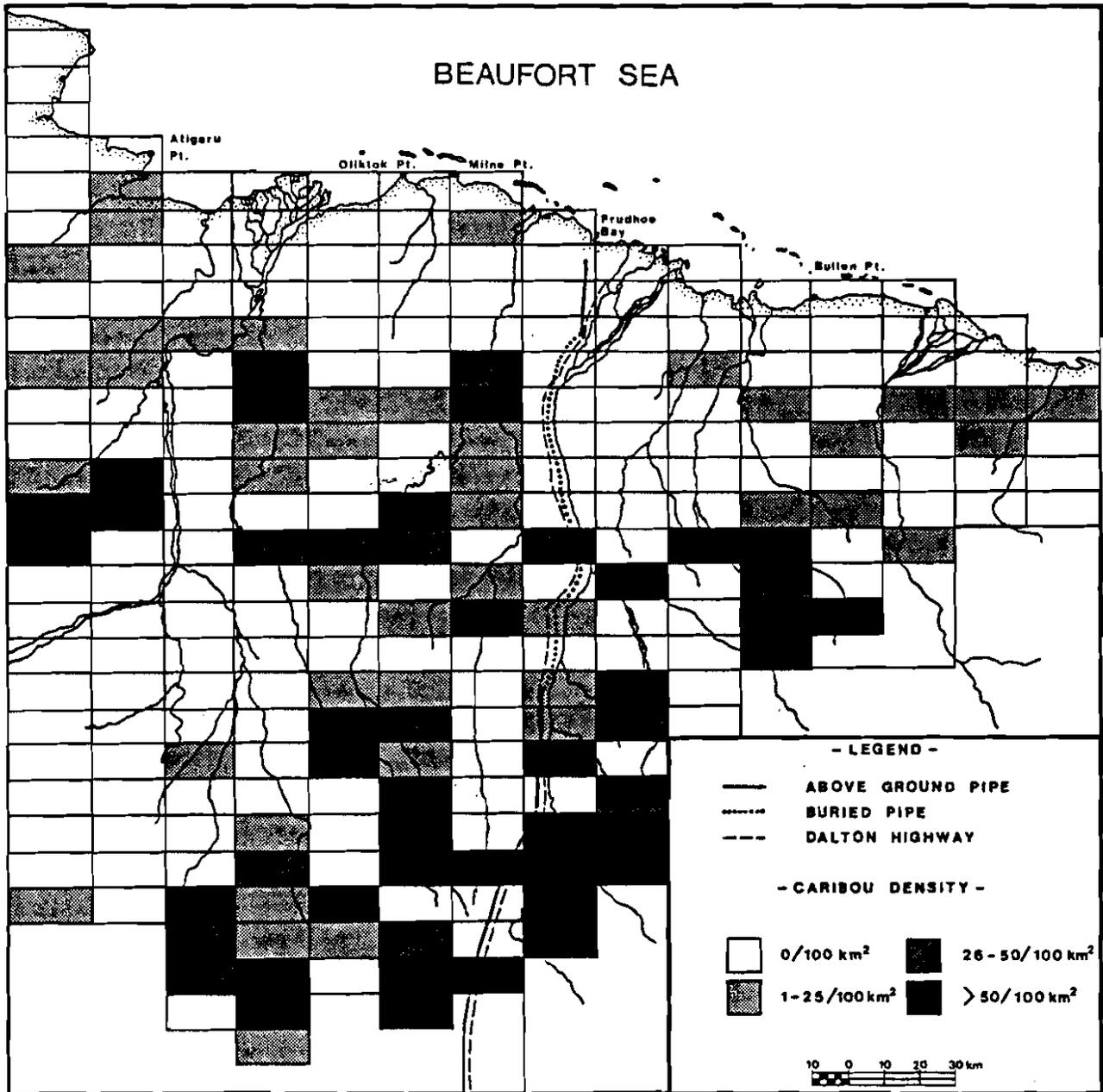


Figure 7. Distribution of caribou in March 1986.

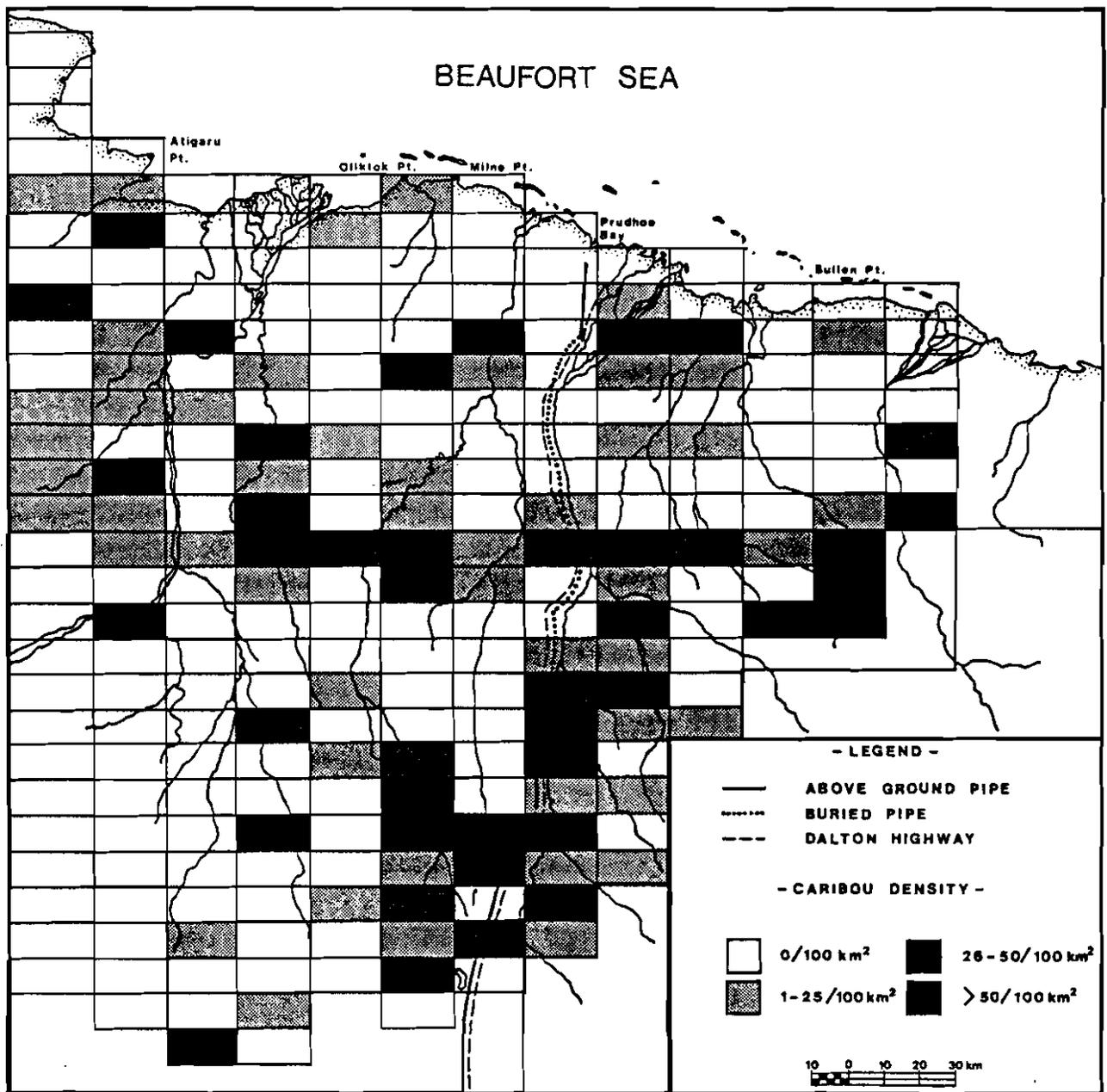


Figure 8. Distribution of caribou in April 1986.

Habitat Use

Male and female caribou exhibited different habitat use patterns during May and June and similar patterns during fall and winter (Table 2, Figure 9). In late May and mid-June females were, on average, significantly farther from riparian habitats than were males (9.4 vs 4.7 km and 10.8 vs 3.0 km), confirming the results of surveys between 1981-1985 (Carruthers et al. 1984; Carruthers and Jakimchuk 1985a). The calving areas used by females at this time were characterized by their extreme distance from rivers. These data are supported by Table 2 which indicates that females made greater use of sedge meadow and less use of tussock meadow and riparian habitats than did males.

In November, March and April, the use of tussock meadow, mat and cushion tundra and riparian habitats by females increased to a level similar to that of males (Table 2). However, females still used sedge meadow more than did males. In addition, the average distance of males and females from riparian habitat did not differ significantly during these months (Figure 9).

Table 2. Seasonal habitat use by caribou in the study area, 1985-86.

Date	Habitat						n
	Sedge Meadow	Tussock Meadow	Riparian	Delta	Mat-Cushion	Disturbed	
MAY							
Males	16.7	65.6	17.8	0	0	0	276
Females	43.7	48.5	6.8	1.0	0	0	103
7 JUNE ^a							
Males	49.2	8.6	39.8	1.6	0.8	0	128
Females	89.7	5.5	4.1	0.7	0	0	145
15 JUNE							
Males	23.5	24.4	51.4	0	0	0	459
Females	81.4	9.2	7.7	1.7	0	0	349
NOVEMBER							
Males	13.6	72.9	5.1	0	8.5	0	59
Females	40.6	42.5	17.0	0	0	0	106
MARCH							
Males	4.4	55.2	13.3	0	27.1	0	203
Females	9.7	66.5	7.8	0	16.0	0	424
APRIL							
Males	7.5	62.5	5.0	0	25.0	0	120
Females	16.2	65.4	5.3	0	13.2	0	456

^a June 7th survey was within 70 km of coast.

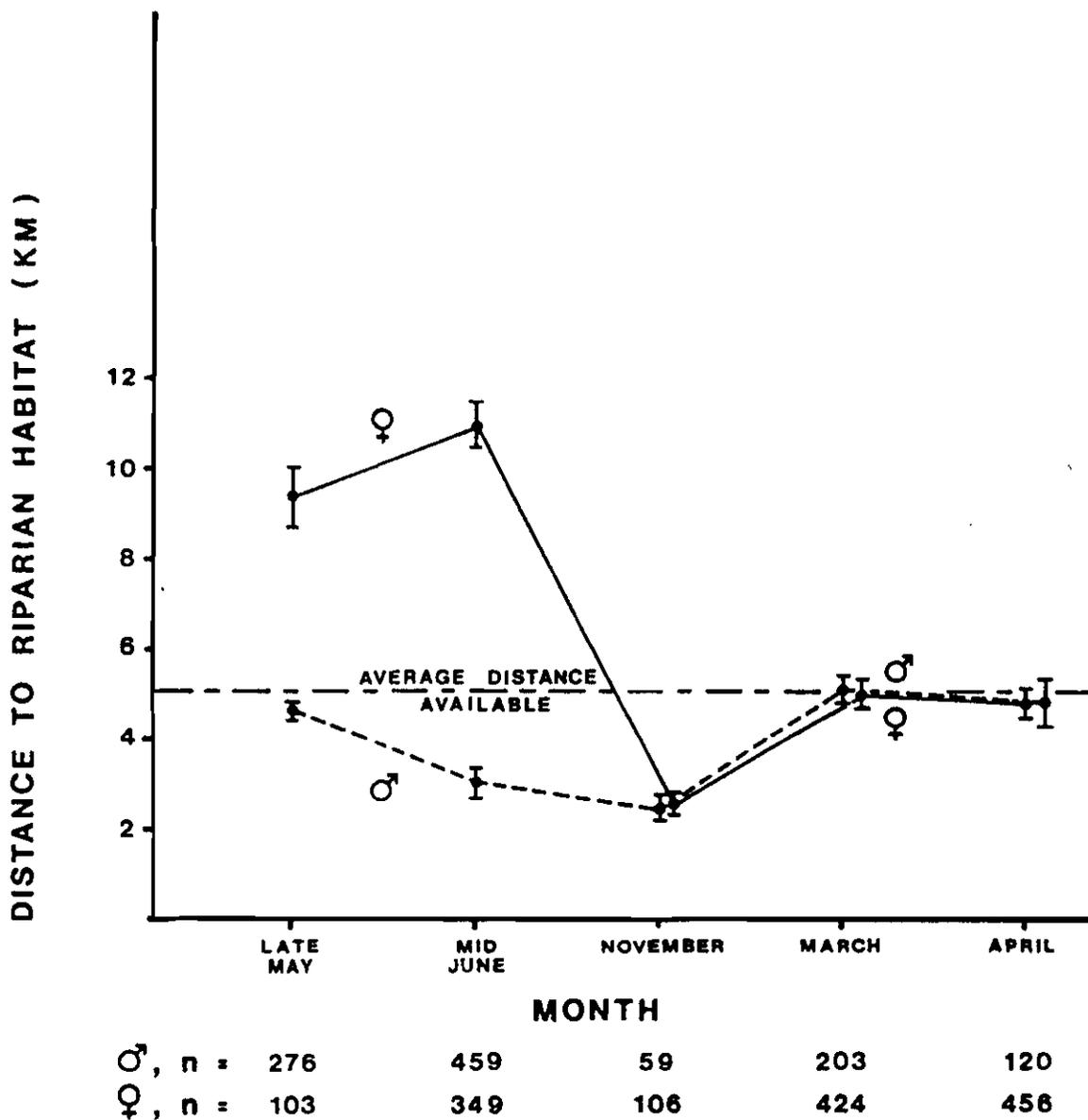


Figure 9. Seasonal changes in mean (\pm S.E.) distance to riparian habitat for individual male and female caribou, 1985-86.

Population Dynamics

Based on the mid-June survey at 10% coverage, the population of caribou in the Central Arctic region in 1985 was estimated at 17,038 caribou (Table 1). Similar surveys conducted at 10% coverage during mid-June 1981-1984 indicated that the population has grown from 4,700 animals in 1981 at an average annual rate of $r = 0.31$ (Carruthers and Jakimchuk 1985b). Stratification of the study area using 20% survey coverage along the coast and 10% inland resulted in a slightly lower estimate of 14,825 animals but still within the 1 S.E. of the 10% estimate. The last photo census conducted by the Alaska Department of Fish and Game resulted in an estimate of 13,000 caribou in June 1983 (Townsend 1986).

The male:female ratio fluctuated dramatically from May 1985 to April 1986 (Table 3). Males comprised 66.1% of adults in May and declined steadily during June, November and March to a level of 19.6% in April. The high percentage of males in late May was similar to the levels recorded in February 1985 (60%) whereas November to April levels are similar to those reported for most surveys from 1981-1984 (Carruthers et al. 1984; Carruthers and Jakimchuk 1985a).

The number of calves:100 females continues to be very high for caribou in the Central Arctic region. Calf:cow ratios

Table 3. Age and sex composition of all caribou observed on aerial surveys, May 1985 to April 1986.

DATE	ADULT MALES	ADULT FEMALES	PERCENT MALES	CALVES	CALVES PER 100 FEMALES	YEAR- LINGS	UN- CLASS- IFIED	TOTAL
LATE MAY	453	232	66.1	85	36.6	123	268	1161
EARLY JUNE	327	766	29.9	715	93.3	146	1535	3489
MID- JUNE	720	664	52.0	522	78.6	138	1252	3296
NOVEMBER	61	111	35.5	52	46.8	-	363	587
MARCH	204	443	31.5	169 ^a	38.1 ^b	-	302	1118
APRIL	122	501	19.6	172 ^a	34.3 ^b	-	449	1244

^a Short-yearlings

^b Short-yearlings per 100 females

were 79:100 immediately after calving and declined gradually to 34:100 by the following April (Table 3). These ratios were very similar to those reported from July 1984 to February 1985 (62:100 to 35:100) (Carruthers and Jakimchuk 1985a).

Yearlings in May 1985 accounted for 15.2% of the population (excluding calves). Yearling estimates in June 1985 were not considered accurate because of the difficulty in identifying yearlings at that time of year. In March and April 1986, the percentage of short-yearlings in the population averaged 21.2%.

DISCUSSION

Our 1985-86 monitoring program continues to indicate that the population of caribou in the Central Arctic region can undergo wide seasonal fluctuations in numbers. The trend for an egress of caribou in late winter or early spring and a subsequent increase prior to calving which was observed from 1981-1984 (Carruthers and Jakimchuk 1985b) was confirmed in 1985. The additional survey conducted in early June indicated that this influx occurred between 30 May and 7 June. However, the major influxes of caribou into the region recorded during

the fall (1982-1984) and winter (1983-1985) were not observed in fall 1985 and winter 1986.

In the past, Western Arctic herd animals have passed through the study area en route to more southerly winter ranges. This type of movement may have occurred undetected during the fall. Our long-term monitoring data indicate that the major changes in numbers tend to occur during spring and fall, but that such changes are not always predictable.

Recent studies by Cameron et al. (1985) showed that females which were radio-collared in the Central Arctic region in spring showed high fidelity to summer ranges in the region in subsequent years. However, these results do not exclude the possibility that females which winter outside the study area also show fidelity to Central Arctic calving and summer ranges. Our data suggest that large numbers of females enter the study area during spring to calve in the region. Also, because cows were not radio-collared during fall and winter 1982-1984, when large numbers of caribou from adjacent herds were in the study area, movements of cows to calving grounds of adjacent herds were not detected.

The calving distribution of caribou in the Central Arctic region in 1985 was similar to that described by Carruthers and Jakimchuk (1985a), Carruthers et al. (1984) and

Lawhead and Curatolo (1984) for the period 1981-1984. There is a calving continuum from the east to west boundaries of the study area with concentrations south of Bullen, Milne/Oliktok and Atigaru Points and east of Franklin Bluffs. Sopuck and Jakimchuk (1985) reported that the area within 25 km of the coast between Oliktok Point and Prudhoe Bay supported an average of 6.1% (n = 3) of calving caribou during 1985 compared to the 1981-1984 average of 14.6% (n = 7). The difference was due mainly to a high percentage observed on 17-18 June 1981 when post-calving caribou had moved toward the coast. Also, survey coverage did not extend as far east and west as in later years, thus possible concentrations of caribou near the extremities of the study area were missed. The percentage of Central Arctic caribou calving in the Oliktok-Prudhoe Bay area has remained relatively stable since 1982, despite increasing hydrocarbon development.

Calving distributions along the coast were characterized by their extreme distances from rivers which confirms the results of surveys conducted from 1981-1984 by Carruthers et al. (1984) and Carruthers and Jakimchuk (1985a) and in 1983 by Lawhead and Curatolo (1984). Males were found closer to rivers than were females during calving and used riparian habitats much more than did females. The avoidance of riparian habitats by females appears to be related to predator avoidance, whereas males use the relatively lush vegetation

within river valleys to replenish depleted fat resources (Jakimchuk et al., in prep.). The avoidance of riparian habitats by females during calving accounts for the differences between cow-calf distribution along the Trans-Alaska pipeline corridor and regionally reported by Cameron and Whitten (1980). These authors concluded that cow-calf avoidance of the corridor resulted solely from disturbance, but their analysis did not include the influence of sexual segregation and differential habitat use by males and females.

Habitat use by male and female caribou was similar during fall and early winter. This was probably due to the mixing of males and females during the rut and to the maintenance of these mixed groups well into the winter. However, because of the more northerly distribution of females on average, females showed slightly greater use of sedge meadow and less use of mat-cushion than males. This difference was most pronounced in November and April. A similar pattern of habitat use by males and females during winter was evident from 1981-85 (Carruthers and Jakimchuk 1985a; Jakimchuk et al., in prep.).

Cameron and Whitten (1980) predicted that the Central Arctic herd may become fragmented because of disturbance associated with the pipeline corridor. However, our surveys from 1981-1985 suggest that there is substantial movement of

animals across the corridor and that the direction of this movement varies annually. Sopuck and Jakimchuk (1985) show that a greater percentage of the herd calved west of the Sagavanirktok River in 1981, 1982 and 1984, whereas a greater percentage calved east of the river in 1983 and 1985. These differences may also be influenced by calving distributions of adjacent herds.

The fall and winter distribution of Central Arctic caribou in 1985-86 was similar to previous years except that densities were lower. Surveys in November 1984 and February 1985 showed high concentrations of caribou in the south-central portion of the study area centred on the pipeline and a smaller concentration to the northwest (Carruthers and Jakimchuk 1985a). The same pattern was evident in November 1985 and March and April 1986, except that the northwestern concentration was not as large. The low densities in 1985-86 indicated that few, if any, Western Arctic herd caribou wintered in the study area as had occurred in previous years.

The population of caribou in the Central Arctic region continues to increase rapidly despite expanding hydrocarbon development. The average annual rate of increase of $r = 0.31$ determined between 1981-1985 is extremely high and probably above the theoretical maximum for a closed population of caribou (Bergerud 1980; Van Ballenberghe 1983). Part of

this increase may be related to an ingress of animals from adjacent herds. Yearling recruitment and calf productivity were high in 1985 indicating that survival of caribou in the Central Arctic region remains high. High productivity and yearling recruitment were confirmed by the Alaska Department of Fish and Game surveys in 1984 and 1985 (Townsend 1986).

Although adult mortality of caribou in the Central Arctic region appears to be relatively low, a doubling of the 1984-85 hunter harvest to 368 animals was reported by the Alaska Department of Fish and Game (Townsend 1986). Hunter harvest may actually be considerably higher because of recent illegal hunting of Central Arctic caribou within the foothills of the Brooks Range (Berry 1986). If hunter harvest continues to increase, the rate of growth of caribou numbers in the Central Arctic region will decline. This increased harvest should be monitored carefully so that its contribution to any sudden demographic changes in the Central Arctic caribou population can be accurately assessed. Such influences on the the herd can have a major bearing on population trends. Any assessment of the potential effects of hydrocarbon development on caribou must take into account and differentiate between developmental influences and the distributional and demographic factors which characterize caribou in the region.

Despite the complexity of caribou inter-relationships within the region, monitoring studies have shown that there is considerable consistency in distributional patterns over the annual cycle. The systematic data base on calving distributions shows that, with minor annual variations, overall distributional patterns have been maintained even though petroleum development activities have expanded. Continued documentation of these interrelationships will provide valuable insight into the longer term significance of the caribou-petroleum development interaction.

Literature Cited

- Barnett, J.A. (ed.). 1984. Annual report of survey inventory activities. Part VI. Caribou. Alaska Dep. Fish and Game, Juneau, Alaska.
- Bergerud, A.T. 1980. A review of the population dynamics of caribou and wild reindeer in North America. Int. Reindeer/Caribou Symp. 2:556-581.
- Bergerud, A.T., R.D. Jakimchuk and D.R. Carruthers. 1984. The buffalo of the north: Caribou (Rangifer tarandus grant) and human development. Arctic 37(1):7-22.
- Berry, K. 1986. Ill-gotten harvest - caribou hunters cross the line. April 26 article in the Daily News-Miner, Fairbanks, Alaska.
- Cameron, R.D. and K.R. Whitten. 1980. Influences of the Trans-Alaska Pipeline corridor on the local distribution of caribou. Int. Reindeer/Caribou Symp. 2:475-481.
- Cameron, R.D., K.R. Whitten and W.T. Smith. 1985. Summer range fidelity of radio-collared caribou in Alaska's Central Arctic herd. Paper presented at the Fourth International Reindeer/Caribou Symposium. Whitehorse, Yukon; August 1985.
- Carruthers, D.R. 1983. Overlap of Central and Western Arctic caribou within the current range of the Central Arctic herd. Prep. for ARCO Alaska Inc. by Renewable Resources Consulting Services Ltd. 20 pp.
- Carruthers, D.R. and R.D. Jakimchuk. 1985a. The distribution and numbers of caribou in the Central Arctic region of Alaska, 1984-1985. Prep. by Renewable Resources Consulting Services Ltd. for Alyeska Pipeline Service Company, ARCO Alaska Inc., Chevron U.S.A. Inc., Conoco Inc., Exxon Company U.S.A., and Sohio Alaska Petroleum Company. 47 pp.
- Carruthers, D.R. and R.D. Jakimchuk. 1985b. Caribou of the Central Arctic Region in relation to adjacent caribou herds. Paper presented at the Fourth International Reindeer/Caribou Symposium, Whitehorse, Yukon; August 1985.
- Carruthers, D.R., R.D. Jakimchuk and S. Ferguson. 1984. The relationship between the Central Arctic caribou herd and the Trans-Alaska Pipeline. Prep. by Renewable Resources Consulting Services Ltd. for Alyeska Pipeline Service Company, Anchorage. 207 pp.

- Davis, J.L., P. Valkenburg and H.V. Reynolds. 1980.
Population dynamics of Alaska's Western Arctic caribou
herd. *Int. Reindeer/Caribou Symp.* 2:595-604.
- Jakimchuk, R.D., S.H. Ferguson and L.G. Sopuck. In prep.
Differential habitat use and sexual segregation in the
Central Arctic caribou herd. Submitted to *Can. J. Zool.*
- Lawhead, B.E. and J.A. Curatolo. 1984. Distribution and
movements of the Central Arctic caribou herd, summer 1983.
Prep. by Alaska Biological Research for ARCO Alaska Inc.
52 pp.
- Sopuck, L.G. and R.D. Jakimchuk. 1985. Calving and post-
calving distributions of Central Arctic caribou 1981-1985.
Prep. by Renewable Resources Inc. for Alyeska Pipeline
Service Company, Amerada Hess Corporation, ARCO Alaska
Inc., Conoco Inc., Exxon Company U.S.A., and Sohio Alaska
Petroleum Company. 1 p + map folio.
- Townsend, B. (ed.). 1986. Annual report of survey inventory
activities. Part XI. Caribou. Alaska Dep. Fish and
Game, Juneau, Alaska. 58 pp.
- Van Ballenberghe, V. 1983. Rate of increase in moose
populations. *Alces* 19:1-20.