Alaska Department of Fish and Game
Division of Wildlife Conservation

Grant W-24-1, W-24-2, W-24-3

Federal Aid in Wildlife Restoration
Research Final Report
1 July 1992 - 31 December 1994

Influence of Body Condition on Productivity of Adult Female Caribou in the Porcupine Caribou Herd

Kenneth R. Whitten

Study 3.39
October 1995

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STATE OF ALASKA
Tony Knowles, Governor

DEPARTMENT OF FISH AND GAME
Frank Rue, Commissioner

DIVISION OF WILDLIFE CONSERVATION
Wayne L. Regelin, Director

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RESEARCH FINAL REPORT

STATE: Alaska

COOPERATORS: Thomas R McCabe, US Fish and Wildlife Service; Donald E Russell, Canadian Wildlife Service; Robert G White, University of Alaska Fairbanks

PROJECT NO.: W-24-1, W-24-2, W-24-3 **PROJECT TITLE:** Wildlife Research and Management

STUDY NO.: 3.39 **STUDY TITLE:** Influence of Body Condition on Productivity of Adult Female Caribou in the Porcupine Caribou Herd

PERIOD COVERED: 1 July 1992-31 December 1994

SUMMARY

Biologists from cooperating agencies captured, weighed, measured, sampled, and determined body condition scores of cow and calf caribou (*Rangifer tarandus*) from the Porcupine Caribou Herd (PCH) during March, early June, late June, mid July, late September/October, and mid November, 1992-1994. Calves were collected for necropsy during early June, early July, and early October 1992. We analyzed changes in weight and body condition parameters relative to parturition or lactation status and time of year. Results of these studies should enable management agencies to make more informed decisions on the importance of specific habitats on the coastal plain of the Arctic National Wildlife Refuge to the well-being of the PCH. If petroleum development should ever occur on the coastal plain, these baseline data will also be useful in identifying and mitigating effects on caribou.

Key words: Arctic National Wildlife Refuge, body condition, caribou, Porcupine Caribou Herd, productivity, *Rangifer tarandus.*

CONTENTS

BACKGROUND

The coastal plain of the Arctic National Wildlife Refuge (ANWR) is the most promising onshore prospect for a major new petroleum discovery in the United States (Clough et al. 1987). Both the federal government and the state of Alaska favor petroleum leasing and development within ANWR, but only if it proceeds in a manner sensitive to the environmental needs of the Porcupine Caribou (*Rangifer tarandus*) Herd (PCH) and other wildlife.

The PCH is an important international resource and a major food source for Native villages in northeastern Alaska, the Yukon, and Northwest Territories of Canada. Porcupine Herd caribou are also used by sport hunters in both nations and are becoming increasingly popular with hikers, river floaters, wildlife watchers, and photographers in ANWR and the Ivvavik and Vuntut National Parks in the Yukon. An International Agreement between the United States and Canada recognizes both nations' commitment to preserving these animals for present and future generations.

Proposed petroleum development on the ANWR coastal plain could affect the PCH's use of calving and summer habitats. Because of consistent and long-term use, these habitats are presumed important to caribou. Previous research has documented higher calf survival when the PCH uses coastal plain habitats during calving, apparently as a consequence of lower predator densities on the coastal plain relative to adjacent foothills and mountains (Fancy and Whitten 1991, Whitten et al. 1992). The coastal plain may also provide higher forage quality and quantity (White et al. 1989, Fancy and Whitten 1991). If caribou access to preferred habitats is reduced due to oil development on the ANWR coastal plain, the PCH might be adversely affected through increased mortality and/or lower nutritional status.

We lack baseline data on caribou body condition relative to specific habitat use within the proposed development area and adjacent areas to which caribou might be displaced. Agencies managing the PCH must have reliable baseline data on caribou use of ANWR habitats to plan adequately for responsible development and to detect and mitigate adverse effects from development. Such baseline data will be necessary to determine whether any future declines in caribou body condition are human-caused or fall within the range of natural variation and whether these declines will reduce productivity or lower calf survival.

Therefore, the Alaska Department of Fish and Game (ADF&G), the National Biological Service (NBS), the Yukon Wildlife Branch (YWB), the Canadian Wildlife Service (CWS), and the University of Alaska Fairbanks (UAF) are investigating relationships between caribou habitat use and population dynamics. The primary responsibility of ADF&G was to work with CWS to capture, weigh, and measure radiocollared cow caribou periodically throughout the year and calf caribou during autumn and winter. The NBS handled calves in summer and monitored habitat use daily in June and early July. Graduate student Karen Gerhart of UAF necropsied calves and helped analyze data from in vivo measurements of live-captured caribou. The YWB assisted in most of the above studies and supervised a program to train local hunters to provide specimens from harvested caribou; many results of this study are already being incorporated into YWB's collection program.

OBJECTIVES

General objectives of this study were to characterize and compare oversummer weight gain of female caribou and their calves, examine relationships between fall body weight/condition and subsequent calf production and survival, and determine patterns of summer range use which may cause insufficient weight gain leading to pregnancy failure or lowered calf survival.

Specific job objectives were to:

1 Determine oversummer changes in body weight and composition of nonlactating adult female caribou.

2 Determine oversummer changes in body weight and composition of lactating adult female caribou and their calves.

3 Determine whether differences in weight and condition between nonlactating and lactating females are reflected in calf growth.

4 Refine existing relationships between fall body weight and subsequent reproductive success, emphasizing the relative influence of fat reserves versus protein reserves.

5 Establish relationships between body condition as determined by necropsy and in vivo morphometric measurements, weight, and body condition ratings for calves.

6 Recommend a routine program for monitoring female body condition to predict changes in pregnancy rate and/or production of viable calves.

METHODS

Biologists from cooperating agencies captured, weighed, measured, sampled, and determined body condition scores of 74 cow:calf pairs during late June 1992-1994. The NBS staff had already collared calves as neonates, and we placed radiocollars on their mothers. Seventy previously collared cows that had given birth, but lost their calves, were also captured and handled during late June. We caught newborn calves by running them down on foot, but used net-guns fired from helicopters for all other captures. Habitat use of collared cow:calf pairs was monitored daily by NBS staff from early June through mid July. In late September and/or early October 1992-1994, we recaptured 76 cows and 32 calves that had been caught the previous June. In early November 1993 and 1994, we recaptured 12 additional cows and 13 calves caught during June and 6 cows and 5 calves caught in both June and September/October. In November 1993 we also captured and radiocollared 7 cows not previously sampled, but whose calves had been caught in June. In March 1994 and 1995 we captured 7 calves and 45 cows that had been caught the previous summer and fall. We monitored all cows captured between June and November again in late May and early June of the next year to determine parturition status and, if appropriate, calving date and early calf survival. We collected 40 calves from the Central Arctic Herd, with the sample divided evenly from early June (near birth), late June, mid July, and late September 1992.

RESULTS

We addressed Job Objectives 1 and 2 straightforwardly by capturing, weighing, and taking body condition scores (BCS) of cows and calves in June and September each year. The BCS was determined by palpating the withers, ribs, and rump of captured animals, giving each site a subjective rating of 1 (emaciated) to 5 (obese), then summing the results (Gerhart 1995). Because we also captured cows and calves in November and March, we presented data on weight and body condition through early and late winter, as well as oversummer (Table 1).

Job Objective 3 was naively conceived. The implied hypothesis for this objective was that combined weight gain for a cow:calf pair would be comparable to weight gain of a nonlactating female. To test that hypothesis, we would have had to account for differences in efficiency of conversion of ingested forage to milk versus cow body tissue, efficiency of conversion of milk to calf body tissue, and the contribution of calf forage ingestion to weight gain, all of which were beyond the scope of this study. Instead, we were able to show that weights and weight gain of cows and calves were correlated (Fig 1; Chapter 4 in Appendix A).

Job Objective 4 was addressed by UAF graduate student Karen Gerhart and discussed in her PhD dissertation (Gerhart 1995). Two pertinent chapters of Gerhart's thesis have been submitted for publication (Chapters 1 and 2 in Appendix A). In Table 2 we present additional data that were not available to Gerhart (1995).

All work on Job Objective 5 was accomplished by Gerhart (1995). The pertinent chapter of her thesis has also been submitted for publication (Chapter 3 in Appendix A).

To address Job Objective 6, findings from this study are being incorporated into a routine carcass sampling and analysis program administered by YWB.

DISCUSSION

We examined oversummer weight gain only for known reproductive females, all of which had borne calves before capture. Cows characterized as nonlactating lost their calves before capture in late June and consequently underwent little if any costs of lactation. Cows characterized as lactating still had calves when captured in September/October, and thus bore the full costs of summer lactation. Cows characterized as having "lost calves" had calves in late June, but not September/October.

On average, nonlactating cows had higher rates of oversummer weight gain than lactating cows and were heavier and fatter in autumn (Tables 3 and 4). Nonlactating cows also lost less weight overwinter (Table 3). Pregnancy was directly correlated with fall body weight (Gerhart 1995; Table 2). However, lactating females had less fat and had to be heavier than nonlactating females to achieve the same probability of pregnancy. At the same fatness levels, lactating females were not less fertile than nonlactaters. Only very lean Porcupine Herd females failed to ovulate, so pregnancy (as determined by progesterone assays in Nov) was apparently a function of successful embryo implantation (Gerhart 1995). Probability of pregnancy was also moderated by whether and how long females lactated prior to rut and/or embryo implantation. Females with calves were generally still lactating during rut. Most cows with calves ceased lactation shortly after rut, but some continued lactation through winter. Cows with prolonged lactation (at least into Nov) were unlikely to become pregnant, regardless of their body weight or fat levels (lactational infertility). Prediction of pregnancy improved when multiple independent variables, including weight, fat content, skeletal measurements, and lactation status, were included in logistic models (Gerhart 1995).

Calf birth weights and growth rates through late June, September, and November correlated with their mothers' body weight in late June (Fig 1). Heavier cows were apparently able to divert energy to their calves, meet their own nutritional demands for maintenance and growth, and achieve fall weights and fat levels sufficient to become pregnant. Lighter cows apparently could not produce as much milk, causing their calves to grow more slowly. Some lighter cows failed to supply the needs of their calves, plus their own nutritional demands, and did not become pregnant the next fall. Cows which lost calves gained the least weight oversummer, and sometimes even lost weight (Tables 3 and 4). It seems plausible that these females in poorest condition could not produce sufficient milk for their calves' basic survival.

Habitat preferences of Porcupine Herd cows during the calving and early postcalving seasons (roughly 1 Jun-10 July) varied both within and among years (B Griffith, NBS, unpubl data). Cows seemed to prefer rapidly growing forage plants rather than specific plant species or habitat types. Higher calf growth rates also appeared to correlate with rapidly growing forage. The traditional core calving area centered on the ANWR coastal plain between the Hulahula and Aichilik rivers supported extensive areas of rapidly growing forage in most years. The core calving area has already been shown to have relatively few predators, and displacement from the core area correlates with poorer neonatal calf survival (Fancy and Whitten 1991, Whitten et al. 1992).

ACKNOWLEDGMENTS

TC McCabe, DB Griffith, NE Walsh, and D Young of NBS captured and radiotracked calves during summer and assisted in radiotracking all caribou during the remainder of the year. DE Russell and D van de Wetering of CWS captured cows and calves. B Gilroy and D Cooley of YWB and G Lortie of Whitehorse, Yukon Territory also assisted in capturing cows and calves. RD Cameron of ADF&G assisted in collecting calves. K Gerhart of UAF performed calf necropsies and assisted with caribou captures and calf collections. DC Miller, D Sowards, and R Kaye piloted fixed-wing planes. D Washington, R Warbelow, and J Hodges flew helicopters.

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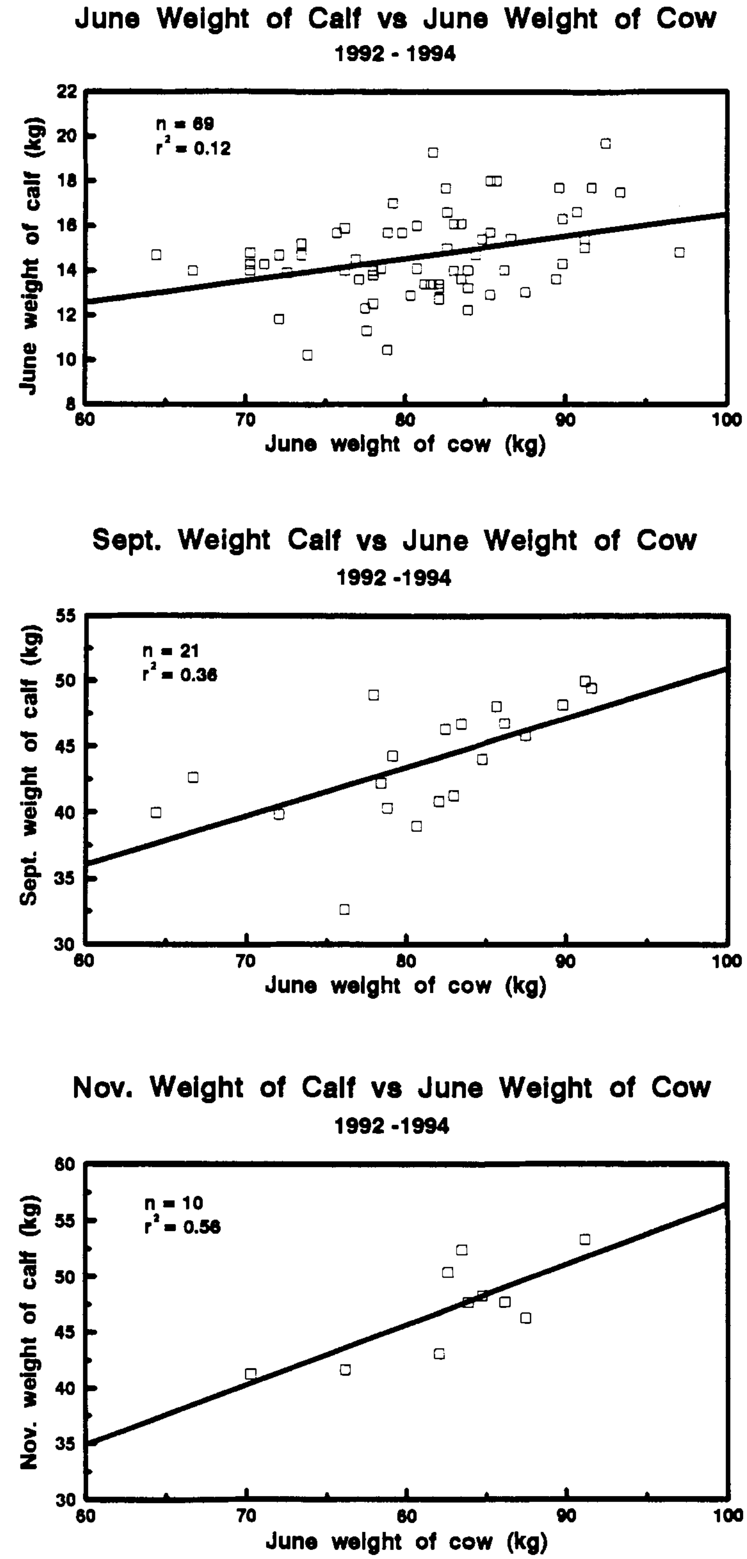


Figure 1 Regressions of June, September, and November calf weights on June cow weights for cow:calf pairs from the Porcupine Caribou Herd 1992-1994. All regressions are significant ($p < 0.01$).

Table 1 Weights, body condition scores, and morphometric measurements of cow and calf caribou from the Porcupine Herd, 1992-1995

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1992	Jun	Ca	A21	GY00	16.1	9.0	15.0	29.0	61
1992	Jun	Ca	A23		16.4	-	16.7	30.9	-
1992	Jun	Ca	A25		14.1	-	15.0	26.9	-
1992	Sep	Ca	A25		39.0	-	20.9	31.9	96
1992	Jun	Ca	A26		13.8	8.0	15.4	27.9	56
1992	Jun	Ca	A27	GY10	14.7	8.0	14.3	27.4	61
1992	Sep	Ca	A27	GY10	40.0	7.5	20.1	33.2	89
1992	Jun	Ca	A28		15.0	-	16.5	28.1	54
1992	Jun	Ca	A31		15.4	-	15.2	30.3	-
1992	Jun	Ca	A32		18.6	-	15.8	30.4	-
1992	Jun	Ca	A36		14.4	-	16.2	29.6	59
1992	Jun	Ca	A42	GY6	14.3	8.5	15.2	27.5	55
1992	Sep	Ca	A42	GY6	32.9	5.5	19.3	31.5	90
1992	Jun	Ca	A63		16.8	-	16.3	28.9	-
1992	Jun	Ca	A64	GY20	16.6	8.0	16.5	29.1	60
1992	Jun	Ca	A65		15.9	-	15.6	28.2	-
1992	Jun	Ca	A67	GY14	17.0	9.0	15.4	29.4	63
1992	Sep	Ca	A67	GY14	44.4	6.0	20.2	34.2	96
1992	Jun	Ca	A70	GY8	14.7	8.5	14.5	27.0	56
1992	Jun	Ca	A73	GY4	12.9	8.0	14.5	27.6	54
1992	Jun	Ca	A76	GY15	14.7	8.5	14.5	27.9	57
1992	Sep	Ca	A76	GY15	39.9	7.5	19.6	32.9	94
1992	Jun	Ca	A100	GY16	15.7	8.0	15.4	28.2	60
1992	Sep	Ca	A100	GY16	40.4	7.5	19.8	33.1	97
1992	Jun	Ca	A101	GY23	17.5	7.5	16.2	28.5	64
1993	Jun	Yr	A101	GY23	55.3	-	23.2	36.8	-
1992	Jun	Ca	A102		17.2	-	15.6	28.7	-
1992	Nov	Ca	A102		39.2	9.0	20.9	34.0	84
1992	Jun	Ca	A105		12.7	9.0	14.4	27.2	57
1992	Jun	Ca	A108		17.5	-	15.1	29.0	61
1992	Jun	Ca	A109		15.0	8.5	14.7	28.5	58
1992	Jun	Ca	A111		17.0	9.0	15.1	29.0	62
1992	Sep	Ca	A111		45.4	8.0	20.3	33.8	95
1992	Jun	Ca	A112	GY12	19.7	8.0	16.4	29.6	69
1992	Jun	Ca	A113		13.2	-	15.4	27.8	-
1992	Jun	Ca	A114	GY19	13.4	8.0	14.2	27.6	54
1992	Jun	Ca	A115		12.2	8.5	14.2	26.7	53
1993	Sep	Yr	A115		61.7	8.0	22.8	36.4	109
1992	Jun	Ca	A117	GY7	13.4	8.0	14.6	27.4	60
1992	Sep	Ca	A118		50.3	7.5	19.9	35.0	102
1992	Jun	Ca	A121	GY13	14.7	8.0	15.0	27.5	57
1992	Jun	Ca	A122	GY5	12.9	8.5	15.5	26.6	56
1992	Sep	Ca	A123		43.1	4.5	20.4	34.5	98
1992	Jun	Ca	A124	YB78	15.7	8.0	14.5	25.4	57
1992	Jun	Ca	A126	GY1	15.2	9.0	14.8	28.9	59
1992	Jun	Ca	A127		14.7	-	15.7	28.7	-
1992	Jun	Ca	A129		16.8	9.5	15.7	28.5	61
1992	Jun	Ca	A130		14.5	-	14.5	28.1	58

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1992	Jun	Ca	A131		20.4	-	16.8	31.6	-
1992	Sep	Ca	A131		52.2	6.0	22.1	35.8	107
1992	Jun	Ca	A132	GY17	12.5	9.5	14.3	26.7	54
1993	Jun	Yr	A132	GY17	49.4	-	23.3	35.8	92
1992	Jun	Ca	A133		12.2	-	14.3	28.1	-
1992	Jun	Ca	A134	GY18	12.3	9.5	14.7	27.9	57
1992	Jun	Ca	A135		14.1	-	14.9	29.1	-
1992	Sep	Ca	A135		45.8	6.0	20.3	35.4	98
1992	Jun	Ca	A136	GY3	15.7	9.0	15.3	29.1	61
1992	Jun	Ca	A137		12.9	-	15.6	28.3	-
1992	Jun	Ca	A138		13.8	-	14.1	27.4	-
1992	Jun	Ca	A139	GY2	14.3	9.0	14.4	28.1	58
1992	Jun	Ca	A140		16.3	-	14.5	27.9	-
1992	Jun	Ca	A141		13.6	-	15.0	28.0	-
1993	Jun	Yr	A141		54.4	9.0	22.7	36.8	99
1992	Jun	Ca	A142		12.2	-	14.2	26.6	-
1992	Jun	Ca	A143		15.9	-	14.5	28.5	-
1992	Jun	Ca	A144		16.8	10.0	15.2	29.4	60
1992	Jun	Ca	A146	GY24	14.1	8.0	19.9	28.1	55
1992	Jun	Ca	A147	GY9	13.4	8.5	15.6	28.5	56
1992	Jun	Ca	A148		17.9	8.0	15.7	29.2	61
1992	Jun	Ca	A149	GY21	19.3	8.0	15.7	30.6	62
1992	Jun	Ca	A150		20.0	-	15.2	31.1	-
1992	Jun	Ca	A151		16.6	-	14.8	30.0	-
1992	Jun	Ca	A153		13.8	-	15.7	29.0	-
1992	Sep	Ca	A153		38.1	5.0	19.4	33.6	95
1992	Jun	Ca	A157	GY22	13.8	8.0	15.6	28.7	56
1992	Jun	Ca	A158		15.0	-	14.8	28.1	-
1992	Jun	Ca	A159		15.2	8.0	14.8	28.5	58
1992	Jun	Ca	A160		9.8	-	14.1	26.0	-
1992	Jun	Ca	A161		13.2	8.5	14.9	27.5	53
1992	Jun	C-	YB6		92.1	6.5	26.8	40.4	114
1992	Sep	C-	YB6		107.5	10.5	26.1	41.0	128
1994	Jun	C-	YB6		95.3	8.0	27.9	40.7	117
1994	Jun	C-	YB6		93.4	5.5	28.1	40.7	115
1994	Sep	C-	YB6		113.5	9.5	25.8	41.0	126
1995	Mar	C-	YB6		107.6	6.0	28.3	40.6	124
1992	Jun	C-	RY13		82.5	4.5	28.3	40.4	115
1992	Sep	C-	RY13		99.8	6.5	29.4	40.4	122
1992	Jun	C-	BY13		73.9	5.5	25.9	38.6	111
1992	Sep	C-	BY13		87.1	8.5	26.6	39.3	121
1993	Jun	C-	BY13		78.0	6.5	26.3	39.0	117
1993	Sep	C-	BY13		96.6	10.5	26.9	39.0	119
1992	Jun	C-	YB29		81.6	7.0	26.4	38.6	115
1992	Sep	C-	YB29		97.1	8.0	27.9	39.1	129
1992	Jun	C-	OB44		85.3	-	27.7	38.4	-
1992	Jun	C-	RY21		88.4	7.5	27.4	39.7	113
1993	Jun	C-	RY21		88.0	7.0	27.9	40.1	117
1993	Sep	C-	RY21		108.0	11.0	28.2	41.3	130
1994	Mar	C	RY21		96.2	8.5	28.2	41.1	121
1992	Jun	C-	YBA2		81.2	6.0	27.5	38.7	113

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1992	Sep	C-	YBA2		98.9	10.0	27.3	39.3	127
1993	Jun	C-	YBA2		83.0	8.0	26.0	38.4	114
1993	Sep	C-	YBA2		98.9	10.5	27.2	39.3	130
1993	Nov	C-	YBA2		99.7	9.5	26.9	38.6	121
1994	Jun	C-	YBA2		84.4	6.5	27.0	39.2	118
1994	Sep	C-	YBA2		100.8	11.0	26.3	38.6	110
1995	Mar	C-	YBA2		93.1	7.5	26.7	39.2	116
1992	Jun	C-	BY00		92.5	4.5	27.2	40.1	117
1992	Sep	C-	BY00		104.8	-	27.0	39.8	129
1992	Jun	C-	RY55		88.0	4.0	27.6	38.2	115
1992	Sep	C-	RY55		101.1	8.0	27.6	39.3	131
1992	Jun	C-	WB5		83.5	5.5	26.4	39.7	107
1992	Jun	C-	S73		80.3	6.0	27.8	38.8	114
1992	Sep	C-	S73		93.9	8.0	26.7	39.4	130
1992	Jun	C-	YB14		75.7	5.5	26.5	38.6	110
1992	Sep	C-	YB14		95.7	8.0	29.2	38.2	127
1992	Jun	C-	RY40		99.3	6.5	28.0	40.5	121
1992	Jun	C-	RY45		73.5	4.5	27.1	39.1	115
1992	Sep	C-	RY45		86.6	10.0	27.2	38.7	123
1992	Jun	C-	YB32		73.5	6.0	27.1	37.9	109
1992	Jun	C-	YB28		81.2	6.0	27.6	38.7	117
1992	Sep	C-	YB28		93.4	9.0	25.5	39.2	120
1992	Jun	C-	BY0X		76.2	6.0	27.3	39.3	115
1992	Sep	C-	BY0X		91.6	7.5	27.6	39.5	128
1993	Jun	C-	BY0X		85.7	7.5	28.5	40.2	118
1992	Jun	C-	GY11		88.4	5.5	27.6	38.6	115
1992	Sep	C-	GY11		103.4	7.0	27.5	38.4	129
1992	Jun	C-	GY9		69.4	4.5	24.5	38.1	107
1992	Jun	C-	BY31		79.8	3.5	27.4	38.9	116
1992	Jun	C+	MORT[h]		84.8	5.0	27.4	40.0	111
1992	Jun	C+	MORT		74.4	4.5	26.0	38.9	110
1992	Jun	C+	MORT		73.5	4.5	27.9	38.0	110
1992	Jun	C+	MORT		81.7	4.5	27.3	40.0	113
1992	Jun	C+	GY20		90.7	4.0	28.8	39.4	112
1992	Sep	C+	GY20		102.0	5.0	27.6	39.6	124
1992	Jun	C+	YB78		79.8	3.5	26.8	40.1	110
1992	Jun	C+	GY22		78.0	4.5	26.7	40.0	115
1992	Sep	Cl	GY22		84.8	7.5	26.8	40.4	109
1992	Jun	C+	GY24		80.7	4.5	27.7	38.9	111
1992	Sep	Cl	GY24		87.5	7.5	30.2	37.6	129
1992	Jun	C+	GY21		81.7	4.5	27.7	38.9	116
1992	Sep	Cl	GY21		92.5	6.5	27.9	38.9	119
1993	Jun	C-	GY21		82.5	6.5	27.9	39.2	114
1993	Sep	C-	GY21		99.8	11.0	28.3	39.6	135
1994	Jun	C-	GY21		88.0	6.0	28.4	39.2	116
1994	Sep	C-	GY21		107.1	11.0	26.6	39.4	126
1994	Mar	C-	GY21		92.5	8.0	28.7	39.0	122
1995	Mar	C-	GY21		100.8	10.0	28.5	39.4	120
1992	Jun	C+	GY23		93.4	3.5	27.8	39.2	110
1992	Jun	C+	GY7		81.2	5.5	26.3	40.0	110
1992	Jun	C+	GY8		84.4	6.5	27.4	37.5	118

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1992	Sep	Cl	GY8		91.6	7.5	27.4	38.4	117
1992	Jun	C+	GY15		72.1	4.0	28.1	40.8	110
1992	Sep	C+	GY15		84.4	4.5	27.6	40.4	123
1992	Jun	C+	GY18		77.5	5.5	26.7	38.7	112
1992	Jun	C+	GY4		80.3	4.5	27.0	39.6	112
1992	Jun	C+	GY3		75.7	3.0	26.7	38.7	119
1993	Jun	C-	GY3		80.7	6.5	27.0	38.5	113
1994	Mar	C-	GY3		91.2	8.0	27.9	38.7	120
1992	Jun	C+	GY2		89.8	5.0	28.1	41.0	119
1994	Jun	C-	GY2		92.5	5.5	28.9	41.4	121
1994	Sep	C-	GY2		114.0	10.5	27.9	40.9	126
1994	Nov	C-	GY2		111.7	8.5	28.9	41.0	127
1992	Jun	C+	GY19		82.1	4.0	28.6	39.7	112
1992	Sep	Cl	GY19		92.5	4.5	28.8	38.4	121
1992	Jun	C+	GY18		81.2	6.0	27.4	40.5	114
1992	Jun	C+	GY5		85.3	5.0	27.6	38.9	115
1994	Jun	C-	GY5		88.5	5.5	28.4	38.6	113
1994	Sep	C-	GY5		93.1	5.0	28.3	38.7	118
1992	Jun	C+	GY17		78.0	4.5	26.4	39.4	111
1993	Jun	C-	GY17		81.6	7.0	27.3	39.9	114
1992	Jun	C+	GY1		73.5	6.0	28.3	39.2	116
1993	Jun	C-	GY1		78.5	7.0	27.8	38.6	113
1993	Sep	C-	GY1		98.9	10.0	28.5	37.8	117
1994	Mar	C-	GY1		91.2	9.5	27.7	38.9	115
1992	Jun	C+	GY14		79.2	5.0	28.7	38.9	116
1992	Sep	C+	GY14		85.3	4.5	28.3	39.5	126
1993	Jun	C-	GY14		80.3	7.0	28.1	39.7	122
1993	Sep	C-	GY14		95.7	10.0	29.1	39.7	124
1994	Mar	C-	GY14		93.0	8.5	28.4	39.3	127
1992	Jun	C+	GY6		70.3	4.5	27.1	39.6	113
1992	Sep	C+	GY6		85.3	7.0	27.5	39.6	126
1992	Jun	C+	GY16		78.9	4.0	26.1	38.6	114
1992	Sep	C+	GY16		96.1	6.5	25.9	38.9	124
1992	Jun	C+	GY13		73.5	5.0	25.7	39.7	112
1992	Jun	C+	GY12		92.5	4.0	27.5	40.1	116
1992	Sep	C+	GY12		100.2	6.0	27.7	40.4	133
1992	Jun	C+	GY10		64.4	5.0	24.9	39.3	116
1992	Sep	C+	GY10		74.4	7.0	25.5	39.5	115
1992	Jun	C+	GY00		83.0	4.5	26.2	38.6	115
1992	Nov	Cu	YB43		98.2	8.5	28.0	40.5	-
1993	Jun	Ca	B21	YB85	16.3	8.5	14.5	28.9	-
1993	Sep	Ca	B21	YB85	48.2	9.5	20.3	35.4	97
1993	Jun	Ca	B23	YB84	15.9	9.5	14.8	27.2	-
1993	Nov	Ca	B23	YB84	41.7	8.0	20.4	33.2	91
1993	Jun	Ca	B25	YB97	13.6	8.5	14.3	29.3	-
1993	Sep	Ca	B25	YB97	46.8	9.5	20.1	34.4	95
1993	Nov	Ca	B25	YB97	52.4	7.5	21.8	35.7	93
1993	Jun	Ca	B26	YB99	11.3	9.0	14.4	27.3	-
1993	Jun	Ca	B27	YB90	10.2	8.0	14.1	27.1	-
1993	Jun	Ca	B36	YB83	17.2	9.5	14.6	27.6	-
1993	Jun	Ca	B42	YB87	12.2	7.5	13.7	25.7	-

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1993	Jun	Ca	B60		14.1	9.0	14.6	27.6	-
1993	Jun	Ca	B64	YB93	11.8	9.0	14.4	27.4	-
1993	Jun	Ca	B65		14.5	-	14.2	27.2	-
1993	Jun	Ca	B73	YB95	13.6	-	14.7	27.7	-
1993	Jun	Ca	B76		14.5	9.5	14.9	28.9	-
1993	Jun	Ca	B101	YB63	17.7	9.5	15.5	28.5	-
1993	Sep	Ca	B101	YB63	49.5	9.0	21.3	34.7	98
1994	Mar	Ca	B101	YB63	46.4	7.0	21.9	34.4	92
1993	Jun	Ca	B102	YB92	12.7	8.5	14.7	27.1	-
1993	Jun	Ca	B107	YB64	14.1	9.0	15.1	28.4	-
1993	Sep	Ca	B107	YB64	42.3	7.5	20.3	34.0	91
1994	Mar	Ca	B107	YB64	43.6	5.0	20.2	35.6	92
1993	Jun	Ca	B109	YB67	14.5	9.0	14.5	27.6	-
1993	Jun	Ca	B115	YB88	17.7	9.0	15.9	29.0	-
1993	Jun	Ca	B117	YB82	15.0	7.5	15.2	28.6	-
1993	Sep	Ca	B117	YB82	50.0	7.5	21.1	34.4	99
1993	Jun	Ca	B122	YB69	15.4	9.0	14.6	27.5	-
1993	Sep	Ca	B122	YB69	44.1	7.5	22.4	33.4	93
1993	Nov	Ca	B122	YB69	48.3	9.0	21.5	35.7	99
1993	Jun	Ca	B123	YB96	15.4	8.5	15.4	29.3	-
1993	Nov	Ca	B123	YB96	53.3	11.0	21.5	35.7	99
1993	Jun	Ca	B129	YB74	13.2	7.5	13.8	28.3	-
1993	Jun	Ca	B136	YB73	13.2	9.0	14.1	27.3	-
1993	Sep	Ca	B136	YB73	40.9	7.0	10.5	32.8	100
1993	Nov	Ca	B136	YB73	43.1	7.5	20.2	34.1	99
1993	Jun	Ca	B138	YB66	17.7	9.0	14.9	27.6	-
1993	Sep	Ca	B138	YB66	46.4	6.5	19.5	33.7	89
1993	Jun	Ca	B143	YB98	14.1	9.0	14.4	27.5	-
1993	Sep	Ca	B143	YB98	42.3	8.5	29.3	32.8	95
1993	Jun	Ca	B158	YB86	15.4	7.5	15.1	28.1	-
1993	Jun	Ca	B162	YB70	13.6	7.5	14.1	26.3	-
1993	Jun	Ca	B165	YB94	10.4	7.5	14.1	26.9	-
1993	Nov	Ca	B127		46.0	7.5	21.1	35.1	98
1993	Nov	Ca	B128		51.0	8.5	21.2	34.2	103
1993	Nov	Ca	B148		51.7	9.0	22.0	35.0	97
1993	Nov	Ca	B163		48.3	7.5	20.3	35.3	99
1993	Nov	Ca	B167		48.7	8.0	21.3	34.0	97
1993	Jun	C-	YB56		95.7	6.0	27.9	39.9	114
1994	Mar	C-	YB56		96.2	5.5	27.7	39.8	119
1993	Jun	C-	RY89		79.8	5.5	26.6	38.9	110
1994	Mar	C-	RY89		91.6	9.0	25.9	38.7	124
1993	Jun	C-	YB58		96.2	7.0	29.1	41.0	126
1994	Mar	C-	YB58		105.2	7.0	29.0	41.4	122
1993	Jun	C-	YB53		79.8	3.5	27.5	47.1	112
1993	Sep	C-	YB53		98.5	10.5	28.2	37.8	122
1993	Jun	C-	OB43		83.0	7.0	27.5	38.6	112
1994	Mar	C-	YB53		95.3	7.5	27.6	37.7	117
1993	Sep	C-	OB43		96.2	11.0	26.6	39.1	124
1994	Mar	C-	OB43		90.7	8.0	27.6	39.5	117
1993	Jun	C-	BY14		79.4	4.5	27.5	44.5	113
1993	Sep	C-	BY14		97.5	10.5	27.6	40.3	124

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1994	Mar	C-	BY14		87.5	7.5	27.3	40.9	117
1993	Jun	C-	YBA6		87.5	7.0	27.2	39.7	109
1993	Jun	C-	YB26		98.0	6.0	27.3	40.1	124
1993	Sep	C-	YB26		113.0	10.0	27.7	40.9	130
1993	Jun	C-	YB89		85.7	7.0	28.1	39.9	107
1994	Jun	C-	YB89		78.5	6.0	28.1	39.5	110
1993	Nov	C-	YB89		96.9	11.5	26.7	39.6	121
1994	Mar	C-	YB89		93.0	9.0	28.9	39.8	122
1994	Nov	C-	YB89		96.2	9.0	27.6	40.4	114
1995	Mar	C-	YB89		86.7	6.0	28.0	39.5	116
1993	Jun	C-	RY31		92.1	7.0	27.9	40.9	114
1993	Jun	C-	RY56		87.5	7.5	27.9	40.0	114
1993	Sep	C-	RY56		99.8	10.5	28.1	40.1	130
1994	Mar	C-	RY56		97.5	8.5	28.3	40.5	118
1993	Jun	C-	YB4		84.8	7.5	28.4	40.1	109
1993	Jun	C-	YB19		88.9	5.5	27.1	40.4	122
1993	Sep	C-	YB19		106.2	9.0	27.8	40.7	130
1994	Mar	C-	YB19		98.4	7.5	27.9	40.6	117
1993	Jun	C-	RY44		85.7	7.0	28.4	40.4	112
1993	Jun	C-	YB48		84.4	5.5	28.0	39.0	112
1993	Sep	C-	YB48		98.0	11.0	26.4	39.0	124
1993	Jun	C-	YB34		88.0	6.0	28.5	39.2	117
1993	Sep	C-	YB34		98.9	8.0	28.8	40.0	135
1994	Mar	C-	YB34		99.3	8.0	28.6	39.9	122
1993	Jun	C-	YB68		82.5	6.0	26.9	40.9	114
1993	Sep	C-	YB68		99.8	9.5	27.8	40.9	122
1994	Mar	C-	YB68		96.2	7.5	27.4	41.0	122
1993	Jun	C-	WB4		79.4	7.0	27.3	39.6	109
1994	Mar	C-	WB4		97.5	10.0	27.9	39.7	121
1993	Jun	C+	MORT		80.7	6.0	27.6	39.2	107
1993	Jun	C+	YB69		84.8	4.5	27.5	38.4	113
1993	Sep	C+	YB69		95.7	8.5	28.1	38.4	127
1993	Nov	C+	YB69		90.1	6.5	27.3	38.1	112
1993	Jun	C+	YB85		89.8	5.0	28.0	40.7	119
1993	Sep	C+	YB85		102.5	6.5	29.6	40.4	127
1994	Mar	C+	YB85		95.7	6.0	28.5	40.9	127
1993	Jun	C+	YB88		89.6	5.0	26.8	39.2	113
1993	Jun	C+	YB99		77.6	6.5	27.9	39.1	119
1994	Mar	C-	YB99		88.9	7.5	27.3	39.2	118
1993	Jun	C+	YB96		91.2	6.0	26.9	40.3	127
1993	Nov	C+	YB96		91.0	7.5	27.1	40.5	117
1993	Jun	C+	YB66		82.5	5.5	26.6	39.5	122
1993	Sep	C+	YB66		92.5	7.5	25.3	40.7	119
1994	Jun	C-	YB66		86.6	6.0	27.0	39.5	113
1994	Mar	C+	YB66		83.9	6.0	26.6	39.2	115
1993	Jun	C+	YB97		83.5	5.5	28.4	40.9	114
1993	Sep	C+	YB97		101.6	8.5	26.3	40.0	130
1993	Nov	C+	YB97		98.3	7.5	27.9	40.5	117
1993	Jun	C+	YB94		78.9	3.0	28.0	40.1	117
1993	Sep	Cl	YB94		88.0	5.5	28.6	39.9	117
1993	Jun	C+	YB73		82.1	6.5	26.6	38.1	114

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1993	Sep	C+	YB73		96.2	7.5	26.4	37.8	132
1993	Nov	C+	YB73		90.8	8.0	26.3	38.4	119
1993	Jun	C+	YB93		72.1	6.5	27.3	37.7	114
1993	Jun	C+	YB80		84.8	5.0	27.4	39.7	107
1993	Nov	Cl	YB80		92.4	8.5	26.8	37.9	125
1994	Mar	C-	YB80		84.8	6.5	25.2	38.6	117
1993	Jun	C+	YB95		89.4	6.0	29.0	40.2	128
1994	Mar	Cu	YB95		98.0	6.5	29.8	40.3	124
1993	Jun	C+	YB87		83.9	3.0	27.4	39.2	114
1994	Jun	C-	YB87		91.6	6.0	28.6	39.6	119
1994	Sep	C-	YB87		109.9	11.0	28.1	40.1	124
1995	Mar	C-	YB87		99.4	8.5	28.0	39.4	131
1993	Jun	C+	YB84		76.2	6.0	26.3	38.7	114
1993	Nov	C+	YB84		81.0	7.0	26.0	38.8	114
1993	Jun	C+	YB64		78.5	3.5	27.0	40.2	110
1993	Sep	C+	YB64		91.2	7.0	26.9	39.6	117
1994	Jun	C-	YB64		85.7	4.0	26.9	40.1	112
1994	Sep	C-	YB64		100.8	8.0	28.1	40.4	125
1994	Mar	C+	YB64		75.3	4.5	26.4	40.1	110
1993	Jun	C+	YB86		86.6	6.5	27.7	39.3	117
1994	Mar	C+	YB86		93.9	7.5	27.8	39.3	125
1993	Jun	C+	YB92		82.1	5.0	27.2	39.9	114
1993	Nov	C+	YB92		89.2	7.5	27.7	42.3	114
1993	Jun	C+	YB70		77.1	6.0	26.0	39.1	112
1993	Sep	Cl	YB70		63.0	5.0	25.4	38.7	-
1993	Jun	C+	YB91		73.9	6.5	26.5	39.9	110
1993	Jun	C+	YB98		78.5	6.0	26.3	38.5	114
1993	Sep	C+	YB98		92.5	7.0	27.5	38.9	119
1994	Mar	C+	YB98		81.6	6.5	26.4	39.1	112
1993	Jun	C+	YB82		91.2	6.5	28.2	39.8	70
1993	Sep	C+	YB82		98.0	8.0	27.7	39.5	119
1994	Jun	C-	YB82		93.0	5.5	27.3	39.5	121
1994	Mar	C+	YB82		87.5	5.0	27.2	39.5	115
1993	Jun	C+	YB90		73.9	6.0	26.6	39.0	110
1994	Jun	C-	YB90		76.7	4.0	26.5	39.2	108
1994	Sep	C-	YB90		89.4	8.5	26.2	38.9	109
1995	Mar	C-	YB90		83.5	6.5	26.8	39.4	112
1995	Mar	C-	YB87		99.4	8.5	28.0	39.4	131
1993	Jun	C+	YB63		91.6	3.5	28.4	39.1	117
1993	Sep	C+	YB63		94.8	6.5	27.7	40.5	119
1994	Mar	C+	YB63		95.3	5.0	27.7	38.2	116
1993	Jun	C+	YB67		76.9	3.5	27.0	38.7	112
1993	Jun	C+	YB74		83.9	5.5	27.6	39.5	122
1993	Jun	C+	YB71		83.9	5.5	27.0	39.6	112
1994	Jun	Ca	C11	OB58	14.0	-	-	-	-
1994	Sep	Ca	C11	OB58	42.7	8.5	17.9	32.0	94
1995	Mar	Ca	C11	OB58	46.8	7.0	21.2	35.5	93
1994	Jun	Ca	C13		14.3	-	-	27.3	-
1994	Jun	Ca	C44	OB73	18.0	-	-	29.2	-
1994	Jun	Ca	C48	OB49	14.8	-	-	27.8	-
1994	Jun	Ca	C53	OB66	14.0	-	-	-	-

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1994	Sep	Ca	C53	OB66	41.3	7.0	19.4	32.3	83
1994	Jun	Ca	C58	RY44	16.0	-	-	-	-
1994	Sep	Ca	C58		44.9	7.5	29.6	33.8	91
1994	Jun	Ca	C61	OB65	18.0	-	-	-	-
1994	Sep	Ca	C61	OB65	48.1	6.5	10.2	33.3	92
1994	Jun	Ca	C68	OB64	15.0	-	-	-	-
1994	Nov	Ca	C68	OB64	50.4	7.5	23.0	34.1	93
1994	Jun	Ca	C69	OB68	14.0	-	-	-	-
1995	Mar	Ca	C69	OB68	29.1	5.5	19.2	31.7	80
1994	Sep	Ca	C69	OB68	32.7	6.0	17.9	30.7	84
1994	Jun	Ca	C82	OB19	15.7	-	-	29.1	-
1994	Jun	Ca	C84	OB70	14.8	-	-	28.3	-
1994	Jun	Ca	C89	OB9	13.0	-	-	-	-
1994	Sep	Ca	C89	OB9	45.9	8.5	29.8	34.4	94
1994	Jun	Ca	C90	OB50	16.0	-	-	-	-
1994	Sep	Ca	C90	OB50	39.0	8.0	20.7	33.5	83
1995	Mar	Ca	C90	OB50	41.3	5.5	-	34.6	90
1994	Jun	Ca	C94	OB7	16.1	-	-	28.9	-
1994	Jun	Ca	C96	OB57	16.6	-	-	28.7	-
1994	Jun	Ca	C99	OB48	14.0	-	-	-	-
1994	Sep	Ca	C99	OB48	46.8	8.0	-	33.7	90
1994	Nov	Ca	C99	OB48	47.7	8.5	21.1	33.7	65
1994	Jun	Ca	C103	OB54	14.0	-	-	-	-
1994	Nov	Ca	C103	OB54	47.7	9.0	21.2	35.2	94
1995	Mar	Ca	C103	OB54	46.8	6.5	21.9	36.2	92
1994	Jun	Ca	C125	OB59	14.0	-	-	-	-
1994	Sep	Ca	C125	OB59	49.0	6.5	21.9	33.6	91
1994	Jun	Ca	C131		14.3	-	-	28.4	-
1994	Jun	Ca	C139	OB52	13.4	-	-	27.7	-
1994	Jun	Ca	C142	OB63	13.9	-	-	28.2	-
1994	Jun	Ca	C166	OB51	14.3	-	-	28.2	-
1994	Jun	Ca	C173	OB36	14.0	-	-	-	-
1994	Nov	Ca	C173	OB36	41.3	8.5	20.6	33.5	92
1994	Jun	Ca	C185	OB53	13.0	-	-	-	-
1994	Nov	Ca	C185	OB53	46.3	8.5	20.5	34.1	96
1994	Jun	C-	RY1X		73.5	5.0	26.5	37.9	117
1994	Jun	C-	RY57		98.0	5.5	28.9	40.5	124
1994	Sep	C-	RY57		117.6	10.5	27.4	41.3	125
1995	Mar	C-	RY57		110.8	7.0	29.6	41.1	130
1994	Jun	C-	YB33		86.6	5.5	28.7	39.6	116
1994	Nov	C-	YB33		106.2	10.0	28.2	41.0	125
1994	Jun	C-	OB91		85.3	5.0	27.7	39.9	117
1994	Jun	C-	YBA1		87.5	4.5	28.2	39.4	114
1994	Nov	C-	YBA1		97.2	8.0	28.3	39.2	120
1994	Jun	C-	YBA9		81.2	6.5	27.6	40.2	112
1994	Sep	C-	YBA9		99.0	8.5	28.9	40.8	130
1995	Mar	C-	YBA9		86.3	5.5	27.9	40.1	117
1994	Jun	C-	OB2		88.9	5.5	26.9	40.7	117
1994	Sep	C-	OB2		104.0	11.0	27.0	41.0	121
1995	Mar	C-	OB2		98.5	6.5	41.0	47.0	120
1994	Jun	C-	RY78		82.1	5.5	26.9	37.6	116

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1994	Jun	C-	S73		81.6	4.5	28.2	39.2	112
1994	Sep	C-	S73		103.5	10.0	28.2	39.9	122
1994	Jun	C-	YB75		69.9	7.0	25.6	38.9	110
1994	Sep	C-	YB75		93.5	11.5	25.9	38.5	117
1995	Mar	C-	YB75		91.7	10.0	25.7	38.7	117
1994	Jun	C-	YB72		93.9	5.0	28.5	41.0	116
1994	Sep	C-	YB72		107.6	10.0	27.8	41.1	128
1994	Jun	C-	BY15		84.8	6.5	28.1	41.2	108
1994	Sep	C-	BY15		103.1	11.0	28.1	40.8	121
1995	Mar	C-	BY15		96.2	8.0	28.8	40.5	116
1994	Jun	C+	MORT		70.8	4.5	26.6	40.5	99
1994	Jun	C+	OB7		83.5	5.0	27.4	39.3	110
1994	Jun	C+	OB19		85.3	4.0	27.5	40.4	117
1994	Jun	C+	OB64		82.6	6.5	27.4	40.6	114
1994	Nov	C+	OB64		94.9	7.5	28.2	40.2	115
1994	Jun	C+	RY44		80.7	4.5	27.1	38.2	111
1994	Sep	C+	RY44		99.4	7.0	26.8	38.9	124
1994	Mar	C+	RY44		83.5	5.5	27.3	39.1	117
1994	Jun	C+	OB48		86.2	4.0	28.0	39.0	110
1994	Sep	C+	OB48		96.7	6.0	27.2	39.4	121
1994	Nov	C+	OB48		89.9	8.5	28.3	39.6	112
1994	Jun	C+	OB9		87.5	5.5	27.8	39.7	128
1994	Sep	C+	OB9		103.5	8.5	29.7	37.6	121
1994	Mar	C+	OB9		93.5	7.5	27.2	39.0	129
1994	Jun	C+	OB66		83.0	5.0	28.0	38.4	111
1994	Sep	C+	OB66		96.2	6.5	27.2	38.0	122
1994	Mar	C+	OB66		79.9	5.0	28.0	37.9	117
1994	Jun	C+	OB50		80.7	4.5	28.0	39.2	114
1994	Sep	C+	OB50		93.5	7.5	27.4	39.6	114
1994	Mar	C+	OB50		76.7	4.5	27.6	39.0	115
1994	Jun	C+	OB68		76.2	4.5	26.4	37.5	109
1994	Jun	C+	OB65		85.7	4.0	27.5	38.8	107
1994	Sep	C+	OB65		97.6	7.0	26.7	39.3	125
1994	Jun	C+	OB33		86.6	5.0	28.3	40.7	116
1994	Sep	Cl	OB33		92.6	7.5	28.5	40.7	116
1994	Jun	C+	OB36		70.3	5.0	26.3	38.0	107
1994	Nov	C+	OB36		77.2	7.5	26.0	38.6	108
1994	Jun	C+	OB49		70.3	4.5	28.0	40.2	109
1994	Jun	C+	OB51		71.2	3.5	27.1	37.6	108
1994	Jun	C+	RY52		72.1	4.0	24.5	38.2	104
1994	Jun	C+	OB52		81.6	5.0	28.5	38.7	118
1994	Sep	Cl	OB52		92.6	6.5	27.9	38.9	120
1994	Jun	C+	OB54		83.9	4.0	27.4	40.2	113
1994	Nov	C+	OB54		95.3	8.0	27.6	40.1	122
1994	Mar	C+	OB54		88.1	5.5	27.2	41.1	115
1994	Jun	C+	OB53		87.5	5.5	28.2	40.4	114
1994	Nov	C+	OB53		101.2	9.5	28.0	39.8	118
1994	Jun	C+	OB63		72.6	5.5	27.3	39.7	112
1994	Jun	C+	OB57		82.6	4.0	27.7	39.7	115
1994	Jun	C+	OB70		97.1	5.5	28.5	42.1	113
1994	Jun	C+	OB59		78.0	4.5	28.6	40.4	113

Table 1 Continued

Year	Date	Type[a]	ID[b]	Dam[c]	Weight (kg)	BCS[d]	Mand[e] (cm)	Meta[f] (cm)	Heart[g] (cm)
1994	Sep	C+	OB59		102.6	7.0	28.9	40.0	128
1994	Jun	C+	OB73		85.3	4.5	29.2	38.9	112
1994	Sep	Cl	OB73		105.8	9.5	29.1	40.1	124
1995	Mar	C-	OB73		96.2	6.5	29.5	38.7	121
1994	Jun	C+	OB58		66.7	4.0	25.6	38.3	107
1994	Sep	C+	OB58		85.4	6.0	25.2	37.5	111
1994	Mar	C+	OB58		69.0	4.5	26.5	38.2	107
1994	Mar	Ca	B128		45.5	8.0	22.0	35.4	101

[a] Ca = calf; C+ = lactating cow; C- = nonlactating cow;
Cl = cow which lost calf between June and September;
Cu = cow of unknown status; Yr = yearling
[b] Individual identification code.
[c] ID code of mother.
[d] Body condition score.
[e] Mandible length
[f] Metatarsus length.
[g] Heart girth.
[h] Cow died during capture.

Table 2 Fall, early winter, and spring body condition versus next year parturition for Porcupine Caribou Herd Cows. Within each year and season, cows are arranged in descending order by weight.

Year	Date	ID[a]	Weight (kg)	BCS[b]	MAND[c] (cm)	META[d] (cm)	Heart[e] (cm)	Part?[f]
1992	Sep	GY11	103.4	7.0	27.5	38.4	129	+
1992	Sep	RY55	101.1	8.0	27.6	39.3	131	+
1992	Sep	GY12	100.2	6.0	27.7	40.4	133	+
1992	Sep	RY13	99.8	6.5	29.4	40.4	122	+
1992	Sep	YBA2	98.9	10.0	27.3	39.3	127	+
1992	Sep	YB29	97.1	8.0	27.9	39.1	129	+
1992	Sep	GY16	96.1	6.5	25.9	38.9	124	+
1992	Sep	S73	93.9	8.0	26.7	39.4	130	+
1992	Sep	GY21	92.5	6.5	27.9	38.9	119	+
1992	Sep	GY19	92.5	4.5	28.8	38.4	121	+
1992	Sep	GY8	91.6	7.5	27.4	38.4	117	+
1992	Sep	BY0X	91.6	7.5	27.6	39.5	128	-
1992	Sep	GY24	87.5	7.5	30.2	37.6	129	+
1992	Sep	BY13	87.1	8.5	26.6	39.3	121	+
1992	Sep	RY45	86.6	10.0	27.2	38.7	123	+
1992	Sep	GY14	85.3	4.5	28.3	39.5	126	+
1992	Sep	GY6	85.3	7.0	27.5	39.6	126	-
1992	Sep	GY15	84.4	4.5	27.6	40.4	123	-
1992	Sep	GY10	74.4	7.0	25.5	39.5	115	-
1993	Sep	YB26	113.0	10.0	27.7	40.9	130	+
1993	Sep	RY21	108.0	11.0	28.2	41.3	130	+
1993	Sep	YB19	106.2	9.0	27.8	40.7	130	+
1993	Sep	YB85	102.5	6.5	29.6	40.4	127	+
1993	Sep	YB97	101.6	8.5	26.3	40.0	130	+
1993	Sep	GY21	99.8	11.0	28.3	39.6	135	+
1993	Sep	RY56	99.8	10.5	28.1	40.1	130	+
1993	Sep	YB68	99.8	9.5	27.8	40.9	122	+
1993	Sep	YBA2	98.9	10.5	27.2	39.3	130	+
1993	Sep	GY1	98.9	10.0	28.5	37.8	117	+
1993	Sep	YB34	98.9	8.0	28.8	40.0	135	+
1993	Sep	YB53	98.5	10.5	28.2	37.8	122	+
1993	Sep	YB48	98.0	11.0	26.4	39.0	124	+
1993	Sep	YB82	98.0	8.0	27.7	39.5	119	-
1993	Sep	BY14	97.5	10.5	27.6	40.3	124	+
1993	Sep	BY13	96.6	10.5	26.9	39.0	119	+
1993	Sep	OB43	96.2	11.0	26.6	39.1	124	+
1993	Sep	YB73	96.2	7.5	26.4	37.8	132	+
1993	Sep	GY14	95.7	10.0	29.1	39.7	124	+
1993	Sep	YB69	95.7	8.5	28.1	38.4	127	+

Table 2 Continued

Year	Date	ID[a]	Weight (kg)	BCS[b]	MAND[c] (cm)	META[d] (cm)	Heart[e] (cm)	Part?[f]
1993	Sep	YB63	94.8	6.5	27.7	40.5	119	+
1993	Sep	YB66	92.5	7.5	25.3	40.7	119	-
1993	Sep	YB98	92.5	7.0	27.5	38.9	119	+
1993	Sep	YB64	91.2	7.0	26.9	39.6	117	-
1994	Sep	RY57	117.6	10.5	27.4	41.3	125	+
1994	Sep	GY2	114.0	10.5	27.9	40.9	126	-
1994	Sep	YB6	113.5	9.5	25.8	41.0	126	+
1994	Sep	YB87	109.9	11.0	28.1	40.1	124	+
1994	Sep	YB72	107.6	10.0	27.8	41.1	128	+
1994	Sep	GY21	107.1	11.0	26.6	39.4	126	+
1994	Sep	OB2	104.0	11.0	27.0	41.0	121	+
1994	Sep	S73	103.5	10.0	28.2	39.9	122	+
1994	Sep	OB9	103.5	8.5	29.7	37.6	121	+
1994	Sep	BY15	103.1	11.0	28.1	40.8	121	+
1994	Sep	OB59	102.6	7.0	28.9	40.0	128	+
1994	Sep	YBA2	100.8	11.0	26.3	38.6	110	-
1994	Sep	YB64	100.8	8.0	28.1	40.4	125	+
1994	Sep	YBA9	99.0	8.5	28.9	40.8	130	+
1994	Sep	RY44	99.4	7.0	26.8	38.9	124	-
1994	Sep	OB65	97.6	7.0	26.7	39.3	125	+
1994	Sep	OB48	96.7	6.0	27.2	39.4	121	-
1994	Sep	OB66	96.2	6.5	27.2	38.0	122	-
1994	Sep	YB75	93.5	11.5	25.9	38.5	117	+
1994	Sep	OB50	93.5	7.5	27.4	39.6	114	-
1994	Sep	GY5	93.1	5.0	28.3	38.7	118	-
1994	Sep	YB90	89.4	8.5	26.2	38.9	109	+
1994	Sep	OB58	85.4	6.0	25.2	37.5	111	-
1992	Nov	YB43	98.2	8.5	28.0	40.5	-	+
1993	Nov	YBA2	99.7	9.5	26.9	38.6	121	+
1993	Nov	YB97	98.3	7.5	27.9	40.5	117	+
1993	Nov	YB89	96.9	11.5	26.7	39.6	121	+
1993	Nov	YB80	92.4	8.5	26.8	37.9	125	+
1993	Nov	YB96	91.0	7.5	27.1	40.5	117	+
1993	Nov	YB73	90.8	8.0	26.3	38.4	119	+
1993	Nov	YB69	90.1	6.5	27.3	38.1	112	+
1993	Nov	YB84	81.0	7.0	26.0	38.8	114	-
1994	Nov	GY2	111.7	8.5	28.9	41.0	127	-
1994	Nov	YB33	106.2	10.0	28.2	41.0	125	+
1994	Nov	OB53	101.2	9.5	28.0	39.8	118	+

Table 2 Continued

Year	Date	ID[a]	Weight (kg)	BCS[b]	MAND[c] (cm)	META[d] (cm)	Heart[e] (cm)	Part?[f]
1994	Nov	YBA1	97.2	8.0	28.3	39.2	120	+
1994	Nov	YB89	96.2	9.0	27.6	40.4	114	+
1994	Nov	OB54	95.3	8.0	27.6	40.1	122	+
1994	Nov	OB64	94.9	7.5	28.2	40.2	115	-[g]
1994	Nov	OB48	89.9	8.5	28.3	39.6	112	-
1994	Nov	OB36	77.2	7.5	26.0	38.6	108	-
1994	Mar	YB58	105.2	7.0	29.0	41.4	122	+
1994	Mar	YB34	99.3	8.0	28.6	39.9	122	+
1994	Mar	YB19	98.4	7.5	27.9	40.6	117	+
1994	Mar	YB95	98.0	6.5	29.8	40.3	124	+
1994	Mar	RY56	97.5	8.5	28.3	40.5	118	+
1994	Mar	WB4	97.5	10.0	27.9	39.7	121	+
1994	Mar	YB68	96.2	7.5	27.4	41.0	122	+
1994	Mar	RY21	96.2	8.5	28.2	41.1	121	+
1994	Mar	YB56	96.2	5.5	27.7	39.8	119	+
1994	Mar	YB85	95.7	6.0	28.5	40.9	127	+
1994	Mar	YB53	95.3	7.5	27.6	37.7	117	+
1994	Mar	YB63	95.3	5.0	27.7	38.2	116	+
1994	Mar	YB86	93.9	7.5	27.8	39.3	125	+
1994	Mar	GY14	93.0	8.5	28.4	39.3	127	+
1994	Mar	YB89	93.0	9.0	28.9	39.8	122	+
1994	Mar	GY21	92.5	8.0	28.7	39.0	122	+
1994	Mar	RY89	91.6	9.0	25.9	38.7	124	+
1994	Mar	GY3	91.2	8.0	27.9	38.7	120	+
1994	Mar	GY1	91.2	9.5	27.7	38.9	115	+
1994	Mar	OB43	90.7	8.0	27.6	39.5	117	+
1994	Mar	YB99	88.9	7.5	27.3	39.2	118	+
1994	Mar	BY14	87.5	7.5	27.3	40.9	117	+
1994	Mar	YB82	87.5	5.0	27.2	39.5	115	-
1994	Mar	YB80	84.8	6.5	25.2	38.6	117	+
1994	Mar	YB66	83.9	6.0	26.6	39.2	115	-
1994	Mar	YB98	81.6	6.5	26.4	39.1	112	+
1994	Mar	YB64	75.3	4.5	26.4	40.1	110	-
1995	Mar	RY57	110.8	7.0	29.6	41.1	130	+
1995	Mar	YB6	107.6	6.0	28.3	40.6	124	+
1995	Mar	GY21	100.8	10.0	28.5	39.4	120	+
1995	Mar	YB87	99.4	8.5	28.0	39.4	131	+
1995	Mar	YB87	99.4	8.5	28.0	39.4	131	+
1995	Mar	OB2	98.5	6.5	41.0	47.0	120	+
1995	Mar	BY15	96.2	8.0	28.8	40.5	116	+
1995	Mar	OB73	96.2	6.5	29.5	38.7	121	-

Table 2 Continued

Year	Date	ID[a]	Weight (kg)	BCS[b]	MAND[c] (cm)	META[d] (cm)	Heart[e] (cm)	Part?[f]
1995	Mar	OB9	93.5	7.5	27.2	39.0	129	+
1995	Mar	YBA2	93.1	7.5	26.7	39.2	116	-
1995	Mar	YB75	91.7	10.0	25.7	38.7	117	+
1995	Mar	OB54	88.1	5.5	27.2	41.1	115	+
1995	Mar	YB89	86.7	6.0	28.0	39.5	116	+
1995	Mar	YBA9	86.3	5.5	27.9	40.1	117	+
1995	Mar	RY44	83.5	5.5	27.3	39.1	117	-
1995	Mar	YB90	83.5	6.5	26.8	39.4	112	+
1995	Mar	OB66	79.9	5.0	28.0	37.9	117	-
1995	Mar	OB50	76.7	4.5	27.6	39.0	115	-
1994	Mar	OB58	69.0	4.5	26.5	38.2	107	-

[a] Individual identification code.
[b] Body condition score.
[c] Mandible length.
[d] Metatarsus length.
[e] Heart girth.
[f] Parturient (+) or nonparturient (-).
[g] Accompanied by previous year's calf during June 1995: possible lactational infertility.

Table 3 Results of ANOVA analysis comparing weight changes (gm/day), SE (*n*) for calves, lactating cows, nonlactating cows, and cows which lost calves between June and late September 1992-1994

Caribou class	Jun-Sep	Jun-Nov	Sep-Nov	Sep-Mar
Calves	292 ± 8 (28)[a]	231 ± 10 (11)[a]	73 ± 24 (4)[a]	1 ± 8 (5)[a]
Lactating cows	140 + 9 (24)[b]	58 ± 10 (12)[b]	-124 ± 23 (4)[b]	-71 ± 6 (11)[b]
Nonlactating cows	168 + 5 (45)[c]	122 ± 11 (6)[c]	-20 ± 40 (2)[a]	-35 ± 4 (24)[c]
Cows-lost calves	81 + 28 (10)[d]			

[a] Weight changes with different letters are significantly different at p = 0.001.

Table 4 Weight change (gm/day) for lactating cows, nonlactating cows, and cows which lost calves between late June and late September 1992-1994

Caribou	Year	# Samples	Weight change (gm/day)	Standard error
Calf	1992	10	278	12.3
	1993	9	308	9.8
	1994	9	290	17.3
Lactating cows	1992	7	123	17.1
	1993	9	127	10.4
	1994	8	160	17.0
Nonlactating cows	1992	13	168	7.9
	1993	15	158	7.8
	1994	17	175	11.0
Cows-lost calves	1992	5	95	10.8
	1993	2	-25	11.8
	1994	3	128	43.7

APPENDIX Abstracts of papers submitted for publication as part of Study 3.39

CHAPTER 1: BODY COMPOSITION AND NUTRIENT RESERVES OF ARCTIC CARIBOU[1]

__Abstract:__ I determined seasonal changes in body weight and composition of arctic caribou (*Rangifer tarandus granti*) in relation to age and reproductive status. Chemical composition was determined for 37 caribou calves from the Central Arctic Herd (CAH) ranging from 1 to 134 days of age, and for 15 adult females collected from the same herd in October, May, and July. Composition of 5 CAH fetuses, 13 Porcupine Herd calves, and 10 captive male reindeer (*R. t. tarandus*) was determined for comparison. Between October 1989 and May 1990, body fat and protein of adult females declined by maxima of 45 and 29%, respectively; an additional 32% of fat was lost between May and July. Mobilization of large amounts of fat and protein suggests winter undernutrition. Chemical composition and growth pattern of calves did not differ between herds. Growth rate of CAH calves was high during the first 28 d post-partum (402 g/d); but both growth rate and fatness declined between 4 and 6 weeks of age (to 306 and -18.3 g/d, respectively), perhaps in response to insect harassment. Birth weights of males and females did not differ, but, by autumn, male calves were 9.1 kg heavier than females. Chemical components (water, fat, protein, ash) were highly correlated with body weight, ingesta-free body weight and carcass weight. Percentages of fat and water were inversely related, but the intercept decreased with age. Marked seasonal hypertrophy of liver and kidneys was noted in caribou, suggesting the presence of mobilizable protein reserves. Seasonal changes in organ weights also may reflect variations in metabolic activity and nutrient intake.

[1]Gerhart, K.L., White, R.G., Cameron, R.D., and Russell, D.E. Submitted. Body composition and nutrient reserves of arctic caribou. Can. J. Zool. **00**: 00-00.

APPENDIX Continued

CHAPTER 2: ESTIMATING FAT CONTENT OF CARIBOU FROM BODY CONDITION SCORES[1]

Abstract: Body condition scores provide a subjective measure of body fatness. I scored the condition of 64 barren-ground caribou and 10 reindeer, which were subsequently killed and analyzed for chemical composition. A body reserve index (the product of body condition score and body weight) was superior to either body weight or body condition score as a predictor of fatness for calves and adults. The probability of pregnancy for 107 adult female caribou was significantly related to both body condition score ($P = 0.017$) and body reserve index ($P = 0.007$).

[1]Gerhart, K.L., White, R.G., Cameron, R.D., and Russell, D.E. Submitted. Estimating fat content of caribou from body condition scores. J. Wildl. Manage. **00**: 00-00.

CHAPTER 3: PREGNANCY OF ADULT CARIBOU: EVIDENCE FOR LACTATIONAL INFERTILITY[1]

Abstract: To examine the relations between pregnancy, body condition, and lactation, 106 adult female caribou (*Rangifer tarandus granti*) of the Porcupine Herd were captured, weighed, measured, and scored for body condition in November 1990-1992. Blood samples were drawn for determination of pregnancy, and body fat content (kg) was estimated from the product of body weight and the body-condition score. Pregnant females were significantly fatter and heavier than nonpregnant females, and nonlactating females were significantly fatter, but no heavier than lactating caribou. Probability of pregnancy was positively correlated with body weight and fat content, but prediction of pregnancy was improved when multiple independent variables, including skeletal dimensions and lactation status, were included in logistic models. Nonlactating females were more fertile than lactating females at a particular body weight and metatarsus length; but, at the same fatness, they were not more fertile than females that had lactated through summer and were ceasing lactation in November. However, females that were extending lactation in November were least fertile, and this reduction of fertility was not explained by differences in body condition or skeletal dimensions. I suggest that the extended lactation group is exhibiting lactational infertility. Finally, unexplained differences in the relation between pregnancy rate and body condition exist among years, suggesting that interannual patterns in the nutrition and ecology of caribou affect the physiological relation between pregnancy and body condition.

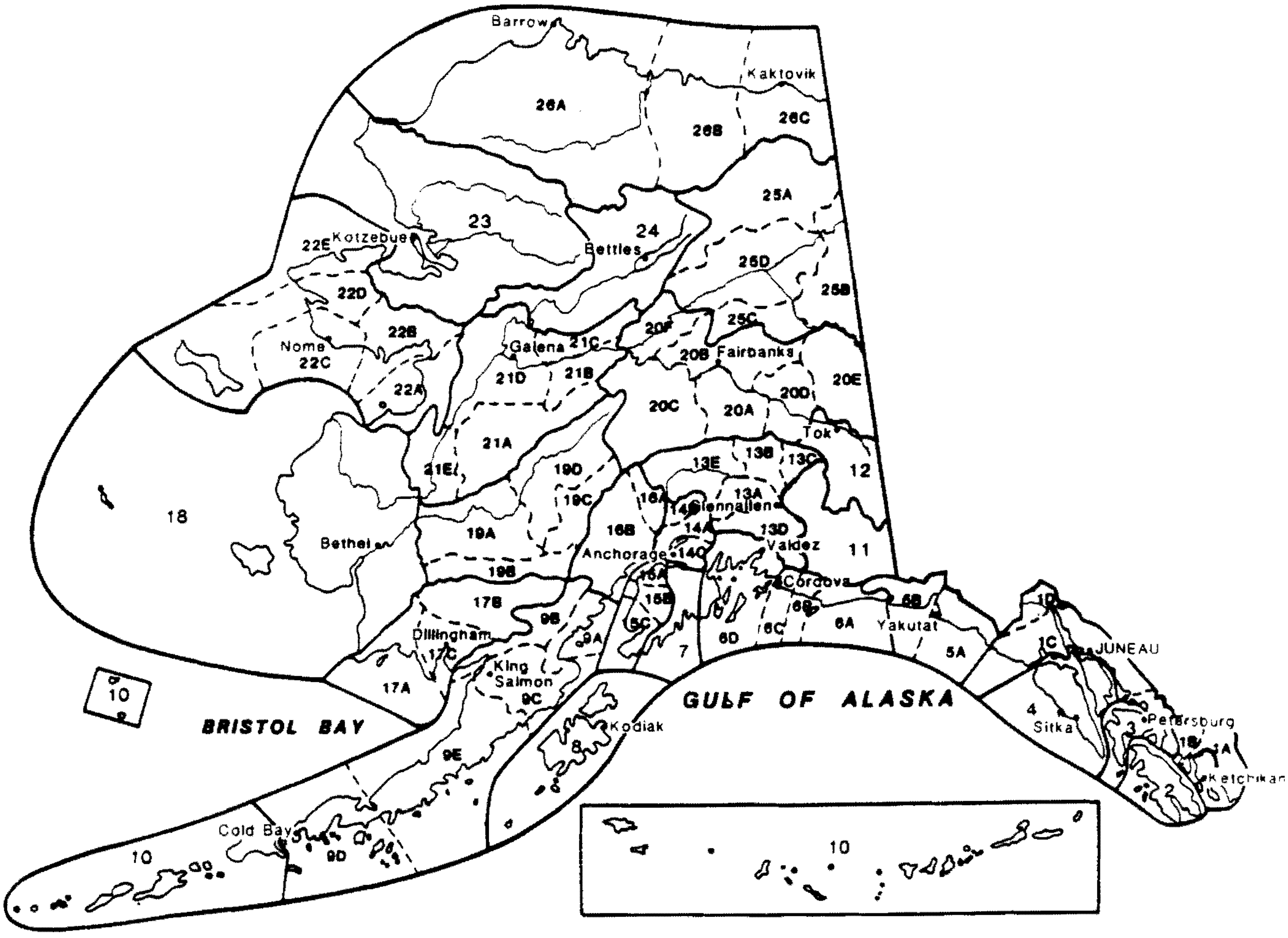
[1]Gerhart, K.L., Russell, D.E., Wetering, D., White, R.G. and Cameron, R.D. In Prep. Pregnancy of caribou: Evidence for lactational infertility. J. Zool. Lond. **00:** 00-00.

CHAPTER 4: GROWTH OF CARIBOU CALVES IN RELATION TO MATERNAL CONDITION[1]

__Abstract:__ Patterns of first-summer growth were characterized in captive and wild maternally-raised arctic caribou calves. Calf growth was then compared with the oversummer weight gain of the calf's dam. Peak growth rates of captive Porcupine Herd and wild Central Arctic and Porcupine Herd calves were similar. Ecological constraints apparently influenced the timing of autumn growth stasis, and therefore body weight of the calf upon entering winter: growth greatly slowed or stopped at 100 d of age for wild calves, but continued for another month or more in captive calves fed a diet containing moderate levels of protein and energy. Caribou therefore have the genetic potential for extended duration of first-summer growth beyond that observed in wild populations. Among wild calves, autumn body weight was influenced by early growth: birth weight and growth rate from birth to 3 weeks of age accounted for nearly 79% of the variation in autumn body weight. Birth weights of wild Porcupine Herd calves were related, in turn, to maternal weight 3 weeks postpartum, implying that females with low body weights during late gestation gave birth to the lightest calves. Finally, birth weights of wild Porcupine and Central Arctic Herd calves were relatively low in 1992. However, weights of calves entering winter were more sensitive to changes in duration of growth than to differences in early growth or maternal body condition 3 weeks post-calving. Captive adult Porcupine Herd females weighed 15 kg more than wild Porcupine Herd females in June. The larger body reserves of captive females may have permitted additional flexibility in milk production, since autumn body weight of captive calves was unrelated to birth weight or early growth. Among Porcupine Herd caribou, captive lactating females and nonlactating wild females gained weight more rapidly than wild lactating females. No compensatory weight gains were evident among adult female Porcupine Herd caribou: those with low June body weights gained weight no more rapidly than heavier females in the same lactation class, and autumn body weight was highly correlated with June body weight.

[1]Gerhart, K.L., White, R.G., Cameron, R.D., Russell, D.E., Griffith, D.B. In Prep. Growth of caribou calves in relation to maternal body condition. Can. J. Zool. **00:** 00-00.

Alaska's Game Management Units



The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve, and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes for responsible hunting. Seventy-five percent of the funds for this report are from Federal Aid.

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