Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report

Nutritional Status of the Southern Alaska Peninsula, Nelchina and Other Southcentral Alaska Caribou Herds

by

Thomas M. McCarthy

Project W-23-5
Study 3.36
November 1992

Alaska Department of Fish and Game
Division of Wildlife Conservation
November 1992

Nutritional Status of the Southern Alaska Peninsula, Nelchina and Other Southcentral Alaska Caribou herds

Thomas M. McCarthy

Federal Aid in Wildlife Restoration
Research Progress Report
Grant W-23-5
Study 3.36

STATE OF ALASKA
Walter J. Hickel, Governor

DEPARTMENT OF FISH AND GAME
Carl L. Rosier, Commissioner

DIVISION OF WILDLIFE CONSERVATION
David G. Kelleyhouse, Director
Wayne L. Regelin, Deputy Director

Additional copies of this report and other Division of Wildlife Conservation publications may be obtained from:

Publications Specialist
ADF&G, Wildlife Conservation
P.O. Box 22526
Juneau, AK 99802
(907) 465-4190

PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: U.S. Fish and Wildlife Service: University of Alaska: Ray Cameron, Craig Gardner, Kris Hundertmark, Chuck Schwartz, Dick Sellers, Curt Shuey, Ted Spraker, Bob Tobey, Larry Van Daele, Jim Woolington; Alaska Department of Fish and Game

Project No.: W-23-5 Project Title: Wildlife Research and Management

Study No.: 3.36 Study Title: Nutritional Status of the Southern Alaska Peninsula, Nelchina and Other Southcentral Alaska Caribou Herds

Period Covered: 1 July 1991 - 30 June 1992

SUMMARY

The regional caribou (*Rangifer tarandus*) biologist position was filled mid-way through this report period after a 13-month vacancy. During the interim, Moose Research Center (MRC) staff monitored the captive caribou at the MRC. Other field activities scheduled for this project resumed in late spring 1992. Analysis of data collected during this and previous report periods was initiated but remains incomplete. Bioelectrical impedance and body condition score derived fat indices are provided for herds exhibiting differential growth rates. Initial results for gestation length, calf body parameters, and neonatal survival from controlled nutrition studies are presented.

Key Words: Caribou, *Rangifer*, nutrition, Nelchina herd, Southern Alaska Peninsula herd, Mulchatna herd, body condition score, bioelectrical impedance, calf recruitment, calving chronology, gestation length.

TABLE OF CONTENTS

BACKGROUND

Since the early 1970s, dramatic fluctuations in the size of many Alaskan caribou (*Rangifer tarandus*) herds have necessitated restrictive management responses, resulting in dissatisfied user groups and criticism of both state and federal management programs. In Southcentral Alaska the Nelchina caribou herd (NCH) grew to high levels during the early and mid-1960s and then declined to very low levels in the early 1970s. The NCH has since rebounded and now numbers more than 45,000 and continues to grow. In contrast, the Southern Alaska Peninsula caribou herd (SAPCH) has declined from a recent high over more than 10,000 animals (1983) to a current low of about 3,200. While apparently no longer in decline, calf counts and census data from summer 1992 indicate that SAPCH numbers have, at best, only stabilized.

The appropriate management strategy for the herds at either extreme is not easily determined. Uncertainty as to the importance of density dependent food limitations in population regulation for this species confounds the issue (Pitcher 1991). The role of nutritional factors, predation, climatic conditions, and human harvest in regulating Alaskan caribou herds has been the subject of considerable debate, particularly for the NCH (Skoog 1968, Bos 1975, Doerr 1979, Van Ballenberghe 1985, Bergerud and Ballard 1989). However, a direct relationship between body condition and reproductive performance of female caribou has been documented in numerous studies (Dauphine 1976, Thomas 1982, Reimers et al. 1983, Skogland 1984, Allaye-Chan 1991, Cameron et al. 1992). Our understanding of these relationships remains incomplete and we need additional information to guide management.

Population and animal (physiologic) indicators (Franzmann 1985) are known to reflect the relationship between a herd and its environment; changes in nutritional status lead to changes in biological and population parameters. Population indicators, such as calving chronology, birth rates, survival rates, age of sexual maturation, and various demographic parameters can be determined through standard survey techniques and carcass analysis. Individual animal indicators, which intuitively should be more sensitive to nutritional perturbations, have been more difficult to measure. Recent advances in non-lethal *in vivo* methods of measuring body condition, such as bioelectrical impedance (BIA) and body condition scoring (BCS), may provide practical methods for managers to monitor physiological indicators (Lukaski et al. 1985, Hall et al. 1989, Hundertmark et al. 1991, Gerhart 1992). Herds under varying nutritional regimens occur in southcentral Alaska and allow for comparative analyses of various nutritionally mediated parameters. Spatial (between herd) and temporal (over time) comparisons of potential nutritional indicators such as body condition, birth weight, growth, and calving chronology will allow us to evaluate the efficacy of these new techniques in herd management.

Factors other than density-dependent nutritional limitation, particularly predation and human harvest, are significant in regulating populations of caribou herds. However, adequate nutrition is essential for the production and survival of animals at a high enough rate to allow herds to overcome cumulative environmental resistance and provide for a harvestable surplus. The primary focus of this project is to evaluate the nutritional status of caribou herds.

GOAL

The goal of this study is to develop a practical and economical procedure to evaluate and monitor the nutritional status of southcentral Alaskan caribou herds.

OBJECTIVES

Objectives for this study are to:

1. Determine which potential animal and population indicators reflect nutritional status by characterizing indicators from herds of varying nutritional status.

2. Experimentally determine the effects of nutrition on calving chronology, birth weight, body composition, blood and urine chemistry, and neonatal survival.

3. Experimentally determine if differences between herds in calving chronology, birth weights, and growth are mediated by heredity or nutrition.

4. Determine if undernutrition is contributing to low calf recruitment and declining population size in the SAPCH.

Working Hypotheses

1. Undernutrition in caribou herds will be reflected in a measurable and predictable way by selected biological and population parameters.

2. All caribou herds in southcentral Alaska comprise a single genetic population and have similar potential for growth, condition, and calving chronology.

3. The SAPCH is currently nutritionally limited to the extent that calf survivorship, growth, physical condition (including normal patterns of seasonal fattening and weight loss) and timing of calving are being negatively impacted.

METHODS

Job 2. Body Composition and Growth as Nutritional Indicators

During April-May 1990, October 1990, April-May 1991, and April-May 1992; 64, 17, 61, and 86 caribou were live-captured, respectively, from southcentral Alaska caribou herds.

During this study period we captured caribou using a skid mounted net-gun on a Hughes 500D helicopter and immobilized them by intramuscular injections of rompun (xylazine). We weighed the animals and took a series of body measurements (total length, mandible length, chest girth, metatarsal length). A subjective index was applied to each animal to evaluate body condition. We collected blood for packed cell volume determinations.

We took bioelectrical impedance measurements from each subject. Animals were placed on their sides with legs perpendicular to the body and we inserted electrodes under and parallel to the skin at the joint immediately proximal to the hoof. Electrode tips were pointed distally. We obtained resistance (R) and reactance readings using a bioelectrical impedance analyzer (RJL, Inc., Detroit, MI). Total body length, from base of tail to tip of nose was recorded.

We assigned body condition scores (1-4, 4 being high) based on the amount of soft tissue covering bone at each of 3 sites: ribs, hips, and along the spine. Scores were summed for an overall BCS. We calculated body reserve index (BRI) (weight * BCS) after Gerhart et al. (1992).

We estimated percent body fat by three different methods. Gerhart et al. (1992) used stepwise linear regression to examine the relationships between multiple independent variables and the dependent variables total body water (TBW), and body fat. They found that TBW, which exhibits a tight inverse relationship to body fat, was more strongly correlated with body weight (BW) (r^2=0.95) than with impedance expressed as length^2/resistance (r^2=0.78). However, use of the only BW to predict TBW would not be sensitive to the relationship between skeletal size and body weight. TBW in this study was then estimated by using the equation

$$TBW = 34.3 + 0.2 * L^2/R$$

where L^2 = body length^2 and R = resistance (*ibid.*). The fat-free body mass (FFM) was calculated using the interspecific hydration coefficient for lean tissue (0.723) with an arbitrary correction for ruminants. We then estimated percent body fat by the equation

$$\% \ FAT_1 = 100 * [IFBWt - (TBW/.77)]/IFBWt$$

where IFBWt = calculated ingesta-free body weight (live weight * 0.82).

Gerhart *et al.* (1992) also provide predictive equations to directly calculate body fat from the BRI, and using the impedance value. For comparative purposes we used both methods here. Two additional estimates of percent fat were then calculated as

$$\% \ FAT_2 = -4.9 + 0.02 * BRI,$$

and

$$\% \ FAT_3 = -6.3 + 0.1 * L^2/R.$$

Job 4. Calving Chronology Surveys

In late May of 1990-1992, we flew low-level aerial surveys over the Nelchina herd calving grounds to document calving chronology. The sampling scheme and data analysis techniques have been described by Becker (Pitcher 1991:35) and were designed to detect annual shifts in peak of calving within and between herds. Limited surveys were also flown over portions of the Mulchatna herd's range to delineate areas used for calving, and to gain general calving dates to facilitate more intensive future chronology work.

Job 5. Effect of Nutrition on Calving Chronology, Birth Weight and Neonatal Survival

Staff captured 8 Nelchina herd caribou, 6 females and 2 males, in September 1990 and transported them to the Moose Research Center on the Kenai Peninsula. The two bulls died and were replaced by 3 males from Kenai herds in summer and fall 1991. All Kenai caribou are the product of recent transplants from the Nelchina herd and of the same genetic stock as the bulls they replaced. We kept subject animals in a 4-ha enclosure and fed them a pelleted commercial reindeer ration *ad libitum*. Caribou supplemented that diet with natural forage (lichen were not available). During the rut, animals were restricted to a 700 m^2 holding pen to facilitate observation and documentation of breeding date. We weighed the animals up to five times per year.

Calving activity by captives was closely monitored and birthing dates recorded. We weighed, measured and ear-tagged the newborns within 12-hours of birth. Subsequent neonatal survival was ascertained. We calculated gestation length in cases where breeding date was known.

RESULTS AND DISCUSSION

Job 2. Body Composition and Growth

We determined body condition parameters for 86 total caribou from 5 different southcentral herds in spring 1992 and compared them with similar data collected in 1990 and 1991 (Table 1).

Body condition scores reported here were subjectively assigned. We attempted to standardize these scores across herds by having one individual trained in BCS estimation consult with local area managers when scoring. Still, we encountered biases based on the "local" perception of what constituted a caribou in good condition for a given herd on a given date. Despite this tendency, ranked BCSs seem to be correlated with at least two condition indices that were generated from direct measurements; the weight:length ratio and % FAT_1 (derived from body length and resistance values). BCS ranks were identical to % FAT_2, but those values are not independent as % FAT_2 is calculated using BRI, a derivative of BCS and weight.

Mean BCS, weight/length ratios, and 2 of 3 fat estimates were lowest for the SAPCH, the southcentral herd most recently in decline. The MULCH, which may be growing faster than any other southcentral herd, consistently scored near the top in all categories. Further, BCS ratings for the SAPCH declined between 1990 and 1992, while MULCH have improved. Rank correlation analyses may determine the significance of these observations. Relationships between body condition parameters and calf recruitment or stocking rates have not yet been examined due, in part, to incomplete data for the later values.

The difficulty in estimating body composition accurately from currently available and easily applied *in vivo* techniques is apparent from the range of estimates presented in Table 1. Two other published methods were tested but rejected because of the extreme values generated (range, -50% to +48% fat). All 3 body fat equations used here are based on either subjective body condition scores that are subject to the aforementioned biases, or on BIA measurements. The usefulness of BIA techniques as indicators of body condition in wild ungulates has come under question (Hundertmark, ADF&G, pers.

commun.). In field conditions here, resistance readings varied by nearly 10% when leg position was altered only slightly. The importance of consistency in electrode placement was even more apparent when resistance values dropped by 30% with relatively small increases in needle separation. Accurate predictions of body composition in caribou may not be achievable with BIA techniques. However, uniform application may provide data useful in determining trends or detecting differences between herds, especially if BIA results are used in conjunction with other condition estimates. If variability and sources of error can be controlled, BIA may yield a measurable index that has advantages over purely subjective methods.

Packed cell volume values determined in this study exhibited a high degree of variability within herds and did not appear to be correlated with any other body condition parameter measured.

Job 4. Calving Chronology

We conducted calving chronology flights on May 22, 24, 27, 29, and June 2 for the NCH. Recent attempts to examine calving chronology for this herd indicated a need for more frequent and seasonally later monitoring flights. Because of weather and fiscal constraints, we improved little in 1992 data collection. Data analysis followed methods outlined by Becker (Pitcher 1991:35) to derive a logistic regression model. A graph of the model fit to data for the past three years is given in Figure 1. Calving activity apparently peaked between May 26 and May 29, similar to previous years.

Area staff initiated calving survey flights this year for the Mulchatna herd. They located two large calving aggregations near the head of the Mosquito River and near Sleitat Mountain, each numbering in excess of 20,000 animals. A smaller aggregation of 10,000-15,000 animals was stretched from Whitefish Lake to the Chilikodrotna River. Calving was well under way in the two largest groups by the time of the first flight on May 19th. Calves comprised approximately 33% of these groups at that time, a figure not achieved until near the end of May in the Nelchina herd. This year's work has provided generalized dates and calving locations, and will allow standardization of techniques for future calving surveys.

Job 5. Effect of Nutrition on Calving Chronology, Birth Weight and Neonatal Survival

Some difficulties in handling captive caribou from wild stock have became apparent. The reluctance of captives to be forced or baited on to scales made reliable and frequent body weight estimates impossible to attain (Table 2). Recent technique improvements should allow for more frequent weighings with less animal stress.

We determined positive breeding dates, and subsequent gestation length for only 3 female caribou at the MRC. Staff recorded birth dates, weight, and body measurements (Table 3). Five of six calves were born over a six-day period from 23 to 28 May. This chronology of parturition is similar to that observed for Nelchina females in the wild. The sixth calf was born on 15 June and was possibly the product of a second estrus breeding. Breeding was not observed for this female. Estrus cycles of 10-12 days have been reported for caribou (Bergerud 1978). Birth weights were greater for males (mean=8.1, SD=0.12, n=3) than females (mean=6.4, SD=0.35, n=2).

Three calves had died by the end of June. One death was attributed to handling loss when the female abandoned it shortly after birth. She failed to accept the calf after it had been weighed and measured despite a separation of less than 5 minutes. The calf was approximately one-hour old at handling. Two other calves, both males, died at 14 and 17 days old. Necropsies failed to determine cause of death.

RECOMMENDATIONS

This preliminary analysis of body condition data for herds experiencing differential growth rates suggests that continued investigation of these indicators as potential management tools should be continued and refined. Cooperation with other studies where body composition is being addressed should be pursued.

We need to improve our techniques for examining population indicators, such as calving chronology and birth rates, so that their sensitivity to modest variation is enhanced. Current methods of monitoring calving chronology in southcentral herds will probably not allow us to detect shifts in peak calving dates with the degree of precision necessary to meet this study's objectives.

To allow examination of the relative influence of genetics and nutrition on both population and animal indicators, captive studies should continue. A high nutrition diet should be fed for an additional year before nutritionally stressing the animals. This will provide improved baseline data and allow biologists to better estimate gestation length and seasonal patterns of weight gain.

LITERATURE CITED

Allaye-Chan, A. C. 1991, Physiological and ecological determinants of nutrient partitioning in caribou and reindeer. Ph. D. thesis, University of Alaska, Fairbanks, Alaska.

Bergerud, A. T. 1978. Caribou. Pages 83-102 *in* J. L. Schmidt and D. L. Gilbert, eds. Big game of North America, ecology and management. Stackpole Books, Harrisburg, PA.

Bergerud, A. T., and W. B. Ballard. 1989. Wolf predation on the Nelchina caribou herd: a reply. J. Wildl. Manage. 53:251-259.

Bos, G. N. 1975. A partial analysis of the current population status of the Nelchina caribou herd. Proc. Int. Reindeer and Caribou Symp. 1:170-180.

Cameron, R. D., W. T. Smith, S. G. Fancy, K. L. Gerhart, and R. G. White. 1992. Calving success of female caribou in relation to body weight. Can. J. Zool. (Submitted April 1992)

Dauphine, T. C., Jr. 1976. Biology of the Kaminuriak population of barren-ground caribou. Part 4. Growth, reproduction, and energy reserves. Can. Wildl. Serv. Rep. Ser. No. 38.

Doerr, J. 1979. Population analysis and modeling of the western Arctic caribou herd with comparisons to other Alaskan *Rangifer* populations. M.S. Thesis, Univ. Alaska Fairbanks. 340pp.

Franzmann, A. W. 1985. Assessment of nutritional status. Pages 239-258 *in* R. J. Hudson and R. G. White, eds. Bioenergetics of wild herbivores. CRC Press, Boca Raton, Florida.

Gerhart, K. L., R. G. White, and R. D. Cameron. 1992. Estimating body composition of caribou and reindeer using bioelectrical impedance analysis and body condition scores. Rangifer. In Press.

Hall, C. B., H. C. Lukaskai, and M. J. Marchello. 1989. Estimation of rat body composition using tetrapolar bioelectrical impedance analysis. Nutrition Reports Int. 39:627-634.

Hundertmark, K. J. 1992. Evaluation and testing of techniques for moose management. Alaska Dep. of Fish and Game Res. Fed. Aid in Wildl. Rest. Res. Prog. Rep. Proj. W-23-4. Study 1.39. Juneau. 31pp.

Lukaski, H. C., P. E. Johnson, W. W. Bolonchuk, and G. I. Lykken. 1985. Assessment of fat-free mass using bioelectrical impedance measurements of the human body. Am. J. Clin. Nutr. 41:810-817.

Pitcher, K. W. 1991. Nutritional Status of the Southern Alaska Peninsula, Nelchina, and other Southcentral caribou herds. Alaska Dep. of Fish and Game. Fed. Aid in Wildl. Rest. Res. Prog. Rep. Proj. W-23-4. Study 3.36. Juneau. 42pp.

Reimers, E., D. R. Klein, and R. Sorumgaard. 1983. Calving time, growth rate, and body size of Norwegian reindeer on different ranges. Arctic and Alpine Research 15:107-118.

Skogland, T. 1984. The effects of food and maternal conditions on fetal growth and size in wild reindeer. Rangifer 4:39-46.

Skoog, R. O. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. Thesis. Univ. of California, Berkeley. 699pp.

Thomas, D. C. 1982. The relationship between fertility and fat reserves of Peary caribou. Can. J. Zool. 60:597-602.

Van Ballenberghe, V. 1985. Wolf predation on caribou: the Nelchina herd case history. J. Wildl. Manage. 49:711-720.

Prepared by:

Thomas M. McCarthy
Wildlife Biologist

Approved by:

D G Kelleyhouse

David G. Kelleyhouse, Director
Division of Wildlife Conservation

Submitted by:

Karl B. Schneider
Regional Research Coordinator

Steven R. Peterson

Steven R. Peterson, Senior Staff Biologist
Division of Wildlife Conservation

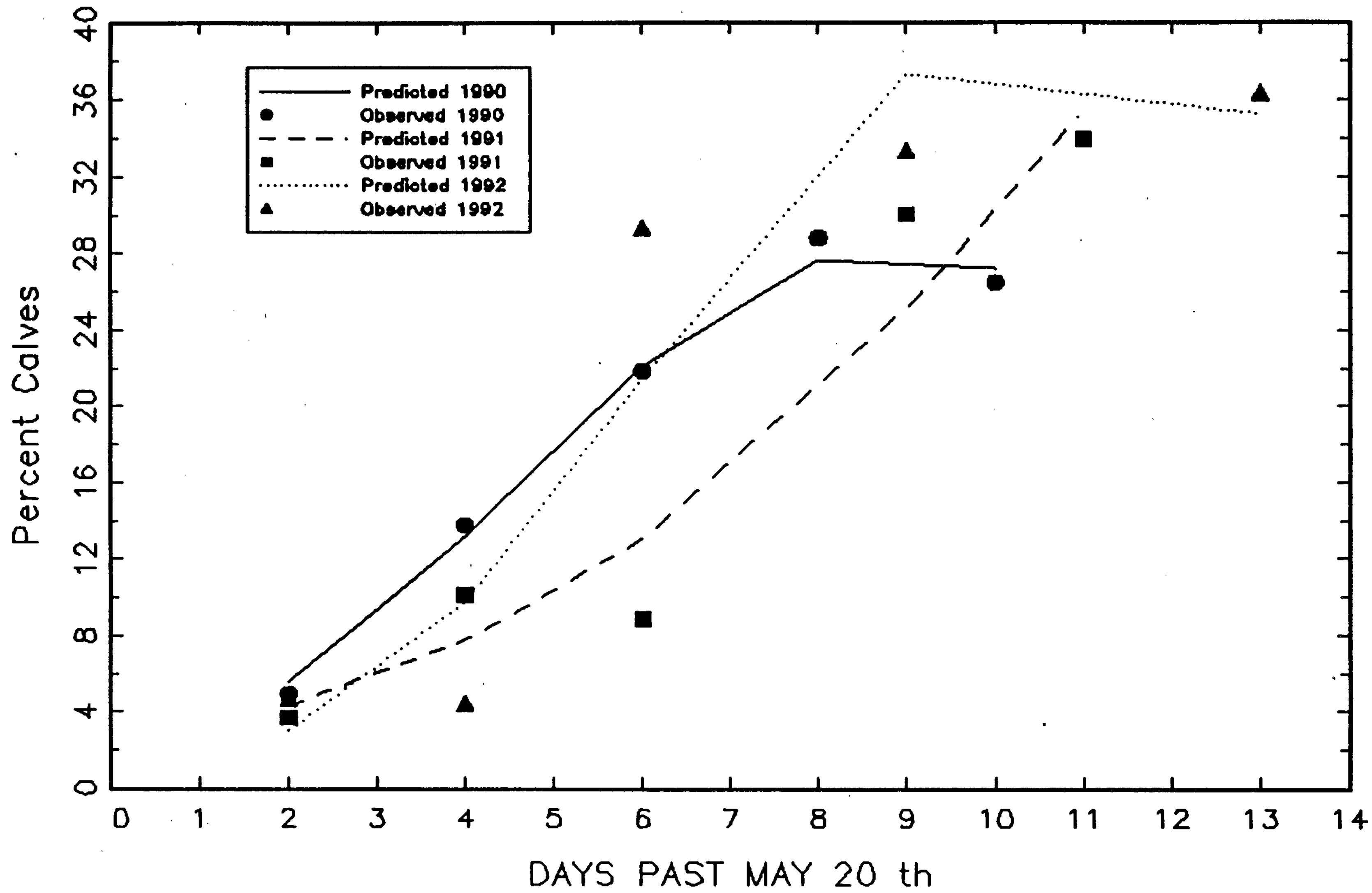


Figure 1. Plot of logistic regression model of caribou calving chronology for the Nelchina herd, 1990-1992.

Table 1. Comparative body condition parameters from selected southcentral Alaska caribou herds, 1990-1992. Means are reported with standard deviation in parentheses.

Parameter/ Year	HERD				
	NCH_1	NAPCH	SAPCH	MULCH	NUSHCH
BCS					
1990	5.7 (1.7)	6.0 (0.8)	6.5 (0.9)	6.1 (1.1)	
1991	4.6 (0.9)			6.9 (1.0)	
1992	6.6 (1.0)	7.4 (1.1)	5.4 (0.9)	7.2 (1.2)	7.1 (0.8)
PCV					
1990	49.5 (3.0)	49.6 (3.7)	49.5 (2.8)	50.2 (3.9)	
1991	51.6 (2.6)				
1992	56.3 (2.6)	50.5 (3.0)	51.2 (3.6)	54.9 (5.1)	54.1 (3.9)
Wt/Lngth					
1990	0.54 (0.05)	0.53 (0.04)	0.47 (0.04)	0.58 (0.05)	
1991	0.56 (0.04)			0.58 (0.15)	
1992	0.53 (0.06)	0.54 (0.04)	0.48 (0.03)	0.55 (0.04)	0.53 (0.06)
% Fat_1					
1990	26.6 (6.7)	26.2 (7.2)	17.6 (6.3)	33.3 (4.8)	
1991	31.1 (3.8)			32.8 (6.1)	
1992	20.7 (6.2)	22.6 (7.0)	13.6 (6.7)	23.5 (6.0)	21.5 (4.4)
% Fat_2					
1990	8.2 (4.1)	8.7 (1.9)	8.4 (2.8)	9.5 (2.7)	
1991	5.9 (2.4)			11.9 (2.2)	
1992	10.4 (3.0)	12.6 (2.7)	6.4 (2.4)	11.8 (2.8)	11.3 (2.2)
% Fat_3					
1990	1.3 (1.0)	-0.5 (1.1)	-2.6 (3.4)	0.7 (0.4)	
1991	0.8 (0.8)			0.8 (2.2)	
1992	4.1 (1.9)	2.8 (2.0)	2.2 (1.8)	3.4 (1.2)	1.9 (1.4)

NCH = Nelchina
NAPCH = Northern Alaska Peninsula
SAPCH = Southern Alaska Peninsula
MULCH = Mulchatna
NUSCH = Nushagak
BCS = Body condition score
PCV = Packed cell volume

Table 2. Weights of captive caribou at the Moose Research Center, 1990-1992.

	Weight (kg)											
Caribou	9/90	11/90	12/90	2/91	3/91	11/91	1/92	3/92	4/92	5/92	6/92	7/92
BR	113	--	--	98	102	118	116	--	122	--	--	107
Blue	120	--	--	--	--	120	122	--	122	--	--	105
BY	117	--	--	104	104	113	112	--	117	--	110	--
White	112	--	--	--	--	122	119	--	126	--	--	114
RW	102	--	--	92	93	113	111	--	115	105		
Orange	80	--	--	--	--	96	93	--	102	--	--	97
Yellow	101	--	94									
Red	88	79[a]										
Lowland	--	--	--	--	--	91	95	--	101	--	--	115
Killey	--	--	--	--	--	128	--	117[a]				

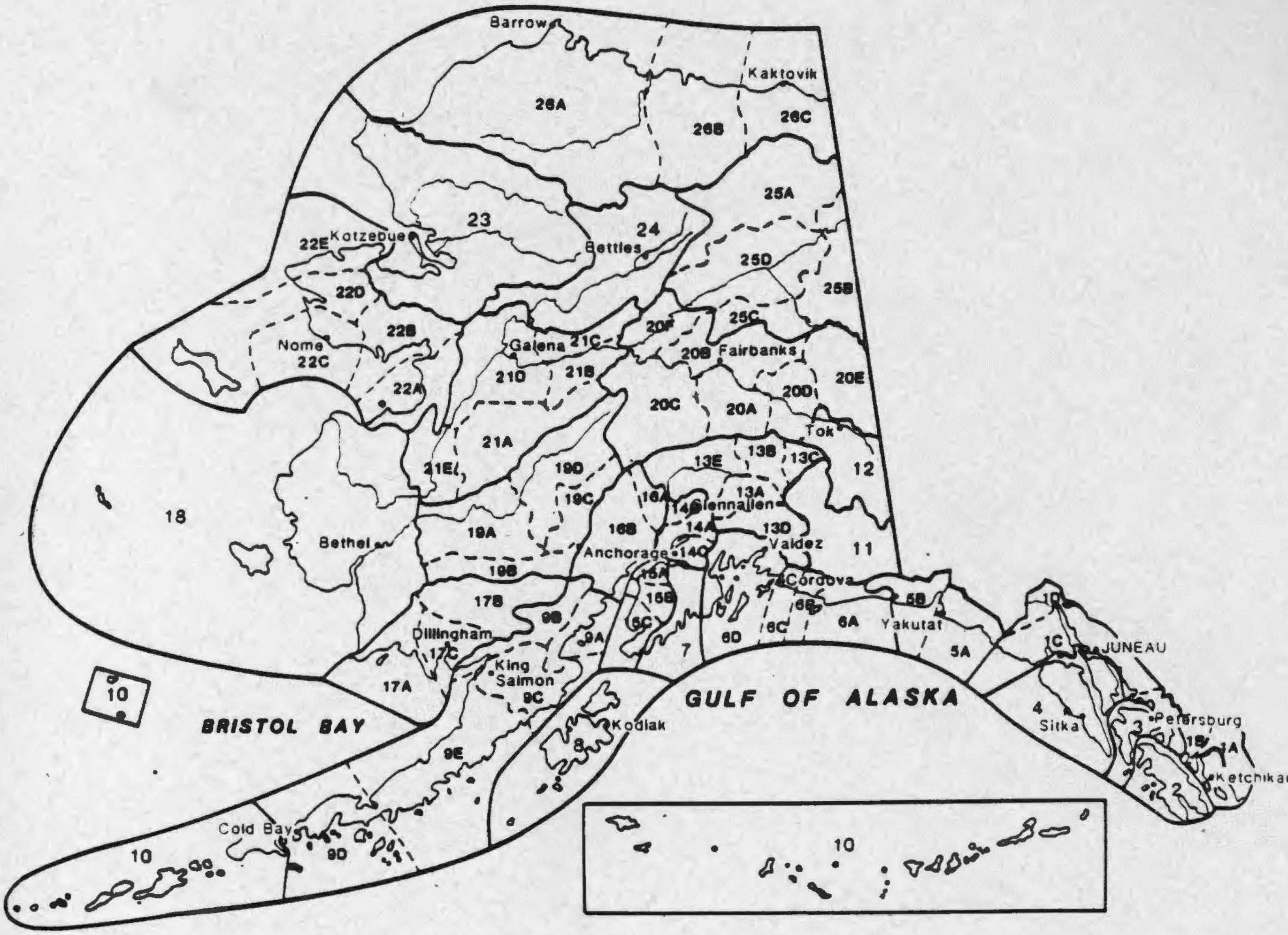
[a] Dead weight

Table 3. Birth dates, weights, and morphometric measurements of caribou calves born at the Moose Research Center in 1992.

Female	Date of Parturition	Length of Gestation	Sex	Birth Weight (kg)	Total Length (cm)	Mandible Length (cm)	Metatarsal Length (cm)
Blue	5/23/92	222 days	F	6.6	79	--	26.0
White	5/24/92	224 days	F	6.1	78	--	26.0
Orange	5/25/92	Unknown	M	8.0	84	14.5	26.5
RW	5/26/92	228 days	M	8.2	85	13.5	27.0
BR	5/28/92	Unknown	M	8.2	94	14.0	28.0
BY[a]	6/ /92	Unknown	M				

[a] Suspected second estrus breeding.

Alaska's Game Management Units



WILDLIFE RESTORATION

Project funded by Federal Aid in Wildlife Restoration