Alaska Department of Fish and Game Division of Wildlife Conservation Federal Aid in Wildlife Restoration Research Progress Report

# DEMOGRAPHY OF THE DELTA CARIBOU HERD UNDER VARYING RATES OF NATURAL MORTALITY AND HARVEST BY HUMANS



by James L. Davis Patrick Valkenburg and Mark E. McNay Project W-23-1 Study 3.33 December 1989

# STATE OF ALASKA Steve Cowper, Governor

# DEPARTMENT OF FISH AND GAME Don W. Collinsworth, Commissioner

# DIVISION OF WILDLIFE CONSERVATION W. Lewis Pamplin, Jr., Director Donald E. McKnight, Planning Chief

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# PROGRESS REPORT (RESEARCH)

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Cooperator: <u>Steve Fleischman, University of Alaska,</u> <u>Cooperative Wildlife Research Unit</u>

- Project No.: <u>W-23-1</u> Project Title: <u>Wildlife Research and</u> <u>Management</u>
- Study No.: 3.33 Study Title: Demography of the Delta Caribou Herd Under Varying Rates of Natural Mortality and Harvest by Humans

Period Covered: <u>1 July 1987-30 June 1988</u> (Includes data through October 1988)

# SUMMARY

Distribution of the Delta and Yanert Caribou (<u>Rangifer</u> <u>tarandus granti</u>) Herds overlapped during the census of postcalving aggregations on 15 July 1988. Conservatively, we estimated  $\geq 8,500$  caribou (including calves) in the 2 herds. The sex and age compositions in 1987 and 1988 that showed declining bull:cow ratios were predictable because of the males-only hunting season. Natality data were obtained primarily from monitoring radio-collared females from these herds. Natality remained relatively high at 88% in 1988. A manuscript entitled "Mortality of Delta Herd Caribou to 24 Months of Age" (Appendix B) was finalized and published in the <u>Proceedings of the 3rd North American Caribou Workshop</u> (Davis et al. 1988<u>b</u>).

<u>Key Words</u>: caribou, census, Delta herd, demography, grizzly bear, mortality, population dynamics, Rangifer, recruitment, wolf, Yanert herd.

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# BACKGROUND

The Alaska Department of Fish and Game's (ADF&G) goal for some caribou (<u>Rangifer tarandus granti</u>) herds is to stabilize them at specific levels and ensure that others do not decline below set minimum sizes. However, few caribou herds in Alaska have remained stable for more than a few years; it has been particularly rare for a heavily harvested herd to remain stable. If these goals are to be accomplished and management programs successful, understanding the mechanics of caribou population dynamics is essential. Although the factors that determine population dynamics for all wildlife species are the same (i.e., births, deaths, and emigration/immigration), the specific variables affecting these factors can differ greatly.

A quantitative demographic assessment of an Alaskan caribou herd has never been conducted over a period where the natural and human-induced mortality rates have fluctuated so greatly. In a recent workshop (Klein and White 1978) attended by leading caribou researchers in North America, a need for intensive demographic study of one or more caribou herds in Alaska was identified. Its proximity to Fairbanks and our considerable background information as well as options for intensively managing (i.e., manipulating) it, make the Delta Caribou Herd (DCH) ideal for a long-term demographic study. Hypotheses may be more feasibly tested on the DCH than on larger herds (i.e., Western Arctic and Porcupine herds), regarding many aspects of general caribou ecology. Davis and Preston (1980) revealed that herd demography was misunderstood for the DCH from 1975 through 1979. Because the DCH will continue to be intensively managed, a thorough understanding of its demography is essential.

Davis and Neiland (1975) reviewed and compiled available data for the DCH. Additional background information has been presented by Davis and Preston (1980), Davis and Valkenburg (1981, 1983, 1985), and Davis et al. (1982, 1983, 1987, 1988<u>b</u>). During the past 16 years, the DCH has declined dramatically (i.e., from 5,000 in 1969 to about 2,000 in 1975) and increased even more dramatically (i.e., from about 2,000 in 1975 to 7,000 in 1982). Since 1982 herd growth has been slowed by hunting. During the past 16 years, high and low levels of both natural mortality and harvest have occurred and much has been learned about caribou population dynamics (Davis et al. 1983). More importantly, much has been learned about the interrelationships between large predators, prey, and humans in Subunit 20A (Gasaway et al. 1983).

By continuing to study the DCH's demography and simultaneously intensifying study of the herd's behavior, nutrition, energetics, and interaction with the biotic (including predators) and abiotic environment, we should ultimately understand caribou ecology to the degree presently demanded by the growing pressures on caribou and their habitat. Since study of the DCH was intensified in 1979, considerable data on herd movements and distribution have been collected incidental to fulfilling major objectives. Skoog (1968:202, 655) and Bergerud (1974<u>a</u>) discussed the effects of movements and distribution of caribou on herd demography. As populations increase, caribou travel more widely and may increase their use of marginal ranges. Use of marginal ranges result in lower natality and increased mortality because of greater energy expenditures, poorer quality forage, and greater vulnerability to predation.

Our rudimentary understanding of the relationships of movements and distribution of caribou herds to population demography are sufficient to warrant analysis of existing movement and distribution data. If the DCH continues to increase in size, any change in movements and distribution will be better interpreted if earlier patterns have been well documented.

Opposing views are emerging among caribou biologists regarding basic social organization of caribou, including questions of herd identity, definition, and fidelity to calving areas and seasonal ranges (Bergerud et al. 1984, Carruthers 1985, Martell and Russell 1985). The known histories of radio-collared caribou in the DCH and the Yanert Caribou Herd (YCH) could prove invaluable in contributing empirical evidence about the social organization of caribou (Davis et al. 1986).

The use of aerial photography for estimating population size of caribou herds is becoming more popular. The assumption that all caribou (including calves) that are photographed can be counted from photos has not been validated; many other caribou management/research techniques presently employed also require validation. For example, the reliability of herd composition counts conducted in April as an indication of "yearling recruitment" has not been critically examined. Also, use of a small cohort of radio-collared cows to estimate herd natality and calf survival has not been critically evaluated.

Availability of radio-collared caribou with known histories is requisite for several objectives of the current study. Fortunately, caribou that were collared during a previous demographic study (Davis and Valkenburg 1985) still have functioning radio collars and are available. Pertinent information was summarized in Davis et al. (1988<u>a</u>: Table 1) concerning all radio-collared Delta and Yanert herd caribou studied during the reporting period.

# GOAL

To estimate population parameters (i.e., birth, death, and dispersal) of the DCH and YCH and to evaluate field procedures for estimating those parameters.

### OBJECTIVES AND PROCEDURES

1. Objectives 1a through 1g will be worked toward over a 5-year period (1986-90). Procedures for 1a through 1g have been described or cited in a prior Federal Aid report (Davis and Valkenburg 1985). The following objectives will be accomplished by the ADF&G survey and inventory program and/or by this research project.

a. <u>To census the DCH and the YCH in 1986, 1987, 1988,</u> <u>1989, and 1990</u>. We will use the modified aerial photodirect/count-extrapolation (APDCE), radio-search, or total-count techniques (using 2 helicopters) to annually census the 2 herds.

b. To determine the annual natality rates and calving chronologies of the 2 herds. Monitoring about 50 radio-collared cows and sampling the herd at large will enable us to determine the natality rate. Other supporting information will be obtained by using a helicopter to aid in obtaining composition counts and udder counts. Documenting annual calving distribution is a priority.

To determine yearling recruitment in the DCH and the c. YCH. We will monitor the radio-collared cows to determine their natality rate and subsequent calf survival. Composition counts will be conducted during April on the herd at large. We will attempt to obtain random, even-sized subsamples to facilitate evaluation of bias and for calculation of a confidence interval Our sample design requires classifying for the data. approximately 100 caribou closest to each radio-collared caribou to ensure classification of entire groups. This rationale for sampling assumes that the basic social structure of caribou consists of "temporary tenuous association(s) of individuals" (Lent 1965) or "open social units" (Bergerud 1974b) that have validated for some been Alaskan caribou herds through radiotelemetry studies (Valkenburg et al. 1983).

d. <u>To measure harvest by hunters</u>. The existing survey and inventory program will collect harvest data through various reporting procedures.

e. <u>To determine when major mortality occurs to both calves</u> and adults and to characterize caribou dying from natural causes. Data from radio-collared caribou and composition counts will determine the chronology of calf mortality. Survival rates of adult caribou will be calculated from the radio-collared caribou. Carcasses of caribou dying from natural causes will be collected and examined.

f. To determine caribou:predator ratios in the range of the DCH and YCH. These ratios will be determined using data from the annual caribou censuses, caribou distribution surveys of radio-collared caribou, results of wolf (<u>Canis lupus</u>) surveys conducted in GMU 20A by the management staff (augmented by our surveys when required), and results of a concurrent ADF&G study of grizzly bears (<u>Ursus arctos</u>) (Reynolds et al. 1987).

g. To determine the seasonal movements, distribution, and fidelity to respective calving grounds of radio-collared caribou, We will locate all radio-collared caribou monthly and monitor all female radio-collared caribou 2 or more times during the calving period.

2. Objectives 2a through 2k will be addressed by collecting data during 1 or more years of this 5-year study.

a. To determine if bearing a calf when a cow is 24-36 months old, or for several successive years, influences the probability of calving in subsequent years. We will keep active radio collars on about 50 cows to determine their reproductive history.

b. <u>To determine if there are any differing cohort-specific</u> pregnancy probabilities for cows 24 or 36 months old. Same procedure as 2a. c. To determine if the natality rate of 24- and 36-monthold cows is determined by their weight at the time of the rut. We will collar ten 12-month-old females in each cohort to determine natality rate at 24 months. We will weigh 16-month-old females and correlate weight with subsequent natality.

d. To determine if caribou killed by predators are taken in proportion to their representation in the population in terms of sex and age. We will compare the sex and age data of radiocollared caribou killed by predators with data from the total radio-collared sample. We will do likewise for caribou in the population at large.

e. <u>To determine the correlation between wolf abundance and</u> <u>the number of caribou killed by wolves</u>. Estimates of caribou population size and distribution and estimates of wolf abundance and distribution, coupled with caribou mortality rates from wolf predation, will allow this correlation to be tested.

f. <u>To determine if DCH and YCH caribou are faithful to</u> <u>their respective calving grounds</u>. We will determine this by monitoring radio-collared cows and by conducting aerial surveys of the respective calving areas.

g. <u>To determine if dispersal is important to the</u> <u>population dynamics of the DCH and YCH</u>. We and workers on concurrent studies will monitor radio-collared caribou in the Delta, Yanert, Denali, Nelchina, Macomb, and Fortymile Herds. Also, annual censuses should identify inexplicable major increases or declines that suggest immigration or emigration has occurred.

h. <u>To compare food habits of the Delta, Yanert, Denali,</u> <u>and Fortymile Herds</u>. Monthly fecal pellet collections will be made for herds where data are currently unavailable.

i. To determine if all caribou photographed during censuses appear as discrete images and are enumerated during photo interpretation. Ground counts will be made to determine the exact number of calves and older caribou in groups that will subsequently be photographed at the scale used during censuses. Different scales (altitude), photo angles, and film will be evaluated.

j. To determine if yearling recruitment is precisely and accurately estimated by conducting herd composition surveys in <u>April</u>. Precision will be tested by conducting serial counts of the same sample area (e.g., on successive days, weeks, or months). Evaluating accuracy will involve modeling for crosschecking recruitment data.

k. <u>To identify the limits of validity in using a small</u> <u>sample of radio-collared cows to estimate herd natality and</u> <u>recruitment</u>. Modeling results will be compared with empirical

data from the herd at large and from the radio-collared cohort. The validity of judging calf recruitment by monitoring radiocollared females will be evaluated by determining when the cowcalf bond breaks and by determining the sex and age of caribou that unbonded calves associate with.

# STUDY AREA

Skoog (1968) originally described the range of the DCH. Based on subsequent study, Hemming (1971) modified Skoog's description and described the physical environment. Little has changed since Hemming's revision. The DCH currently ranges over about 9,600 km<sup>2</sup> on the northern slopes of the Alaska Range, between the Nenana River on the west and the Delta River on the east approximately 110 kilometers south of Fairbanks. The Alaska Range rises abruptly from its foothills and consists of rugged, glaciated ridges at elevations of 1,830-2,740 meters interspersed with glacier-capped mountains exceeding 3,660 meters. The northern foothills of the Alaska Range are flat-topped ridges at elevations of 610-1,370 meters separated by rolling tussock tundra, muskegs, and spruce (Picea spp.) covered lowlands. North of the foothills lies the predominantly spruce-covered Tanana Flats. The entire area is drained by the Tanana River. The transition is abrupt from the foothills to the Tanana Flats. The Flats have little relief, and elevations range from 130 to 300 Because the Flats are underlain by permafrost, the meters. drainage is poor, resulting in numerous shallow ponds and extensive bogs.

Fire has greatly influenced the lowland vegetation, resulting in the creation of a mosaic of shrub and young forest-dominated seres, climax bogs, and mature black spruce (<u>P. mariana</u>) forest (LeResche et al. 1974). Fires have also occurred on the calving area and adjacent tundra and uplands (Davis et al. 1985). Vegetation in the hills, foothills, and mountains grades from taiga of white spruce (<u>P. glauca</u>), black spruce, paper birch (<u>Betula papyrifera</u>), and quaking aspen (<u>Populus tremuloides</u>) into shrub communities of willow (<u>Salix</u> spp.); dwarf birch (<u>B</u>. <u>glandulosa</u> and <u>B. nana</u>) occurs at low elevations and alpine tundra at high elevations (LeResche et al. 1974).

The study area is largely snow-free from May until October. Annual temperatures range from approximately 29 C to -51 C. Annual precipitation and snow accumulation averages about 30 and zero to 50 centimeters, respectively; however, snow occasionally exceed 80 cm. Ground vegetation in the foothills and mountains is frequently exposed during winter because of strong winds. Although the DCH is widely distributed from the mountains to the Flats during winter, the foothills appear most used.

As calving time approaches, cows and many short yearlings move into the upper portion of the Little Delta River and Delta Creek to the traditional core calving areas, which have been used since before the 1950's. Most calves are born in tussock tundra, but many others are born in the low shrub and sparse spruce-dominated areas. Most bulls and some short yearlings remain widely scattered throughout the herd's entire range during calving.

In this report, all references to the DCH prior to 1980 include the Delta and Yanert Herds.

# RESULTS AND DISCUSSION

# Census of the DCH and YCH

Several complications confounded the quality of the 1988 census of the DCH and YCH. The 2 herds were intermingled when censused, and the number of caribou (i.e., including calves) "enumerated" was 8,338 (Appendix A). A minimum of several hundred more caribou were present but not enumerated. A conservative estimate, including calves, would be  $\geq 8,500$ .

In 1988 the DCH and YCH census was initiated on 15 July; 3 aircraft were employed. Jim Davis and J. Wright crewed a Bellanca Scout, M. McNay and R. Boertje crewed a Piper Super Cub, and P. Valkenburg, R. Beasley, V. Crichton, and J. Winters crewed a DeHavilland Beaver. The Scout and Super Cub combined radiotracking and visual searches of the area adjacent to the locations of radio-collared caribou in the upper Wood River watershed and adjoining areas (Appendix A).

Groups of caribou located by the Scout and Super Cub (Appendix A) were photographed or visually enumerated. Photographs were taken with 35-mm SLR cameras using color print film (i.e., Kodak VRG, 100 ASA). The crew in the Beaver aircraft searched and enumerated caribou on the north side of the Yanert River drainage.

Before all radio-collared caribou had been located and before a portion of the census area known to contain several hundred caribou could be intensively searched (Appendix A), a huge storm prematurely terminated the census on 15 July. The entire census area was covered by storms on 16 July. On 17 July, J. Davis and V. Crichton flew the Scout to locate radio-collared caribou missed on 15 July and to reconoiter the area that had not been intensively searched on 15 July.

### Sex and Age Composition

Sex and age composition data from the DCH and YCH are summarized in Tables 1 and 2.

# Natality Rate

During this reporting period, natality data were obtained primarily from radio-collared DCH caribou (Table 3).

# Yearling Recruitment in the DCH and YCH

Recruitment is discussed in Appendix B.

# Harvest by Hunters

Historical harvest data for the DCH and YCH are summarized in Table 4. Historical hunting seasons and bag limits are summarized in Tables 5 and 6 for the YCH and DCH, respectively. During regulatory years 1986-87 and 1987-88, M. McNay and others manned hunter check stations near the main access routes for hunters and contacted several hundred DCH and YCH hunters while they were in the field. Field checks by McNay (1988) indicated that the rate of reporting by successful and unsuccessful hunters via the hunter report card/harvest ticket system resulted in a gross underestimation of the actual harvest (Table 4).

# <u>Mortality</u>

Mortality is discussed in Appendix B.

# Wolf:Caribou and Grizzly Bear:Caribou Ratios

Davis et al. (1987) presented the data base and rationale for calculating and discussing wolf:caribou and grizzly bear:caribou ratios in both the DCH and YCH. Although we have attained additional caribou census data and updated estimates of wolf abundance, the general discussion in our last report does not warrant updating. Wolf numbers, pack distribution, harvest rates, necropsy data, and radio-cesium 137 burdens and food habits will be reported in subsequent reports.

# Seasonal Movements, Distribution, and Fidelity to Calving Grounds

Throughout the study period, we monitored radio-collared caribou to document seasonal movements and distribution. A University of Alaska, Cooperative Wildlife Research Unit Master of Science project by Steve Fleischman is contributing toward collation, analysis, and interpretation of movements and distribution data. The draft thesis is in review and will be submitted as a Federal Aid report 30 June 1989.

# Data to be Collected During 1 or More Years to Test Hypotheses

Some field data pertaining to several of the objectives (<u>see</u> Objectives and Procedures) were collected. However, no in-depth analyses were conducted, so reporting will occur in subsequent reports.

# Other Progress During This Reporting Period

Project personnel assisted in radio-collaring several wolf packs in Subunit 20A in cooperation with the ADF&G survey and inventory wolf project. Because many objectives of this study require radio-collared caribou, we radio-collared a number of additional caribou during the study period. Jim Davis spent considerable time editing the <u>Proceedings of the 3rd North American Caribou</u> <u>Workshop</u>, which contained 4 papers pertaining to the DCH and YCH.

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PREPARED BY:

James L. Davis Wildlife Biologist III

Patrick Valkenburg Wildlife Biologist II

<u>Mark E. McNay</u> Wildlife Biologist III W. Lewis Pamplin, Jr., Director Division of Wildlife Conservation

APPROVED BY:

W. Bruce Dinneford Acting Planning Chief Division of Wildlife Conservation

SUBMITTED BY: John W. Schoen Regional Research Coordinator

| Date        | Bulls:<br>100 cows | Yrlgs:<br>100 cows | Calves:<br>100 cows | Yrlg<br>% in<br>herd | No.<br>yrlg | Calf<br>% in<br>herd | No.<br>calves | Cow<br>% in<br>herd | No.<br>cows | Bull<br>% in<br>herd | No.<br>bulls | Sample<br>size |
|-------------|--------------------|--------------------|---------------------|----------------------|-------------|----------------------|---------------|---------------------|-------------|----------------------|--------------|----------------|
| ······      |                    |                    |                     |                      |             |                      |               |                     |             |                      |              |                |
| 10/13-15/69 | 40                 | 21                 | 28                  | 11                   | 85          | 15                   | 116           | 53                  | 410         | 21                   | 166          | 777            |
| 10/21-23/70 | 77                 | 23                 | 34                  | 9                    | 88          | 14                   | 129           | 42                  | 383         | 33                   | 296          | 896            |
| 10/29-31/71 | 29                 | 11                 | 16                  | 7                    | 78          | 9                    | 109           | 64                  | 738         | 18                   | 214          | 1,139          |
| 10/27-31/72 | 32                 | 6                  | 10                  | 4                    | 46          | 7                    | 85            | 67                  | 795         | 21                   | 259          | 1,185          |
| 10/23-24/73 | 28                 | 4                  | 10                  | 3                    | 29          | 7                    | 76            | 70                  | 735         | 20                   | 210          | 1,050          |
| 10/23-25/74 | 27                 | 2                  | 2                   | 1                    | 16          | 1                    | 17            | 76                  | 868         | 21                   | 240          | 1,141          |
| 6/11-12/75  | 3                  | 1                  | 12                  | 1                    | 3           | 11                   | 108           | 86                  | 839         | 2                    | 26           | 976            |
| 6/3/76      | 1                  | 0                  | 41                  | 0                    | 0           | 28                   | 395           | 70                  | 955         | 1                    | 15           | 1,365          |
| 6/6-22/76   | 1                  | 0                  | 55                  | 0                    | 0           | 35                   | 390           | 63                  | 699         | 1                    | 10           | 1,099          |
| 10/29-31/76 | 38                 | 1                  | 45                  | 1                    | 5           | 24                   | 258           | 54                  | 572         | 20                   | 220          | 1,055          |
| 6/16-19/77  | 9                  | 12                 | 34                  | 8                    | 95          | 22                   | 269           | 64                  | 784         | 6                    | 76           | 1,224          |
| 10/26-31/77 | 32                 | 6                  | 42                  | 3                    | 44          | 23                   | 319           | 55                  | 756         | 18                   | 246          | 1,365          |
| 6/13-14/78  | 12                 | 8                  | 23                  | 6                    | 52          | 16                   | 157           | 69                  | 661         | 8                    | 81           | 951            |
| 10/26/78    | 75                 | 10                 | 39                  | 5                    | 33          | 17                   | 126           | 44                  | 324         | 33                   | 242          | 725            |
| 6/23/79     | 12                 | 18                 | 45                  | 10                   | 76          | 26                   | 189           | 57                  | 424         | 7                    | 49           | 738            |
| 12/7/79     | 39                 | 0                  | 65                  | 0                    | 0           | 32                   | 115           | 49                  | 177         | 19                   | 69           | 361            |
| 6/14/80     | 18                 | 0                  | 43                  | 0                    | 0           | 27                   | 324           | 62                  | 748         | 11                   | 137          | 1,209          |
| 10/80       | 85                 | 0                  | 49                  | 0                    | 0           | 21                   | 288           | 43                  | 585         | 36                   | 496          | 1,369          |
| 6/17/81     | 13                 | 16                 | 34                  | 9                    | 87          | 21                   | 182           | 62                  | 543         | 8                    | 68           | 880            |
| 10/2/81     | 59                 | 0                  | 41                  | 0                    | 0           | 21                   | 319           | 50                  | 776         | 29                   | 458          | 1,553          |
| 5/23/82     | 0                  | 0                  | 72                  | 0                    | 0           | 42                   | 108           | 58                  | 151         | 0                    | 0            | 259            |
| 10/8/82     | 54                 | 0                  | 29                  | 0                    | 0           | 16                   | 215           | 55                  | 736         | 30                   | 398          | 1,349          |
| 11/26/82    | 60                 | 0                  | 38                  | 0                    | 0           | 19                   | 65            | 51                  | 173         | 30                   | 104          | 342            |
| 4/20/83     | 23                 | 0                  | 29                  | 0                    | 0           | 19                   | 205           | 66                  | 708         | 15                   | 166          | 1,079          |
| 5/21/83     | 0                  | 7                  | 80                  | 7                    | 275         | 41                   | 1,629         | 52                  | 2,052       | 0                    | 26           | 3,982          |
| 6/15/83     | 4                  | 0                  | 51                  | 0                    | 0           | 33                   | 522           | 64                  | 1,021       | 3                    | 44           | 1,587          |
| 10/4/83     | 54                 | 0                  | 41                  | 0                    | 0           | 23                   | 307           | 50                  | 665         | 27                   | 361          | 1,333          |
| 4/10/84     | 10                 | 0                  | 49                  | 0                    | 0           | 31                   | 194           | 63                  | 396         | 6                    | 38           | 628            |

Table 1. Sex and age composition of Alaska's Delta Caribou Herd, 1969-88.

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| Table | 1.         | Continued  |
|-------|------------|------------|
| Table | <b>-</b> . | ooncinaea. |

| Date       | Bulls:<br>100 cows | Yrlgs:<br>100 cows | Calves:<br>100 cows | Yrlg<br>% in<br>herd | No.<br>yrlg | Calf<br>% in<br>herd | No.<br>calves | Cow<br>% in<br>herd | No.<br>cows | Bull<br>% in<br>herd | No.<br>bulls | Sample<br>size |
|------------|--------------------|--------------------|---------------------|----------------------|-------------|----------------------|---------------|---------------------|-------------|----------------------|--------------|----------------|
| 5/20/84    | 0                  | 0                  | 82                  | 0                    | 0           | 0                    | 0             | 0                   | 482         | 0                    | 0            | 877            |
| 6/22/84    | 17                 | 0                  | 56                  | 0                    | 0           | 32                   | 837           | 58                  | 1,508       | 10                   | 259          | 2,604          |
| 10/17/84   | 42                 | 0                  | 36                  | 0                    | 0           | 20                   | 222           | 56                  | 613         | 24                   | 258          | 1,093          |
| 5/3/85     | 0                  | .0                 | 0                   | 0                    | 0           | 34                   | 256           | 66                  | 503         | 0                    | 0            | 759            |
| 10/9-12/85 | 49                 | 0                  | 36                  | 0                    | 0           | 20                   | 228           | 54                  | 630         | 26                   | 306          | 1,164          |
| 4/20/86    | 21                 | 0                  | 29                  | 0                    | 0           | 19                   | 302           | 67                  | 694         | 14                   | 145          | 1,041          |
| 10/22/86   | 41                 | 0                  | 29                  | 0                    | 0           | 17                   | 330           | 59                  | 1,136       | 24                   | 468          | 1,934          |
| 5/30/87    | 1                  | 30                 | 60                  | 16                   | 325         | 31                   | 649           | 52                  | 1,080       | 1                    | 12           | 2,066          |
| 10/5/87    | 32                 | 0                  | 31                  | 0                    | 0           | 19                   | 323           | 61                  | 1,030       | 20                   | 329          | 1,682          |
| 4/6/88     | 22                 | 0                  | 29                  | 0                    | 0           | 19                   | 285           | 66                  | 976         | 14                   | 212          | 1,473          |
| 10/14/88   | 33                 | 0                  | 35                  | 0                    | 0           | 21                   | 620           | 60                  | 1,790       | 20                   | 593          | 3,003          |

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| Date                  | Bulls:<br>100 cows | Yrlgs:<br>100 cows | Calves:<br>100 cows | Yrlg<br>% in<br>herd | No.<br>yrlg | Calf<br>% in<br>herd | No.<br>calves | Cow<br>% in<br>herd | No.<br>cows | Bull<br>% in<br>herd | No.<br>bulls | Sample<br>size |
|-----------------------|--------------------|--------------------|---------------------|----------------------|-------------|----------------------|---------------|---------------------|-------------|----------------------|--------------|----------------|
| 11/26/82              | 59                 | 0                  | 36                  | 0                    | 0           | 18                   | 56            | 51                  | 156         | 30                   | 92           | 304            |
| 4/13/84               | 22                 | 0                  | 44                  | 0                    | 0           | 26                   | 44            | 60                  | 101         | 13                   | 22           | 167            |
| 10/12/85              | 65                 | 0                  | 40                  | 0                    | 0           | 19                   | 152           | 49                  | 383         | 32                   | 252          | 787            |
| 5/2/86                | 21                 | 0                  | 49                  | 0                    | 0           | 29                   | 53            | 59                  | 107         | 12                   | 22           | 182            |
| 10/22/86              | 70                 | 0                  | 38                  | 0                    | 0           | 18                   | 105           | 48                  | 274         | 34                   | 191          | 570            |
| 10/5/87 <sup>a</sup>  | 41                 | 0                  | 38                  | 0                    | 0           | 21                   | 192           | 56                  | 505         | 23                   | 209          | 906            |
| 10/14/88 <sup>b</sup> | (S                 | ee Delta H         | lerd)               |                      |             |                      |               |                     |             |                      |              |                |

Table 2. Sex and age composition of Alaska's Yanert Caribou Herd, 1982-88.

<sup>a</sup> Sample contains many Delta Herd caribou. Distribution of radio-collared caribou from the Delta and Yanert Herd confirmed overlap of the 2 herds at the time these data were obtained.

<sup>b</sup> No caribou were located in traditional rutting areas within the Yanert Herd's range. All radio-collared Yanert caribou that were located during the rut were totally intermingled with the Delta Herd caribou. (This distribution persisted throughout winter 1988-89, i.e., no caribou were located on traditional Yanert Herd winter ranges.)

| ç                       | June)                 | Radio-collared caribou<br>≥36 months |                     |                 |       |                      |
|-------------------------|-----------------------|--------------------------------------|---------------------|-----------------|-------|----------------------|
| Herd and<br>year        | No. calves<br>counted | No. cows<br>counted                  | Calves:<br>100 cows | No.<br>pregnant | Total | Natality<br>rate (%) |
| Delta 1981              |                       |                                      |                     | 10              | 13    | 77                   |
| Delta 1982              | 108                   | 151                                  | 72                  | 7               | 10    | 70                   |
| Delta 1983              | 1,629                 | 2,052                                | 79                  | 17              | 22    | 77                   |
| Delta 1984              | 395                   | 482 <sup>a</sup>                     | 82                  | 28              | 31    | 90                   |
| De <b>lta 1985</b>      |                       |                                      |                     | 38,             | 41    | 93                   |
| Delta <sup>:</sup> 1986 |                       |                                      | -                   | 33 <sup>0</sup> | 40    | 83                   |
| D <b>elta 198</b> 7     | 649                   | 1,080                                | 60                  | 25              | 28    | 89                   |
| Delta 1988              |                       |                                      |                     | 28              | 32    | 88                   |
| Western Arc             | tic                   |                                      |                     |                 |       |                      |
| 1981                    | 885                   | 1,079                                | 82                  | 31              | 37    | 84                   |
| Western Arc             | tic                   |                                      |                     |                 |       |                      |
| 1982                    | 1,380                 | 1,764                                | 78                  | 24              | 29    | 83                   |
| Fortymile               |                       |                                      |                     |                 |       |                      |
| 1984                    | 1,072                 | 1,478                                | 73                  | 20              | 23    | 87                   |
| Fortymile               |                       |                                      |                     |                 |       |                      |
| 1985                    |                       |                                      |                     | 19              | 19    | 00                   |
| Fortymile               |                       |                                      |                     | _               |       |                      |
| 1986                    |                       |                                      |                     | 20 <sup>c</sup> | 21    | 95                   |
| Fortymile               |                       |                                      |                     |                 |       |                      |
| 1987                    | ÷ -                   |                                      |                     | 18              | 19    | 95                   |
| Fortymile               |                       |                                      |                     |                 |       | e.                   |
| 1988                    |                       |                                      |                     | 27              | 33    | 82 <sup>a</sup>      |
|                         |                       |                                      |                     |                 |       |                      |

Table 3. Natality rates of Delta, Western Arctic, and Fortymile Caribou Herds, estimated from calf:cow ratios and the proportion pregnant among radio-collared females  $\geq$ 3 years old, 1981-88.

<sup>a</sup> Includes some yearlings.

<sup>b</sup> Twenty-six had distended udders, 7 had hard antlers (indicating pregnancy but udder was not seen), 5 had no distended udder, and 2 were antlerless (udder was not seen, but neither one was a naturally polled animal).

<sup>c</sup> Sixteen had distended udders, 3 had hard antlers during calving, and 1 was seen in August and September with a calf following her.

<sup>d</sup> Thirteen of these were immobilized during the rut in 1987, and 5 of the 13 failed to produce calves in 1988.

| Year                   | Males         | Females       | Sex unk       | Total                                | Extrapolated |
|------------------------|---------------|---------------|---------------|--------------------------------------|--------------|
|                        | <u>11</u> (8) | <u>II</u> (8) | <u>II</u> (8) |                                      |              |
| 1968-69                | 119 (81)<br>  | 25 (17)<br>   | 3 (2)         | 147 <sup>b</sup><br>205 <sup>c</sup> | 160<br>NA    |
| 1969-70                | 169 (75)      | 54 (24)       | 2 (1)         | 225                                  | 324          |
| 1970-71                | 198 (72)      | 68 (25)       | 9 (3)         | 275                                  | 428          |
| 1971-72                | 387 (62)      | 226 (36)      | 12 (2)        | 624                                  | 740          |
| 1972-73                | 372 (72)      | 132 (25)      | 13 (3)        | 517                                  | NA           |
| 1973-74                | 158 (70)      | 67 (30)       | 8             | 233                                  | 301          |
| 1974-75 through 193    | 79-80, No ope | n season      |               |                                      |              |
| 19 <b>80-81</b>        | 104 (100)     |               |               | 104                                  |              |
| 1981-82 (fall)         | 78            | 9             |               | 87                                   |              |
| 1981-82 (winter)       | 113           | 64            | 4             | 181                                  |              |
| 1981-82 (total)        | 191           | 73            | 4             | 268                                  |              |
| 19 <b>82-83 (fall)</b> | 92            | 11            | 1             | 104                                  |              |
| 1982-83 (winter)       | 101           | 65            | 3             | 169                                  |              |
| 1982-83 (total)        | 193           | 77            | 4             | 274                                  |              |
| Delta 1983-84          | 576           | 98            | 20            | 694                                  |              |
| Yanert 1983-84         | 40            | 12            | 2             | 54                                   |              |
| Delta 1984-85          | 258           | 153           | 24            | 13                                   |              |
| Yanert 1984-85         | 77            | 22            | 0             | 99                                   | 130          |
| Delta 1985-86          | 250           | 67            | 15            | 332                                  |              |
| Yanert 1985-86         | 52            | 12            | 0             | 64                                   |              |
| Delta 1986-87          | 260           | 77            | 4             | 341 <sup>d</sup>                     |              |
| Yanert 1986-87         | 54            | 16            | 2             | 72                                   |              |

Table 4. Harvest from the Delta Caribou Herd and Yanert Caribou Herd, 1968-87.<sup>a</sup>

| Year           | Males<br><u>n</u> (%) | Females<br><u>n</u> (%) | Sex unk<br><u>n</u> (%) | Total | <b>Extrapola</b> ted<br>total |
|----------------|-----------------------|-------------------------|-------------------------|-------|-------------------------------|
| Delta 1987-88  | 325                   | 36                      | 1                       | 362   | 667 <sup>e</sup>              |
| Yanert 1987-88 | 66                    | 2                       | 0                       | 68    |                               |

Table 4. Continued.

<sup>a</sup> Harvest from Subunit 20A and part of 20C.

<sup>b</sup> From 1969 Alaska Department of Fish and Game Survey and Inventory Progress Report.

<sup>c</sup> From J. Sexton memo 3 December 1970.

<sup>d</sup> Independent assessment of harvest by M. McNay indicates that only about 54% of successful hunters report their kill (M. McNay files, ADF&G, Fairbanks) in the general season (i.e., correction factor may not apply to permit hunt).

<sup>e</sup> McNay (1988) reported that 430 caribou were reported killed from the DCH and YCH by 655 hunters; however, actual harvest was estimated at 667 caribou taken by 1,648 hunters based on hunter field interviews in 1986.

| Year                 | Season  | Bag limit                        |
|----------------------|---|----------------------------------|
| 1984-85 <sup>b</sup> | 10 Aug-31 Mar<br>Unit 20(A), that portion within<br>the Yanert River drainage       | l caribou                        |
| 1985-86 <sup>C</sup> | l Sep-28 Feb<br>Unit 20(A) within the Yanert<br>Controlled Use Area                 | l caribou                        |
| 1986-87 <sup>d</sup> | l Sep-28 Feb<br>Unit 20(A) within the Yanert<br>Controlled Use Area                 | l caribou                        |
| 1987-88 <sup>e</sup> | l Sep-15 Sep<br>l Jan-28 Feb<br>Unit 20(A) within the Yanert<br>Controlled Use Area | l bull                           |
| 1988-89              | l Sep-15 Sep<br>Unit 20(A) within the Yanert<br>Controlled Use Area                 | l bull                           |
|                      | l Jan-28 Feb<br>Up to 25 permits will be<br>issued                                  | l caribou<br>(by permit<br>only) |

Table 5. Hunting seasons and bag limits for Alaska's Yanert Caribou Herd, 1984-88.<sup>a</sup>

<sup>a</sup> The 1st year that the Yanert Herd caribou season was not included as part of the Delta Herd season was 1984-85.

<sup>b</sup> Amended by emergency announcement to close the Yanert River drainage on 8 February 1985.

<sup>C</sup> Amended by emergency announcement to close the Yanert River drainage on 19 February.

<sup>d</sup> Amended by emergency announcement to close the Yanert River drainage on 14 January 1987.

<sup>e</sup> Amended by emergency announcement to close the Yanert River drainage on 14 January 1988.

| Year                       | Season                         | Bag limit  |
|----------------------------|--------------------------------|--|
| 1968- <b>69</b>            | 10 Aug-31 Mar                  | 3 caribou  |
| 1969-70                    | 10 Aug-31 Mar                  | 3 caribou  |
| 1970-71                    | 10 Aug-31 Mar                  | 3 caribou  |
| 1971-72                    | 10 Aug-31 Mar                  | 3 caribou  |
| 1972-73                    | 10 Aug-31 Mar                  | 3 caribou  |
| 1973-74b                   | 10 Aug-31 Dec                  | l caribou  |
| 1974-75c                   | 10 Aug-20 Sep                  | l caribou  |
| 1975-76 through<br>1979-80 | No open season                 |  |
| 1980-81                    | 1 Sep-30 Sep                   | 1 male by drawing<br>permit. 200<br>permits issued.  |
| 1981-82<br>-               | 10 Aug-30 Sep<br>15 Nov-31 Dec | l caribou by drawing<br>permit from 10 Aug-<br>30 Sep; 150 permits<br>issued, up to 25 will be<br>issued to nonresidents.<br>Antlered caribou may be<br>taken from 15 Nov-31 Dec<br>by registration permit.<br>A total of 400 caribou<br>may be taken.                     |
| 1982-83                    | 10 Aug-30 Sep<br>1 Dec-31 Mar  | <pre>1 caribou by drawing<br/>permit from 10 Aug-30 Sep;<br/>175 permits issued, up to<br/>30 will be issued to non-<br/>residents. Antlered<br/>caribou may be taken from<br/>1 Dec-31 Mar by<br/>registration permit. A<br/>total of 500 caribou may be<br/>taken.</pre> |
| 1983-84 <sup>d</sup>       | 10 Aug-31 Mar                  | 1 caribou  |

Table 6. Continued.

| Year                            | Season  | Bag limit   |
|---------------------------------|---|---|
| 1984-85 <sup>e</sup> ,f         | 20 Aug-20 Sep   | l caribou by registration<br>permit only. 600 caribou<br>may be taken. The 20 Aug-<br>20 Sep season will be<br>closed when 300 caribou<br>have been taken; the 1 Feb-<br>31 Mar season will be<br>closed when the total<br>harvest reaches 600 caribou. |
|                                 | 10 Aug-31 Mar   | l caribou   |
| 1985-86g<br>Alaskan Residents   | 10 Aug-31 Dec<br>Unit 20(A) north of<br>the Yanert Controlled<br>Use Area, west of Wood<br>River Controlled Use<br>Area, and south of the<br>Rex Trail  | l caribou by Tier II hunting<br>permit only. 200 permits<br>will be issued.   |
|                                 | l Sep-15 Sep<br>Remainder of Unit 20(A)   | l caribou   |
| 1985-86<br>Nonre <b>sidents</b> | No Open Season<br>Unit 20(A) north of the<br>Yanert Controlled Use<br>Area, west of Wood<br>River Controlled Use<br>Area, and south of the<br>Rex Trail |   |
|                                 | l Sep-15 Sep<br>Remainder of Unit 20(A)   | l caribou   |
| 1986-87                         | 6 Sep-31 Dec<br>Unit 20(A) north of<br>the Yanert Controlled<br>Use Area, west of Wood<br>River Controlled Use<br>Area, and south of the<br>Rex Trail   | l caribou by drawing permit<br>only. 200 permits will be<br>issued.   |
|                                 | l Sep-15 Sep<br>Remainder of Unit 20(A)   | l caribou   |

# Table 6. Continued.

| Year    | Season  | Bag limit   |
|---------|---|---|
| 1987-88 | 10-25 Aug<br>21 Sep-31 Dec<br>Unit 20(A) north of<br>the Yanert Controlled<br>Use Area, west of Wood<br>River Controlled Use<br>Area, and south of the<br>Rex Trail | l caribou by drawing permit<br>only. 200 permits will be<br>issued. |
|         | l-15 Sep<br>Remainder of Unit 20(A)   | 1 bull  |
| 1988-89 | 10-25 Aug<br>21 Sep-31 Dec<br>Unit 20(A) north of<br>the Yanert Controlled<br>Use Area, west of Wood<br>River Controlled Use<br>Area, and south of the<br>Rex Trail | l caribou by drawing permit<br>only. 200 permits will be<br>issued. |
|         | 1-15 Sep<br>Remainder of Unit 20(A)   | 1 bull  |

<sup>a</sup> Subunit 20A and part of 20C.

<sup>b</sup> Amended by emergency announcement to close 20 September.

<sup>c</sup> Amended by emergency announcement to No Open Season.

<sup>d</sup> Amended by emergency announcement to close 28 October, except the Yanert River drainage which remained open through 31 March.

<sup>e</sup> Amended by emergency announcement to close 5 September, except the Yanert River drainage.

<sup>f</sup> Amended by emergency announcement to close the Yanert River drainage on 8 February 1985.

<sup>g</sup> The 1985-86 seasons and bag limits which for the 1st time (at least since 1968) differentiated between residents of Alaska and nonresidents was the result of a judicial ruling which said the State Subsistence Bill had not been properly implemented.

| Group No.         | No. of caribou<br>on photos | No. of caribou<br>visually enumerated | No. of radiocollars<br>in group |
|-------------------|-----------------------------|---------------------------------------|---------------------------------|
| 1                 |                             | 20                                    | 1                               |
| 2                 | 768                         |                                       | 7                               |
| 3                 | 88                          |                                       | 0                               |
| 4                 | 468                         |                                       | 3                               |
| 5                 | 1,734                       | 6                                     | 17                              |
| 6                 | 328                         | 35                                    | 1                               |
| 7                 | 260                         |                                       | 0                               |
| 8                 | 544                         |                                       | 0                               |
| 9                 |                             | 10-12                                 | 1                               |
| 10                |                             | 62-63                                 | 0                               |
| 11                | 169                         |                                       | 0                               |
| 12                | 242                         |                                       | 2                               |
| 13 <sup>a</sup>   | 172                         |                                       | 8 <sup>a</sup> _                |
| $14^{a}_{-}$      | 329                         |                                       | 8 <sup>ª</sup>                  |
| 15 <sup>ª</sup>   | 83                          |                                       | 8 <sup>ª</sup>                  |
| 16 <sup>a</sup>   | 942                         |                                       | 8 <sup>a</sup> _                |
| 17 <sup>a</sup>   | 21                          |                                       | 8 <sup>a</sup>                  |
| 18                | 42                          |                                       | 0                               |
| 19                | 145                         |                                       | 1                               |
| 20                | 46                          |                                       | 0                               |
| 21                | 111                         |                                       | 2                               |
| 22                | 403                         |                                       | 2_                              |
| 23 <sup>a</sup>   | 459                         |                                       | 8 <sup>a</sup>                  |
| 24 <sup>a</sup>   | 222                         |                                       | 8 <sup>a</sup>                  |
| 25                |                             | 75                                    | 1                               |
| 26                |                             | 200                                   | 1                               |
| 27                |                             | 34                                    | 1                               |
| Subtotal<br>Total | 7,576<br>8,338 <sup>°</sup> | 761-764 <sup>b</sup>                  |                                 |

Appendix A. Distribution and size of caribou groups and distribution of radio-collared caribou from the Delta and Yanert Caribou Herds during the 15 July 1988 census (see Fig. A-1).

<sup>a</sup> Groups 13-17 and 23-24 collectively contained 8 radio-collared caribou.

<sup>b</sup> Includes groups of 60, 104, 100, 21, and 34 visually enumerated but not containing any radio-collared caribou.

<sup>C</sup> Two hundred or more known to be present in the Cody Creek-Mystic Creek vicinity but not photographed or visually enumerated; 3 radio-collared caribou not located.



Fig. A-1. Locations of Delta and Yanert Herd caribou during the census, 15 July 1988.

# APPENDIX B

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MORTALITY OF DELTA HERD CARIBOU TO 24 MONTHS OF AGE

- James L. Davis, Alaska Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701
- Patrick Valkenburg, Alaska Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701
- Daniel J. Reed, Alaska Department of Fish and Game, 1300 College Road, Fairbanks, AK 99701

From 1979 through 1987, we investigated natural mortality Abstract: between birth and 24 months of age in the Delta Caribou (Rangifer tarandus granti) Herd (DCH). Calf:cow ratios were obtained at the end of calving, during the rut, and in April to estimate natural mortality within the 0-5 and 5-12 month old cohorts (MOC's). Mean rates of mortality for the 0-5 and 5-12 MOC's, respectively, were 56% and 5.5%. Natural mortality within the 8-12, 12-24, and >24 MOC's was estimated from data on known-age radio-collared caribou. No natural mortality was observed among 8-12 month old females, compared with a rate of 34% for males. Natural mortality rates for females and males in the 12-24 MOC were 4% and 19%, respectively. Among the >24 MOC's, mean annual natural mortality was 7% for females and 19% for males. Within all age cohorts, natural mortality was higher for males than females, which is consistent with the literature. In contrast, the observation that natural mortality in the 5-12 and 12-24 MOC's was no greater than in the >24 MOC's is inconsistent with the literature on moose and was unexpected. Data on caribou herd size, trend and density, and predator:prey ratios are presented to place the derived mortality rates in context.

Key Words: calf, caribou, Delta Herd, mortality, <u>Rangifer</u>, survivorship, yearling

Except for the period from birth to the rut (0-5 months), the ability to empirically estimate age-specific mortality rates of caribou has lagged behind recognition of the utility of accurate mortality rates. Before 1980, few data were available on natural mortality rates of cohorts older

than calves. Although mortality rates for the calf cohort (0-12 months) have been frequently inferred by comparing calf:cow ratios at calving with those in late winter or early spring, little insight exists regarding chronology of mortality within the first 12 months of life. Interpreting changes in serial calf:cow ratios is difficult because of seasonal segregation of the various categories of caribou (e.g., gravid vs. non-gravid in addition to all the sex and age cohorts). In short, sampling bias is common.

Before the 1980's, the literature contained little data on natural mortality rates of caribou. Skoog (1968) and Kelsall (1968) suggested that annual natural mortality rates of 5-6% could be expected for caribou older than yearlings when relatively few wolves (<u>Canis lupus</u>) and grizzly bears (<u>Ursus arctos</u>) were present. Bergerud (1971) reported that male Newfoundland caribou (<u>R. t. caribou</u>) had a higher mortality rate (9%) than females (4%). These mortality estimates were based on the authors' familiarity with the herds they studied; satisfactory quantitative techniques were not available at the time for estimating mortality rates. Lacking empirical estimates of mortality for subadult cohorts (generally defined as caribou 12-36 months old), most workers have inferred rates mid-way between those of the calf and adult cohorts.

Most caribou biologists agree that knowledge of the rates and causes of natural mortality is essential for understanding population change and, hence, central to successful management (Klein and White 1978). To model caribou population dynamics realistically, it is essential to ascertain age-specific mortality rates. A Workshop on "Parameters of Caribou Population Ecology in Alaska" (Klein and White 1978) identified age-specific death rates as one of 8 categories of information necessary to understand caribou population dynamics. Workshop participants agreed that ascertaining serial calf:cow ratios is adequate for assessing calf mortality in summer, but may not be adequate for the rest of the year. In addition, there was a consensus that existing techniques were inadequate for measuring age-specific death rates for age classes older than calves. Therefore, we initiated an investigation to evaluate the

utility of using radio-collared caribou of known age to estimate agespecific mortality.

The mortality rates of caribou <24 months of age are emphasized in this paper. Specifically, we (1) compare and contrast empirical estimates of natural mortality (i.e., all but man-induced mortality) rates for 3 age cohorts <24 months of age: 0-5, 5-12, and 12-24 months old, respectively); (2) compare natural mortality of caribou <24 months old with that of older cohorts; (3) present data on caribou population density and predator:prey ratios for the period in which natural mortality was estimated; and (4) discuss the implications of our results for modelers and managers of caribou populations.

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#### STUDY AREA/HERD

Bibliographic information on the DCH and its environment was cited in Davis et al. (1987).

Large predators in the study area include wolves, black bears (Ursus americanus), and grizzly bears. Major prey species present include moose (Alces alces), caribou, Dall sheep (Ovis dalli), beavers (Castor

canadensis), snowshoe hares (Lepus americanus), and ground squirrels (Citellus parryi).

Skoog (1968) originally delineated the range of the DCH. Based on subsequent study, Hemming (1971) modified Skoog's delineation and described the physical environment. Little change has been warranted since.

The DCH currently ranges over about 9,600 km<sup>2</sup> on the north slopes of the Alaska Mountain Range between the Nenana River on the west and the Delta River on the east (Fig. 1). The area lies approximately 110 km south of Fairbanks. The Alaska Range consists of rugged, glaciated ridges, 1,830-2,740 m in elevation, interspersed with glacier-capped mountains exceeding 3,660 m. The northern foothills of the Alaska Range are flat-topped ridges, 610-1,370 m in elevation, separated by rolling tussock tundra, muskegs, and lowlands dominated by spruce (<u>Picea</u> spp.). North of the foothills lies the predominantly spruce-covered Tanana Flats. The entire area is drained by the Tanana River.

The study area is largely snow-free from May until October. Annual temperature range is approximately 29°C to -51°C. Annual precipitation averages about 30 cm; snow accumulation averages 0-50 cm and rarely exceeds 80 cm. In the foothills and mountains, ground vegetation is frequently exposed during winter by strong winds.

### METHODS

Capture and relocation procedures for radio-collared caribou have been described previously (Davis et al. 1987).

#### Radio-collaring

In each of 7 years between 1979 and 1987, we radio-collared 7-19 caribou (primarily females) that were 8-12 months old. To eliminate the effect of capture-related mortalities, only those caribou alive 7 days after radio-collaring were included in the sample.



Fig. 1. Study area and distribution of the Delta Caribou Herd.

A helicopter (Bell 206B or Hughes 500C or D) and darting or netting equipment were used for capturing the calves. Immobilizing drugs and doses used from 1979 through 1982 were reported in Valkenburg et al. (1983). Davis and Valkenburg (1985a) reported doses of M99 and its antagonist, M50-50, used from 1983 through spring 1985. In fall 1985 we began using Carfentanil and Naloxone as immobilizing drug and antagonist, respectively; results were summarized by Adams et al. (1988).

All radiocollars (Telonics, Inc., Mesa, Ariz.) were in the 150-151 MHz frequency range and contained movement-sensitive mortality switches. On female calves, collars could be put on tight enough that they would not slip over the head when antlers were shed, but would allow growth of the neck to adult size. On males this was not possible because of their greater neck development as adults. We improvised an expandable collar for males in 1979, but it worked poorly; thereafter, we avoided collaring male calves.

#### Radio-tracking

Radio-collared caribou were relocated periodically from fixed-wing aircraft; details are in reports summarized in Davis et al. (1987).

When a mortality signal was heard, the collar site was visually located and evidence of mortality was noted. For confirmed mortalities, a helicopter was flown to the vicinity at a later date, the collar was relocated, and the site closely inspected. The caribou remains and adjacent area were investigated to ascertain the cause of death. Samples were obtained from the carcass, and nearby tracks, scats, and hair were noted and photographed.

#### Natality and Mortality Rates

<u>Calf:cow Ratios</u>: Composition surveys, which yielded calf:cow ratios, were conducted in May, June, October, and April to estimate mortality of the 0-5 and 5-12 MOC's. Details of the methods were presented or cited by Davis et al. (1987). Composition surveys in late May, following the peak of calving, included distended udder counts (Bergerud 1964) which

provide an index of natality. Differences in calf:cow ratios over time served as an estimate of the magnitude and chronology of calf mortality.

<u>Radio-collared Caribou</u>: An annual natality rate for radio-collared caribou was obtained by observing each radio-collared cow at least once at or near the peak of calving and noting the presence of a calf, udder distension, and antlers.

We estimated adult mortality rates for radio-collared caribou data using procedures described by Trent and Rongstad (1974). Previously, we compared and contrasted mortality rates using the Trent and Rongstad (1974) procedure with rates calculated using Gasaway et al.'s (1983) method and found only minor difference (Davis and Valkenburg (1985<u>a,b</u>), as did Edmonds (1987) who compared the procedure of Gasaway et al. (1983) with that of Heisey and Fuller (1985).

No statistical tests were conducted to compare mortality rates among the various sex and age cohorts discussed; conclusions are qualitatively based. The mortality rates presented for the various age cohorts apply to unequal time intervals: 0-5 MOC = 5 months, 8-12 MOC = 4 months, 12-24 MOC = 12 months, and >24 MOC = 12 months (i.e., the mean annual rate).

### RESULTS

# Natality

Herd natality, based on composition surveys, averaged 79 calves:100 cows. The mean birth rate of radio-collared cows  $\geq$ 36 months old was 82% (Table 1).

### Mortality Rates

Observed changes in the calf:cow ratio indicate a mean natural mortality rate of 56% for the 0-5 MOC (Table 2). Our data were inadequate to determine if mortality was similar among males and females within the 0-5 MOC. However, our fall 1988 data showed a sex ratio of 41 males:59 females (we expected 50:50) among the 5-month-old calves, suggesting that males suffer higher mortality within the first 5 months of life.

| Year | Sample from<br>aerial survey<br>of calving ground<br>% parturient for<br>cows >24 mo old<br>(n) | Radio-collared caribou<br>% parturient for<br>cows >36 mo old<br>(n) |  |
|------|---|--|--|
| 1981 | N.A.  | 77 (13)  |  |
| 1982 | 72 (151)  | 70 (10)  |  |
| 1983 | 80 (2,052)  | 77 (22)  |  |
| 1984 | 82 (482)  | 90 (31)  |  |
| 1985 | N.A.  | 93 (41)  |  |
| 1986 | 82 (N.A.)   | 83 (40)  |  |
| 1987 | N.A.  | 84 (32)  |  |
| 1988 | 83 (891)  | 92 (30)  |  |
|      | $\bar{x}$ = 79.0 (4.8 S.D.)   | $\frac{1}{x}$ = 82.0 (8.0 S.D.)                                      |  |
|      | $\overline{9}0$ % C.I. = 79.0 ± 5.6   | $\overline{9}0$ % C.I. = 82.0 ± 6.35                                 |  |

Table 1. Estimates of natality in the Delta Caribou Herd, 1981-86.

We observed no natural mortality among 8-12 month old radio-collared females. This is consistent with the low mortality rate of 5-12 month old caribou (both sexes combined) calculated from the serial calf:cow ratios (Table 3). Limited data on radio-collared males 8-12 months old suggest a 34% natural mortality rate (the small sample makes the finding suspect), which contrasts sharply with the low mortality rate of females.

In the 12-24 MOC's, natural mortality rates were 4% and 19% for females and males, respectively (Table 3). For the >24 MOC's, natural mortality was 7% and 19% for females and males, respectively.

#### DISCUSSION

### Mortality

From 1981 through 1988, the mean rate of natural mortality in the DCH was 56% for the 0-5 MOC's, which is consistent with Bergerud's (1978) conclusion that the calf cohort commonly experiences  $\geq$ 50% natural mortality. However, in contrast to suggestions in the literature and conjecture among caribou workers, we found that the natural mortality

| Date            | Sample size | Calves:<br>100 cows      | <pre>% change in the ratio<br/>of calves:100 cows<br/>birth to fall fall to spring</pre> |  |  |
|-----------------|-------------|--------------------------|--|--|--|
|                 | a           |                          |  |  |  |
| Late May 1981   | 13PC        | 77                       | -47  | ΝΔ   |  |
| 10/2/81         | 1,095       | 41                       | .,   | 11 • 63 •                                    |  |
| Late May 1982   | 10RC        | 70                       |  |  |  |
| 10/8 & 11/26/82 | 1,189       | 31                       | -56  | -6   |  |
| 4/20/83         | 913         | 29                       |  |  |  |
| Late May 1983   | 22BC        | 77                       |  |  |  |
| 10/4/83         | 972         | 46                       | -40  | +4   |  |
| 4/10 & 13/84    | 735         | 48                       |  |  |  |
| Late May 1984   | 31RC        | 90                       |  |  |  |
| 10/17/84        | 835         | 36                       | -60  | N.A.   |  |
| Late May 1985   | 41RC        | 93                       |  |  |  |
| 10/9 & 12/85    | 630         | 36                       | -61  | -14  |  |
| 4/20/86         | 853         | 38                       |  |  |  |
| Late May 1986   | 40 RC       | 83                       |  | N. A.  |  |
| 10/6/86         | 1,576       | 29                       | -65  |  |  |
| Late May 1987   | 328C        | 84                       |  |  |  |
| 10/5/87         | 1.682       | 31                       | -63  | -6   |  |
| 4/16/88         | 1,473       | 29                       |  |  |  |
|                 |             | x = - 56.0<br>90% C.I. = | (9.2 S.D.)<br>-56.0 ± 6.7  | x = -5.5 (7.4 S.D.)<br>90% C.I. = -5.5 ± 8.7 |  |

Table 2. Annual percentage change in calf:cow ratio, birth to fall and fall to spring in Alaska's Delta Caribou Herd, 1981-87.

<sup>a</sup> RC = radio-collared caribou.

rate during the first winter (i.e., 5-11 months of age) was relatively low, with the exception of 8-12 month-old radio-collared males.

Serial calf:cow ratios measure only relative change in the proportion of calves, so they are only an index of the rate of calf mortality. Determining the actual mortality rate of calves requires ascertaining the change in absolute numbers of calves over time. Calf mortality rates estimated from serial calf:cow ratios can be refined by adjusting for the loss of cows during the interval between acquiring ratios. For our data

| Age<br>cohort                     | No, rad<br>(no, co               | io-d<br>llai        | collared<br>r-months)               | No. man-caused<br>deaths<br>(% mortality) | No. natural<br>deaths<br>(% mortality) | No. total<br>deaths<br>(% mortality) |
|-----------------------------------|----------------------------------|---------------------|-------------------------------------|---|--|--------------------------------------|
| 8-12 mo.                          | Female                           | 61                  | (109.5)                             | 0   | 0                                      | 0                                    |
|                                   | Male                             | 10                  | (23.8)                              | 0   | 2(34)                                  | 2(34)                                |
| 12-24 mo.                         | Female                           | 62                  | (659)                               | 0   | 2(2)                                   | 2(4)                                 |
|                                   | Male                             | 7                   | (63.3)                              | 1(19)                                     | 1(19)                                  | 2(38)                                |
| >24 mo. <sup>a</sup>              | Female                           | 64                  | (2,861)                             | 6(3)                                      | 17(7)                                  | 23(10)                               |
|                                   | Male                             | 18                  | (308)                               | 8(31)                                     | 5(19)                                  | 13(50)                               |
| 12-24 mo.<br>>24 mo. <sup>a</sup> | Female<br>Male<br>Female<br>Male | 62<br>7<br>64<br>18 | (659)<br>(63.3)<br>(2,861)<br>(308) | 0<br>1(19)<br>6(3)<br>8(31)               | 2(2)<br>1(19)<br>17(7)<br>5(19)        | 2(4)<br>2(38)<br>23(10)<br>13(50)    |

Table 3. Calculated mean mortality rates for male and female caribou, based on radio-collared caribou, in the 8-12, 12-24, and >24-month-old cohorts, Delta Herd, 1979-87 (after Trent and Rongstad 1974).

<sup>a</sup> Percent mortality represents a mean annual rate.

set, the adjustment for calf mortality overwinter, estimated from October and April calf:cow ratios, would amount to only a couple of percentage points.

An additional complication is that some calves, particularly males, separate from the females during late winter and remain with the adult males, which do not migrate to the calving grounds. Our April composition data always show that bulls are underrepresented, so it follows that calves may be as well. We have no means of objectively correcting for the missed calves, but even a modest elevation of the calf:cow ratio would suggest little difference in overwinter mortality between calves and older cohorts.

Our data from radio-collared caribou suggest that natural mortality of Delta caribou was similar among the 8-12, 12-24, and >24 MOC's. Natural mortality of all cohorts was higher for males than for females, which is consistent with the literature (Bergerud 1978) and our expectations. In contrast, similar mortality rates among >5-month-old calves, yearlings, and adults was unexpected and is inconsistent with the literature on cervids, especially that on moose. When we extrapolate to caribou from the literature, particularly for age-specific mortality and predator-prey

relationships, we rely most on the moose literature. We believe this is common among caribou workers. Moose <24 months old clearly experience higher mortality than the mean for adults (Peterson et al. 1984, Ballard et al. 1987).

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#### Implications for Modeling

Bergerud (1971, 1978, 1980, 1983) has repeatedly emphasized that ascertaining mortality rates is essential to understanding caribou population dynamics and therefore to management. Bergerud (1980) pointed out that conventional life table analysis (Banfield 1955, Bos 1973, Miller 1974) has limited usefulness because caribou populations normally have an unstable age structure, resulting from natural variation in calf survival. He suggested using census, recruitment, and harvest parameters to determine natural mortality rates.

Martell and Russell (1983) concluded that Bergerud's alternative may not be practical because it requires accurate determinations of caribou numbers, recruitment, and harvest, all of which may be difficult to obtain. Instead, they suggested radio-collaring calves and following their survival to breeding age to help resolve the inconsistencies in estimates of early mortality rates. In addition, they suggested that cohort analysis may produce a better estimate of the adult mortality rate by avoiding the problem of an unstable age structure. Whitten et al. (1984) discussed the difficulties of using radio-collared calves to obtain calf mortality data that are representative of the herd. The biases contributed by stillbirths, early neonatal mortality, and the selection of calves for collaring are difficult to overcome.

We believe that the use of radiocollars and the application of cohort analysis can overcome the problem of an unstable age structure. However, a caribou population may contain 10-12 male cohorts and 15 or more female cohorts, so large samples of radio-collared individuals are required. Obtaining adequate mortality data from radio-collared caribou may be as difficult as making accurate determinations of population size, recruitment, and harvest required to indirectly estimate mortality rates.

It is imperative to consider our findings on rates and patterns of natural mortality in proper context (Table 4). Extrapolating too broadly from our results may prove counterproductive. Our mortality rates were obtained from a herd that is part of a multi-prey/multi-predator system (Gasaway et al. 1983). Also, during the period of study, growth rate of the herd varied from rapid increase to near stability, resulting from increasing harvest and predation. Nutrition and weather appeared to be favorable during the study period.

| Year | Size of<br>range km | Population<br>size | Population<br>density<br>caribou:km <sup>2</sup> | Wolf:<br>caribou | Grizzly:<br>caribou |
|------|---------------------|--------------------|--|------------------|---------------------|
| 1979 | 8,023               | 3,831              | 1:2.1  | 1:101            | 1:31                |
| 1980 | 8,023               | 4,321              | 1:1.9  | 1:98             | 1:35                |
| 1981 | 8,023               | 4,750              | 1:1.7  | 1:93             | 1:39                |
| 1982 | 8,023               | 6,545              | 1:1.2  | 1:111            | 1:53                |
| 1983 | 9,339               | 6,170              | 1:1.5  | 1:78             | 1:50                |
| 1984 | 10,007              | 5,660              | 1:1.8  | 1:58             | 1:46                |
| 1985 | 10,339              | 7,483              | 1:1.4  | 1:63             | 1:61                |
| 1986 | 10,786              | 7,204              | 1:1.5  | 1:50             | 1:61                |
| 1987 | 10,786              | 7,780              | 1:1.4  | 1:47             | 1:61                |

Table 4. Range size, population size, density, trend, and predator: caribou ratios of the Delta Caribou Herd, 1979-87.

<sup>a</sup> Assumes 123 grizzlies in 1986 and <u>></u>123 prior to 1986 (after Reynolds et al. 1987).

Although there may be some utility in extrapolating to caribou from the conceptual models of moose ecology, we believe the practice may be counterproductive, particularly with regard to patterns of mortality and predator/prey relationships. Clearly, there is no substitute for empirical data.

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