Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report
1 July 1994 - 30 June 1995

Factors Limiting the Fortymile Caribou Herd

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Study 3.38
Grant W-24-3
August 1995

STATE OF ALASKA
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DEPARTMENT OF FISH AND GAME
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RESEARCH PROGRESS REPORT

State: Alaska

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Grant No.: W-24-3 Project Title: Wildlife Research and Management

Study No.: 3.38 Study Title: Factors Limiting the Fortymile Caribou Herd

Period Covered: 1 July 1994-30 June 1995

SUMMARY

We made major progress this year in defining factors limiting the Fortymile Herd. Deployment of radiocollars on newborn caribou (*Rangifer tarandus granti*) allowed investigation of the causes and rate of mortality among caribou calves. These data allowed us to complete a model illustrating how predation versus other mortality factors affected herd size from mid May 1994 through early May 1995. To summarize, of the 20,000 adults and yearlings and 8260 calves present in mid May 1994, we estimate that wolves (*Canis lupus*) killed 3940 (14%) within 12 months. In contrast, grizzly bears (*Ursus arctos*) killed 2020 (7%), other predators killed 860 (3%), hunters killed 335 (1%), and nonpredation accounted for 1080 deaths (4%). This model indicates the population trend is essentially stable, which is consistent with population size estimates from 1990, 1992, and 1994.

In last year's progress report, we recommended that new management objectives or goals be written for the Fortymile Herd, because the recent objective to attain 60,000 caribou by the year 2000 was not achievable. Several points are listed below to assist with efforts to describe new management objectives or goals:

1 Herd numbers have remained relatively stable in the 1990s (about 22,000 to 23,000 caribou) compared with annual growth rates of 7% to 10% in the 1980s.

2 Wolves and grizzly bears continue to be the major factors limiting herd growth, despite over a decade of the most liberal regulations in the state for public harvesting of wolves and grizzly bears.

3 Restricting harvest of caribou to minimal levels has been inadequate as a means of action for achieving time-specific objectives for elevated caribou numbers. For example, humans harvest only 1% (bulls-only) of the postcalving population, which has negligible effects on the herd's population dynamics.

4 Adverse weather presumably contributed to increased predation rates in several recent years, compared with the 1980s, and likely contributed to reduced natality in 1993.

5 Winter range can support elevated caribou numbers both in regards to lichen availability on currently used winter range and the availability of vast expanses of vacant former winter range.

The most significant factor now limiting Fortymile Herd growth is predation on calves. Natural adult mortality and harvest are at minimal levels, and natality increased in 1994. We plan to continue studies of Fortymile calf mortality during 1995 and 1996 by deploying radiocollars on newborns. These studies will allow evaluation of the annual variability in the causes and extent of calf mortality.

Key words: Alaska, caribou, condition, Fortymile Caribou Herd, management objectives, mortality, nutritional status, pregnancy rate.

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BACKGROUND

The Fortymile Caribou (*Rangifer tarandus granti*) Herd has the potential to be the most economically important wildlife population in Interior Alaska and the southern Yukon - both for consumptive and nonconsumptive uses. Potential for growth is indicated by Murie's (1935) estimate of 568,000 caribou during a 20-day migration across the Steese Highway in 1920 compared with an aerial count of 22,104 caribou in 1994. Caribou herds typically restrict range use as herd size declines. The herd has not migrated across the Steese Highway for several decades because of its reduced size. Today, nearly all of the historical range of the herd is available for use by the herd. The herd's historical range encompassed 220,000 km^2 (Murie 1935) compared with about 50,000 km^2 since 1968 (Valkenburg et al. 1994).

Population objectives for increasing the Fortymile Caribou Herd have wide public support, both in Alaska and the Yukon. This public support has developed because most of the herd's former range was abandoned as herd size declined and because current low numbers are, in part, a result of past mismanagement. Both nonconsumptive and consumptive uses of the herd declined as herd size declined.

International draft objectives from the mid-1980s through 1994 called for increasing the herd to 50,000 adults or 60,000 caribou by the year 2000. These management objectives were written when the herd was growing at 7% to 10% per year and when population objectives were likely to be attained naturally. Instead, herd numbers were nearly stable between 1990 and 1994.

Management actions implemented to increase herd size were insufficient to achieve management objectives. These management actions resulted in reduced harvests of caribou and slightly increased harvests of wolves (*Canis lupus*) and grizzly bears (*Ursus arctos*). The increased harvests of predators were insufficient to significantly reduce overall predation. Harvest of caribou was not an important factor limiting herd size.

We have learned much from management and mismanagement of the Fortymile Herd. Valkenburg et al. (1994) detailed a case history of the herd from 1920 to 1990. The decline in the herd from about 50,000 in 1960 to only 6500 in 1973 was partly a result of errors in the prevailing management beliefs. Overharvesting was allowed in the early 1970s, and, simultaneously, high numbers of wolves and unfavorable weather contributed to the herd's decline to critically low levels (Davis et al. 1978, Valkenburg and Davis 1989; Valkenburg et al. 1994). Had this overharvest been prevented, the herd would likely have declined to only 10,000-20,000 caribou during the early 1970s and may have increased to 30,000-50,000 during favorable conditions in the 1980s. Overharvest was allowed in part because of the belief that poor range condition was the major factor causing low yearling recruitment. Thus, biologists allowed high harvests and ignored wolf predation while

awaiting a compensatory rebound in yearling recruitment from improved range. However, it was a futile vigil; calf caribou became increasingly scarce through 1973. It was mistakenly believed that hunters and predators mostly killed animals that would die before successfully reproducing and that wolf and grizzly bear predation were minor influences on the herd. Also, the size of the Fortymile Herd was grossly overestimated and the trend in herd size inadequately monitored (Davis et al. 1978, Valkenburg and Davis 1989).

Today harvest programs for caribou are managed much more conservatively than in the 1970s, especially during natural declines of caribou to low levels. Since 1984 radiocollaring of Fortymile caribou has provided the ability to efficiently estimate herd size, recruitment, mortality, causes of mortality, and nutritional status (Valkenburg and Davis 1989; Valkenburg et al. 1994). Today managers know that adverse weather can initiate declines in caribou herds (Valkenburg et al. 1994; Boertje et al., unpubl rep). Adverse weather in Interior Alaska in the early 1990s and the simultaneous decline of several Interior caribou herds were, in part, stimuli for this renewed study of the Fortymile Herd.

During periods of adverse weather, herd condition can decline and predation can increase (Mech et al. 1994; Boertje et al., unpubl data). After weather improves, prolonged declines in caribou herds can occur from continued high wolf predation because of wolves switching to caribou as primary prey and because declines in wolf numbers lag behind declines in caribou (predator lag). Examples exist where the proportion of a herd killed by wolves has increased during adverse weather, because caribou were more vulnerable and because wolf numbers increased as caribou declined (Adams et al. 1994; Mech et al. 1994; Boertje et al., unpubl rep). Today it is a well-accepted belief that wolf and bear predation are often the major factors limiting caribou and moose (*Alces alces*) at low densities (Davis et al. 1978, 1983; Gasaway et al. 1983, 1992; Boertje et al. 1987, 1988; Adams et al. 1989; Larsen et al. 1989; Valkenburg and Davis 1989; Boertje et al., unpubl rep).

Ungulate-predator relationships were studied in a portion of the Fortymile Herd's range during the mid-1970s and 1980s (Davis et al. 1978; Boertje et al. 1987, 1988; Valkenburg and Davis 1989; Gasaway et al. 1992). These studies summarized historical and recent predator-prey relationships and documented that predation was the major factor limiting recovery of caribou and moose populations in the area. From 1981 through 1987, management actions were implemented to reduce grizzly bear and wolf predation in a portion of the Fortymile Herd's range (Valkenburg and Davis 1989, Gasaway et al. 1992). Planned reductions in wolf numbers by department personnel were prematurely terminated for political reasons, and grizzly bear numbers were only moderately reduced in a small portion of the range. Subsequent slow increases in moose and caribou numbers could not be definitively linked to predator control. To test the effectiveness of predator control, large reductions in predator abundance are necessary (Crete and Jolicoeur 1987; Farnell and Hayes, unpubl rep). Large reductions in wolf numbers resulted in dramatic increases in caribou numbers in central Alaska (Gasaway et al. 1983) and eastcentral Yukon (Farnell

and Hayes, unpubl rep). In both studies, only 15% to 31% of the original precontrol wolf numbers remained by late winter during the 4 to 6 winters of effective control efforts.

In last year's progress report, we recommended that new management objectives be developed and actions be detailed for achieving objectives. As an alternative, goals could be set without describing management actions. We will fail to attain the previous population objective of 60,000 caribou by the year 2000 regardless of management actions because of biological and time constraints. This research project will provide the biological background necessary for describing new management goals, objectives, and/or actions.

GOAL

Our goal is to determine demographics of the Fortymile Caribou Herd, herd condition (nutritional status), and factors limiting the herd for the purpose of 1) predicting how herd growth rate will respond to various potential predator management and harvest management programs and 2) evaluating responses to potential programs implemented by the ongoing planning process. Historical data will be used to help predict herd responses to management actions.

JOB OBJECTIVES

1 Literature review.

2 Assess extent and cause of death among collared caribou $\geq$ 4 months old.

3 Estimate herd condition.

4 Estimate age-specific mortality rates by collaring 4-month-old calves.

5 Determine total numbers and population trend.

6 Estimate recruitment and mortality rates during the first 4 months of life by annually classifying caribou about 1 October 1993-1997.

7 Evaluate winter range condition with respect to relative lichen versus moss abundance in the feces.

8 Determine extent and cause of death among calves during the first year of life.

9 Determine what weather factors are related to poor herd condition.

10 Analyze data and draft figures for written and oral presentations of the data.

11 Write progress reports and either publish a final report or recommend continuation of this study for 5 additional years.

12 Incorporate results into appropriate Alaska wildlife management plans and survey-inventory activities.

PROCEDURES

Estimating Herd Numbers and Growth Rate From Censuses

We estimated minimum numbers of Fortymile caribou during June or early July 1990, 1992, and 1994 using a radio-search, total search, aerial photo technique (Valkenburg et al. 1985), as in previous estimates of herd size during the 1980s (Valkenburg and Davis 1989). We initially used census data to calculate growth rates; data on recruitment and mortality were used to confirm growth rates.

Estimating Growth Rate From Recruitment and Mortality Data

Caribou were classified from a helicopter during late September or early October 1991-1994 using the distribution of radiocollared caribou to randomly select caribou for counting. Classifications were corrected for the random distribution of radiocollars when necessary. Cows, calves, and small, medium, and large bulls were counted.

Age-specific mortality rates were estimated during October 1991-October 1992 by radiolocating all collared caribou in early January, early March, mid May, mid and late June, and late September. From October 1992 to October 1994, mortality rates were estimated by radiolocating caribou at least monthly. In 1994 flights were made daily between 14 May and 31 May, 12 times in June, weekly during July, and twice in August. Radiocollars contained a mortality sensor that doubled the pulse rate if the collar remained motionless for 6 hours. Annual mortality rate (M) was calculated as $M = A / B \times 100$, where A = the number of caribou dying during the 12-month period, and B = the total number of animals collared at the beginning of the 12-month period. We used computer spreadsheet modeling to estimate the annual finite rate of growth (l) based on trends in recruitment and mortality (ADF&G files).

We radiocollared (Telonics, Mesa, Ariz.) 41 caribou from 27 September to 22 October 1991, 3 on 7 March 1992, 14 from 28 September to 30 September 1992, 14 on 4 October 1993, and 14 on 1 October 1994. We also assisted the Bureau of Land Management collar 17 caribou from 3 April to 29 April 1992. Caribou were darted from a helicopter using 2 cc

Cap-Chur darts with 1.9 cm barbed needles. Except during autumns 1992 through 1994, darts contained 1.5 mg carfentanil citrate (Wildnil®, Wildlife Pharmaceuticals, Fort Collins, Colo.), 67 mg xylazine hydrochloride (Anased®, Lloyd Laboratories, Shenandoah, Ia.) and 0.85 cc of propylene glycol. During autumns 1992 through 1994, we darted only calves and used 1 mg carfentanil citrate and 67 mg xylazine hydrochloride. Most calves were heavily sedated by this dose. For recovery of calves, we administered 100 mg naltrexone hydrochloride (Trexonil®, Wildlife Pharmaceuticals) and 10 mg yohimbine hydrochloride (Antagonil®, Wildlife Pharmaceuticals) intramuscularly. We radiocollared 50 newborn calves in May 1994 using techniques described by Adams et al. (1989).

Evaluating Causes of Natural Mortality

To evaluate causes of death among caribou during their first 4 months of life, we used criteria and techniques described by Adams et al. (1989). To assess cause of death for caribou older than 4 months, we examined death sites within a few days to a few weeks of each mortality using a helicopter, Bellanca Scout, or Supercub. Blood (noncoagulated) on collars or remnants of hide served as evidence of a violent death. In these cases scats, tracks, other signs, and season of kill (bears hibernating in winter) served to identify the predator involved. A collar soaked in blood was indicative of lynx predation, based on evidence of lynx predation in the snow at several sites.

Estimating Harvest

Procedures for estimating total and female caribou harvest varied, depending on the type of harvest reporting system. We included estimates of illegal harvest made during road and trail surveys and applied a correction factor to general season hunts. During general season hunts, harvest was reported by mandatory mail-in report cards without the benefit of reminder letters. Correction factors were derived from road surveys and surveys of transporter services during 1973. To avoid biased reporting, hunters were not told the purpose of the road surveys. The surveys and subsequent mail-in harvest reports were treated as a mark-recapture sample to estimate total harvest. Harvest from general season hunts was multiplied by 1.59. We considered harvest reports collected from permit hunts to be accurate estimates of total harvest because reminder letters were sent to permittees and about 97% of permittees responded.

Evaluating Herd Condition/Nutritional Status

Five indices were used to evaluate relative condition/nutritional status of the herd: 1) autumn calf weights, 2) percent mortality of calves of collared cows during the first 2 days of life, 3) percent natality of collared cows, 4) age of first reproduction, and 5) median calving date. We weighed 14 or 15 female calves in late September or early October 1991 through 1994. High percent calf mortality during the first 2 days of life (e.g., 20% to 30%)

has been linked to malnutrition and we evaluated this factor as an index to herd condition (Whitten et al. 1992; L Adams, unpubl data). To accomplish this, we observed a radiocollared sample of adult cows on consecutive days during calving seasons 1992 through 1994. Cows were observed each day until they gave birth and on the first 2 consecutive days after birth. In 1994 we determined the cause of death among several calves < 48 hours old.

Daily radiolocations during the 1992 through 1994 calving seasons occurred as follows. During 1992, 30 cows were radiolocated on 14 May and from 19 May through 3 June 1992. During 1993, 48 cows were radiolocated on 13 May, 16-28 May, and 3 June. During 1994, 45 cows were radiolocated daily from 14 May to 31 May.

These radiolocations also allowed estimates of natality rate, age of first reproduction, and the median calving date. A cow was judged to be parturient based upon the presence of a distended udder or a calf (Whitten 1995). The median calving date was the date by which 50% of the adult collared cows had given birth. Delayed calving is thought to be indicative of malnutrition (Espmark 1980, Reimers et al. 1983, Skogland 1985).

Identifying Adverse Weather

Nutritional indices will be compared with weather indices to determine what weather indices, if any, can be linked to poor caribou nutrition. For example, are hot, dry summers or deep snows, or both, correlated with herd condition or nutritional status? Also, is performance of the herd strongly linked to malnutrition during adverse weather? Or can recruitment vary independent of nutrition because of overwhelming effects of predation? We plan to use Eagle weather, when available, to describe summer temperature and precipitation. We will attempt to analyze snow data from 6 weather stations surrounding the Fortymile range (Fig 1). Snow data will be corrected for elevation and distribution using universal block kriging (Cressie 1991:179).

Evaluating Lichen Versus Moss Component of the Herd's Winter Diet to Assess Range Condition

We collected 13 fecal samples from the Fortymile Herd winter range during March and early April 1992 and 1993. Each sample contained 25 pellets; 1 pellet was collected from

each of 25 different piles found afield (Boertje et al. 1985). Samples were analyzed at the Composition Analysis Laboratory in Fort Collins, Colorado.

RESULTS AND DISCUSSION

Herd Numbers and Trend

Herd numbers increased during the late 1970s and 1980s at annual rates of 7% to 10% (Valkenburg et al. 1994) and peaked in 1989 or in 1990 (Table 1). Herd numbers probably declined slightly from June 1989 through June 1991 and were approximately stable from June 1992 through June 1994, based on censuses, estimates of calf recruitment in early October, and estimates of adult mortality from collared cows. Relative to the 1980s, the trend has been stable during the 1990s, with approximately 22,000 to 23,000 caribou in the herd. Most recently we counted 22,104 caribou on 1 July 1994 (Table 1).

Extent and Cause of Age-Specific Mortality

Mortality during the first 48 hours of life was highly variable between years, and high mortality was not necessarily indicative of poor nutrition. Mortality ranged from 3% (n = 30) in 1992, 14% (n = 28) in 1993, and 22% (n = 32) in 1994. Originally, we expected that high mortality during the first 48 hours would indicate poor nutritional status of newborn calves and their dams. However, data are equivocal, because several of these early deaths could not be attributed to malnutrition. Cause of death was determined in 4 cases where calves were < 48 hours old: 1 calf was killed by a wolf, 1 calf died from an accident, 1 calf was abandoned by its udderless dam, and 1 calf suffocated during birth presumably because of its large size (10.5 kg versus a range of 5.3-9.3 kg (x = 7.5 kg) for 38 calves £ 24 hours old that survived birth).

Rates of calf mortality (1994 cohort) were 62% (n = 55) by 4 months of age and 71% (n = 55) by 12 months of age (Fig 2). Wolves and grizzly bears, together, killed 24 (71%) of the 34 calves that died from known causes prior to 10 May 1995 (Fig 3). We attributed 13 (38%) of these 34 deaths to wolves, 11 (32%) to grizzly bears, 3 (9%) to eagles, 3 (9%) to accidents (broken legs), 1 (3%) to a black bear, 1 (3%) to a wolverine, 1 (3%) to abandonment, and 1 (3%) to suffocation at birth. Two summer mortalities caused by either wolves or grizzly bears were divided between the 2 predators.

When data were combined for years 1993 and 1994 (Table 1), age-specific mortality rates did not differ significantly (P > 0.1, Chi-Square test) among caribou aged 4 to 16 months (12%, n = 24), 17 to 28 months (10%, n = 20), or older than 28 months (10%, n = 88). Also during 1993 and 1994 annual mortality rates did not differ significantly (P > 0.1) within these age classes (Table 1).

Elevated mortality of the 1991 cohort aged 4 to 16 months (57%, n = 14, Table 1) was probably caused by inadvertent separation of calves from their dams at collaring (27 Sep-22 Oct). We darted calves and their dams simultaneously in 1991 and only 2 of 14 cow-calf pairs reunited after recovery from drugging. In 1990 and 1992 through 1994, we collared calves, but not their dams, and cow-calf pairs consistently reunited. Implications of these data are that human hunting of cows with calves during autumn or early winter can reduce the survival of orphaned calves where wolves are major predators. Seven (88%) of the 8 dead calves were killed by wolves.

Wolf predation has consistently been the major cause of death among caribou older than 4 months. Of the 36 caribou older than 4 months for which cause of death was determined (Oct 1991-May 1994), wolves killed 30 (83%), lynx killed 2 (6%), a grizzly bear killed 1 (3%), and 3 (8%) died from nonpredation deaths. Most (78%) of these deaths occurred during November through April. Lynx killed only calves. Of the 17 calves killed between the ages of 4 and 12 months, wolves killed 14, lynx killed 2, and 1 died from nonpredation causes.

We completed a model using data on natality, mortality, herd size, and composition to illustrate the relative importance of predation as a factor influencing the Fortymile Caribou Herd (Fig 4, based on Appendix). We estimate that wolves killed 14% of the 1994 postcalving population in 1 year (2240 calves and 1710 adults and yearlings) and were by far the major source of mortality. Grizzly bears killed 7% of the postcalving population in 1 year (1900 calves and 100 adults and yearlings). Minor causes of mortality included other predators (3%), nonpredation (4%), and hunters (1%). Annual deaths among the postcalving population (mid May 1994 through early May 1995) totaled 8200 of which wolves accounted for 48%, grizzly bears 24%, other predators 10%, nonpredation 13%, and hunters 4%.

Current harvests do not necessarily provide for herd growth; rather, current harvests allow for near natural fluctuations. Estimated total annual harvest averaged 2.8% of the midsummer herd size during the 6 years prior to 1990. At this time, harvest was intentionally reduced because natural mortality increased and recruitment declined (Table 1). Since 1990 harvest has averaged about 1.8% of the midsummer herd size. Virtually all legal harvest has consisted of bull caribou, and 93% of estimated legal and illegal harvest since 1984 consisted of bulls. Bull:cow ratios remain high (42 bulls:100 cows in Sep 1994) because harvests have intentionally been held low since 1973 to encourage herd growth. However, reduced harvest rates have not resulted in significant herd growth.

Herd Condition/Nutritional Status and Adverse Weather

Of the 5 indices of herd condition/nutritional status, natality rate and age of first reproduction were most affected by the adverse weather of 1992. Only 126 snow-free days

occurred in Fairbanks in 1992 compared with 160-199 days during the previous 19 years. Snow melt was several weeks late during spring 1992, and snowfall was several weeks early in autumn 1992. Many adult cows apparently did not gain sufficient fat to breed in 1992. The natality rate in 1993 was low in the Fortymile Herd (68%; Table 1) and the Delta Herd (30%; Valkenburg 1994). Only 5 (42%) of 12 3-year-olds produced calves in the Fortymile Herd in 1993, compared with 5 (83%) of 6 in 1994 (Table 1).

The remaining 3 indices of herd condition were not sensitive to the short summer of 1992. For example, October calf weights were not significantly lower in 1992 (Table 2). Calf mortality during the first 48 hours of life was not unusually high in 1992 (3%; $n = 30$) or 1993 (14%; $n = 27$) compared with 1994 (22%; $n = 32$), and the median calving date was not unusually late in 1993 (22 May, $n = 24$) compared with 1992 (23 May, $n = 25$).

These 3 indices also conveyed inconsistent results within years. The high perinatal mortality in 1994 suggested poor nutritional status, which is inconsistent with the early 1994 median calving date (18 May, $n = 31$) and moderate 1994 calf weights (Table 2). Also, the late 1992 median calving date (23 May) suggested poor nutritional status, which is inconsistent with the low 1992 perinatal mortality (3%, $n = 30$) and moderate 1992 calf weights. Recommendations for acquiring meaningful indices to Fortymile Herd condition are forthcoming in the final report.

From 1952 to 1990, proportions of calves in September or October were positively correlated with July rainfall and negatively correlated with an index to snow depth (Valkenburg et al. 1994). The snow index was correlated with July temperature and negatively correlated with July rainfall, indicating that high snowfall winters were usually followed by relatively warm and dry conditions in July.

Range Condition

Range condition appeared excellent during winters 1991-1992 and 1992-1993, as evidenced by high proportions (x = 72% to 81%) of lichen fragments in caribou fecal samples (Table 3). Samples were collected from different wintering areas each year (Fig 5). Samples collected during winter 1994-1995 have not yet been analyzed. Boertje (1981) and Boertje et al. (1985) provided data showing the usefulness of fecal samples in evaluating use of lichens on winter ranges. Lichens are slower growing than vascular plants and are a highly preferred winter forage. Fecal samples from overgrazed winter ranges contained higher proportions of mosses and evergreen shrubs and reduced proportions of lichens compared with values observed in this study.

Job Objectives

1 Literature review complete.

2 Caribou 4 to 16 months old died at an annual rate of 12% during 1993 and 1994. Caribou older than 16 months died at a rate of 10%. Wolf predation was by far the major cause of death.

3 Evaluations of condition indices for the Fortymile Herd are forthcoming. Natality rates and age of first reproduction seem to be satisfactory relative indices. The Fortymile Herd is in average condition compared with several other Interior caribou herds. Comparisons are forthcoming.

4 Age-specific mortality rates did not differ for caribou ^{3} 4 months old from 1993 to 1995, when herd size was relatively stable.

5 A census was completed on 28 June 1992; 21,884 caribou were counted. This represents a 4% decline in herd size since June 1990. The camera malfunctioned during the 1993 census, and a new camera was purchased for 1994. A census was completed on 1 July 1994; 22,104 caribou were counted suggesting a relatively stable trend in herd size between 1992 and 1994 (Table 1).

6 The proportions of adult females, calves, and bulls were estimated each year about 1 October to assist with modeling the herd's population dynamics (Fig 4).

7 Fecal samples were collected during March and April 1992 and 1993, and results indicate lichens are abundant in the diet. These data suggest the range can support increased caribou numbers. As the herd uses different portions of its range, more samples will be collected to evaluate different winter ranges used by the Fortymile Herd. Seven samples were collected during winters 1993-1994 and 1994-1995, and have not yet been analyzed.

8 Newborn calves were the first radiocollared during May 1994 and the first year's data were complete at this writing. Collaring resumed in May 1995 and will allow further modeling of the causes and extent of mortality among calves.

9 Short summers can apparently contribute to reduced caribou natality rates. Also, deep snow and dry, warm summers seem correlated with reduced caribou recruitment.

10 A presentation to the Board of Game was completed in November 1992. Data were presented at an interagency and international management meeting on the Fortymile Herd in Tok on 9 February 1994. Several presentations were made to local groups in Tok during winter 1994-1995. A newsletter on the Fortymile Caribou Herd entitled "The Comeback Trail" was produced to better communicate findings of this study and achieve consensus on new management objectives. Presentations were made to the team working on new management plans.

11 Progress reports were written.

12 Results to date were incorporated into Alaska's Area-Specific Wolf Management Plans and presented to the Board of Game in November 1992 to assist the board in decisions regarding wolf control for the Fortymile Herd. Data were incorporated into management reports. Presentations were made to the team working on new management plans.

CONCLUSIONS

For those considering future management direction of the Fortymile Herd, several points are significant:

1 Herd numbers have remained relatively stable in the 1990s, compared with annual growth rates of 7% to 10% in the 1980s.

2 Wolves and grizzly bears continue to be the major factors limiting Fortymile Herd growth, despite over a decade of the most liberal regulations in the state for public harvesting of wolves and grizzly bears.

3 Harvest of Fortymile caribou has been intentionally restricted to allow for growth of the herd, but minimizing harvest is inadequate as a means of action for achieving time-specific objectives for elevated caribou numbers. For example, harvest was only about 300 bull caribou during the 1994-1995 hunting season (1% of the postcalving population).

4 Adverse weather has contributed to reduced natality and, presumably, increased predation rates in recent years, compared with the 1980s.

5 Winter range can support elevated caribou numbers both in regard to lichen availability on currently used winter range and availability of vast expanses of former winter range.

Given current management actions, the herd will likely follow near natural fluctuations dependent on the synergistic effects of weather and predation. Assuring the achievement of time-specific objectives for increased caribou numbers will depend on actions that measurably reduce predation. Reducing predation is a value-based socioeconomic and political decision beyond the scope of this report. Ecological and biological issues are more easily addressed. For example, sustainable harvest of a caribou herd is ecologically sound compared with dependency on alternative livestock and agricultural industries. Past studies have shown that wolf reductions are biologically sound, i.e., 1) caribou herds can grow rapidly following large reductions in wolf numbers, and 2) wolf numbers can recover within a few years (Farnell and Hayes, unpubl rep; Boertje et al., unpubl rep).

large reductions in wolf numbers, and 2) wolf numbers can recover within a few years (Farnell and Hayes, unpubl rep; Boertje et al., unpubl rep).

ACKNOWLEDGMENTS

We acknowledge technical assistance from D Grangaard and pilot L Larrivee in collaring caribou, collecting fecal samples, and evaluating causes of caribou mortality. Pilots R Swisher, H McMahon, P Zaczkowski, and M Webb ably assisted with radiotracking flights. In particular, R Swisher enthusiastically and ably assisted with all phases of the calf mortality study.

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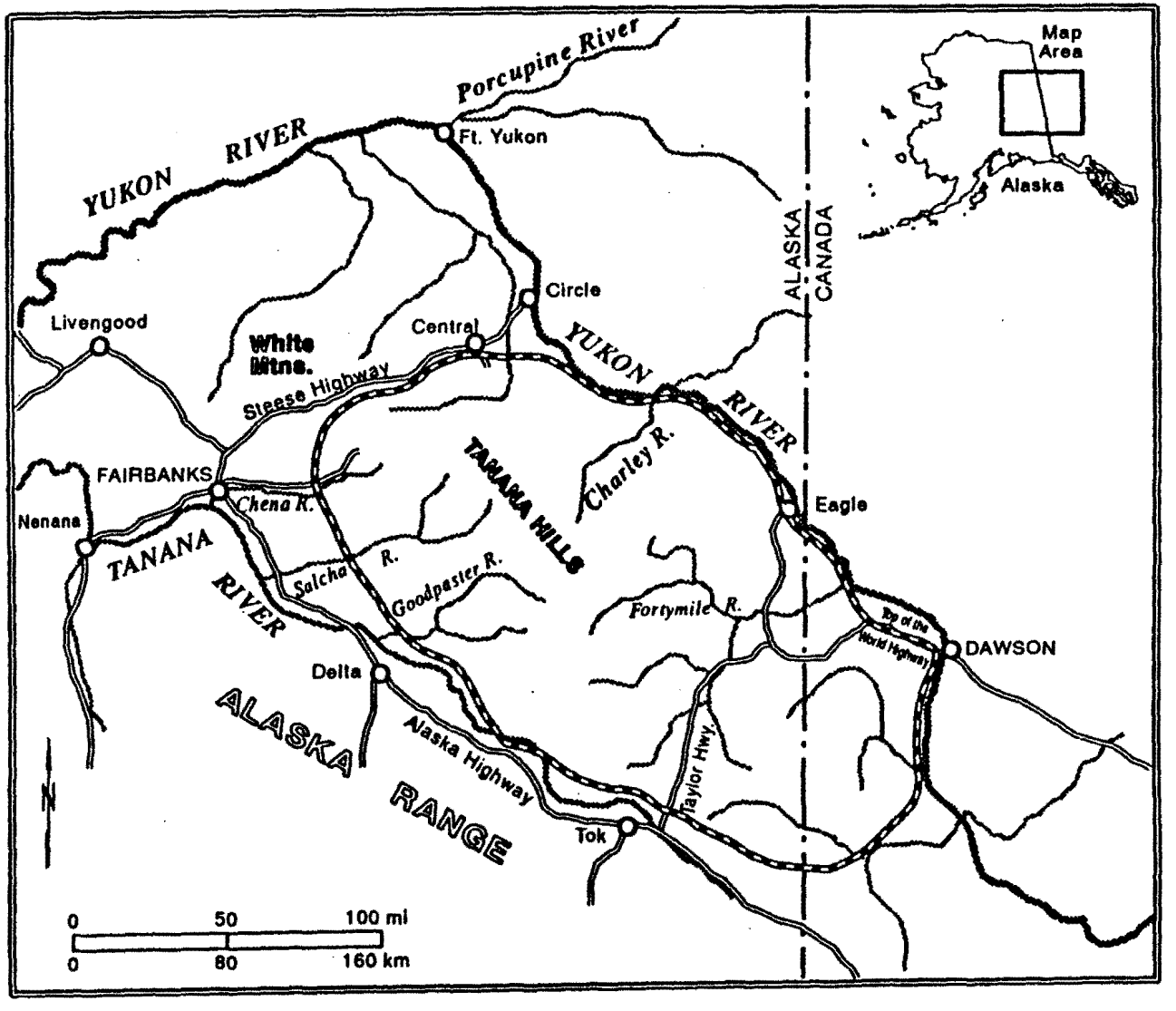


Figure 1 Range of the Fortymile Caribou Herd, 1984-1994

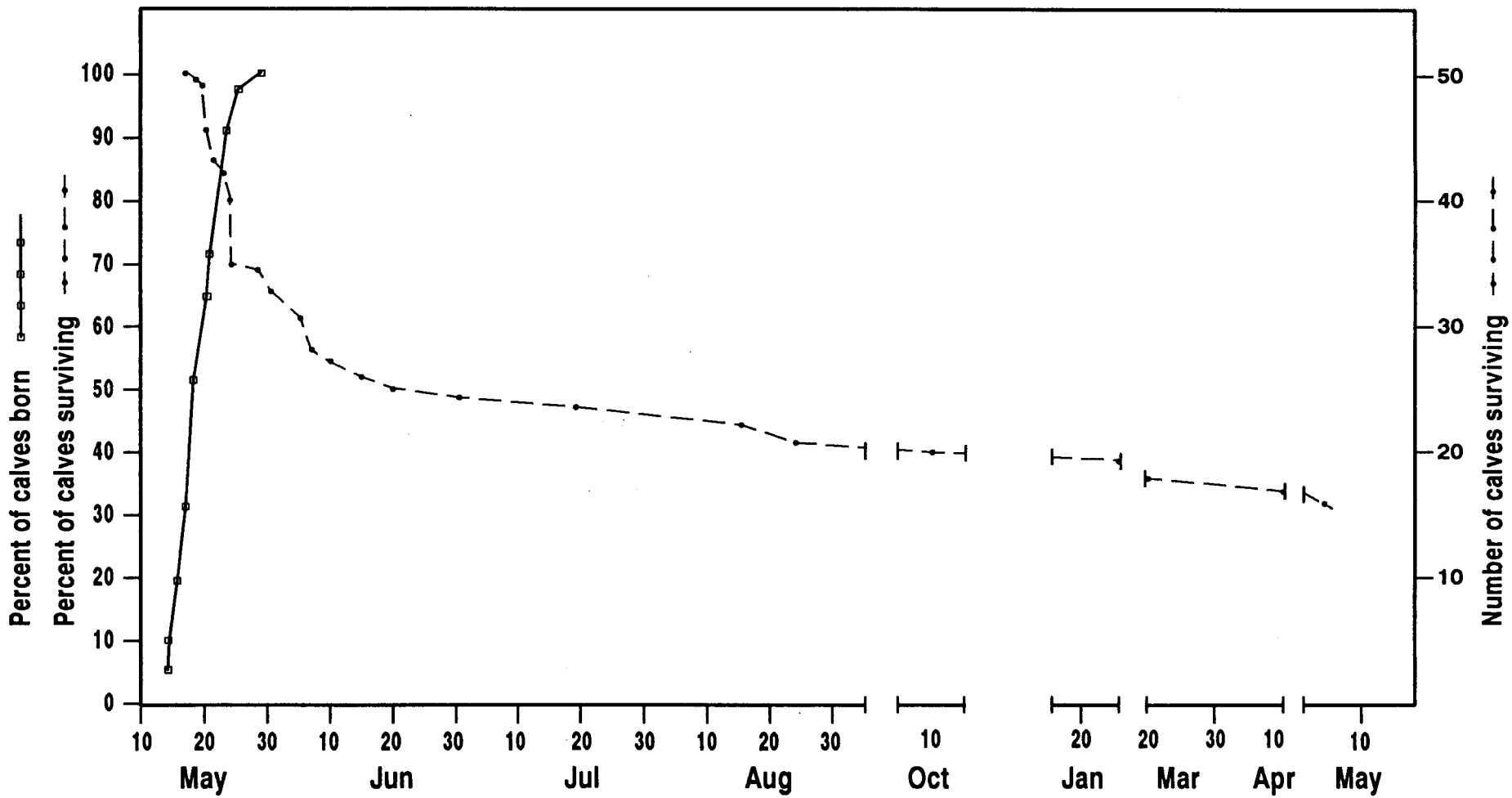


Figure 2 Chronology of births and deaths among 50 caribou calves from May 1994 through May 1995, Fortymile Caribou Herd, eastcentral Alaska

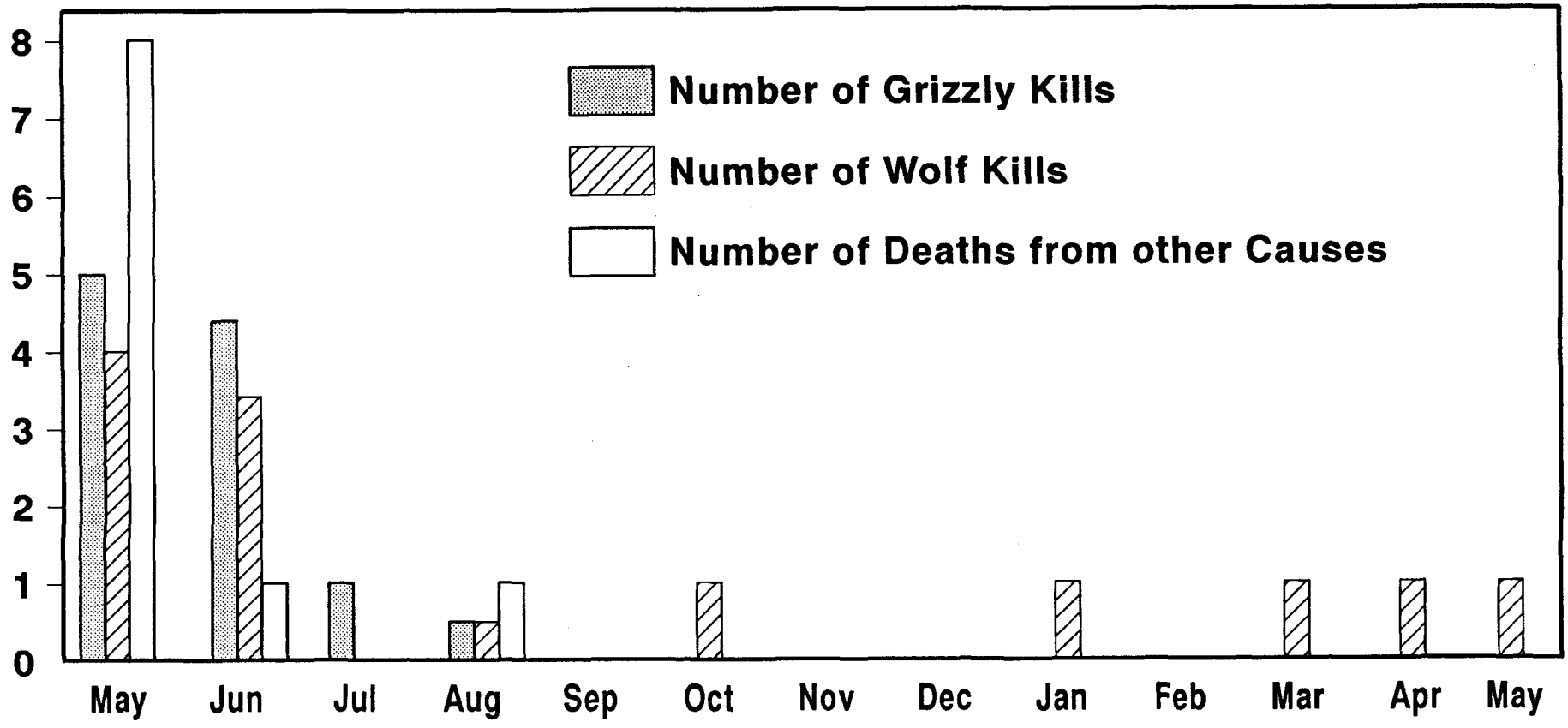


Figure 3 Chronology of wolf and grizzly bear kills and deaths from other causes among 34 caribou calves that died from May 1994 through early May 1995, Fortymile Caribou Herd, eastcentral Alaska

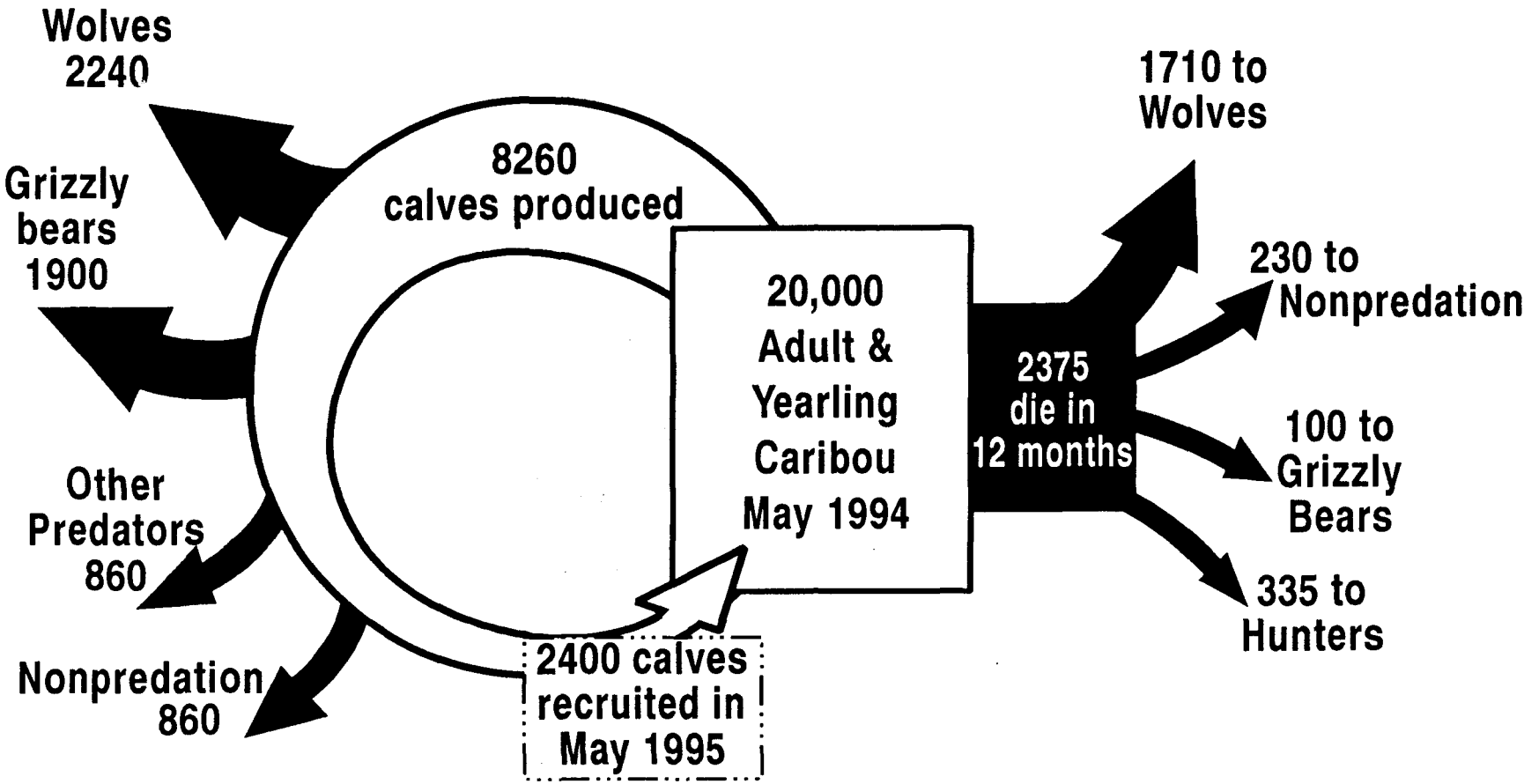


Figure 4 A conceptual model of births and deaths in the Fortymile Herd from 11 May 1994 to 10 May 1995. Black arrows point to numbers of caribou dying from specific causes during the 12-month period, as estimated from telemetry flights and follow-up investigations of causes of death. This model independently arrived at the same conclusion as recent censuses, i.e., that herd size is stable (2400 calves are recruited at the end of 12 months and 2375 adults and yearlings die during the same 12 months). Of the caribou that die in the 12-month period, wolves killed 48%, grizzly bears killed 24%, other predators killed 10%, nonpredation factors killed 13% and hunters killed 4%. This model is derived from data in the Appendix.

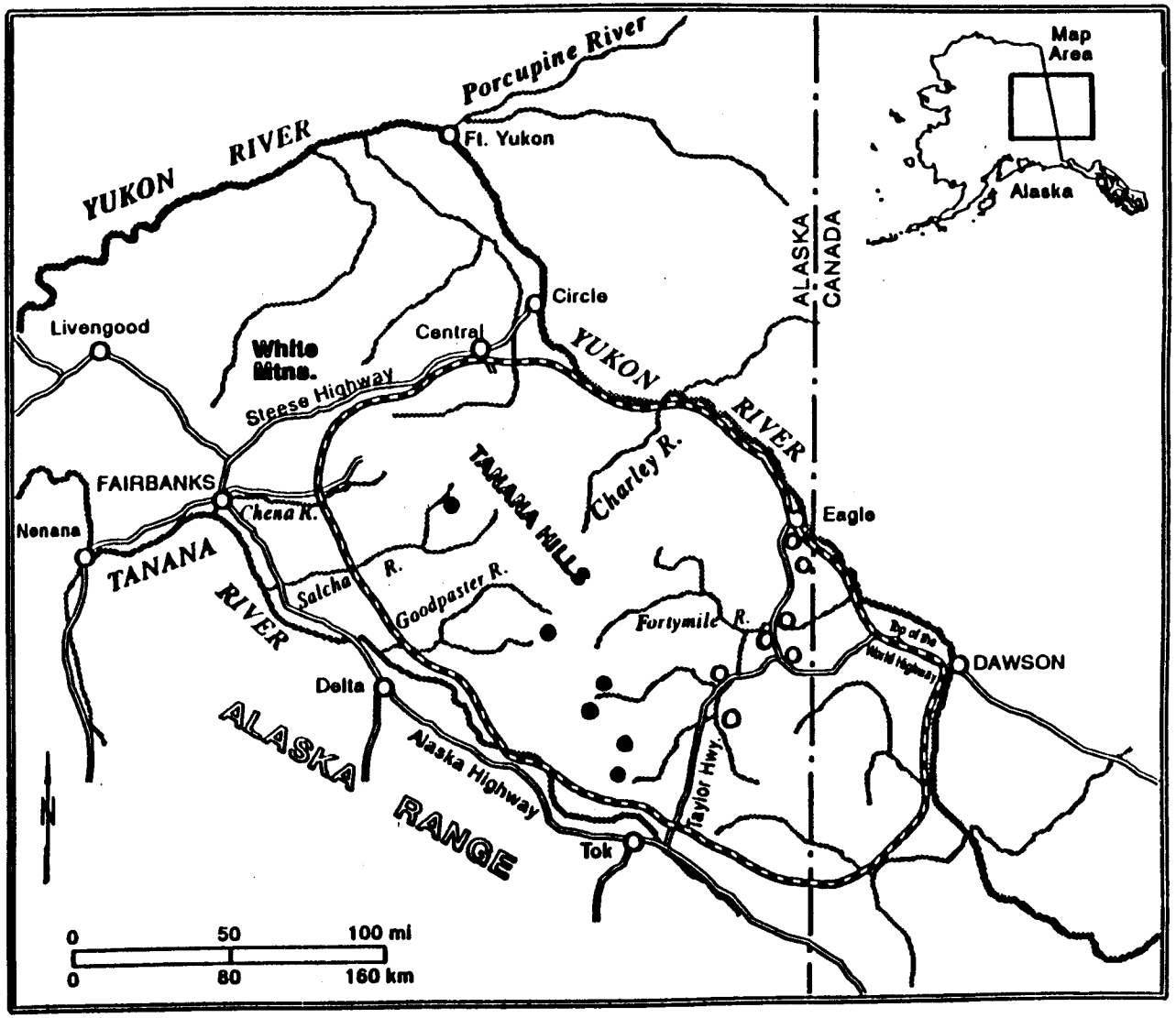


Figure 5 Locations where caribou fecal samples were collected during March and April 1992 (●) and 1993 (○)

Table 1 Estimated numbers, harvest, natural mortality, natality, and recruitment in the Fortymile Herd, 1984-1995

Year	Estimate of herd size	Estimated harvest[b] M	F	% mortality of collared females 4-16 months old for year ending 1 Oct (*n*)	% mortality of collared females 17-28 months old for year ending 1 Oct (*n*)	% mortality of collared females ≥ 28 months old for year ending 1 Oct (*n*)	Natality rate of collared females ≥ 36 months old (*n*)	Calves:100 females (*n*)[a] Sep to Oct
1984	13,402 (19)[c]	430	20			10 (21)	87 (23)	--
1985	--	421	20			9 (22)	100 (19)	36 (574)
1986	15,307 (19)	360	20			17 (24)	95 (21)	28 (842)
1987	--	229	20			5 (19)	95 (19)	37 (1274)
1988	19,975 (39)	645	150			9 (33)	95 (20)	30 (770)
1989	--	400	98			19 (27)	--	24 (1182)
1990	22,766 (16)	321	22			40 (20)	88 (16)	29 (1002)
1991	--	495	10	21 (14)	--	17 (12)	91 (11)	16 (931)
1992	21,884 (64)	432	35	57 (14)	8 (12)	17 (35)	87 (39)	30 (1416)
1993	--	336	10	8 (12)	10 (10)	10 (51)	68 (47)[d]	27 (2095)
1994	22,104 (91)	315	20	17 (12)	10 (10)	11 (37)	82 (45)	33 (1704)
1995	--	--	--	19 (31)[e]	10 (10)[e]	8[e] (40)	85 (41)	--

[a] *n* = number of females ≥ 1 year old classified.

[b] Some harvest occurred during January, February, or March of the subsequent year, but was included in the autumn tally of the previous year.

[c] Number of caribou with radiocollars during census.

[d] During 1993, 5 of 12 (42%) females 3 years old were pregnant, and 27 of 36 (75%) females ≥ 4 years old were pregnant.

[e] Data are summarized through May 1995.

Table 2 Autumn (late Sep-late Oct) weights (kg) of female calves radiocollared in the Fortymile Caribou Herd, 1990-1994

	1990	1991	1992	1993	1994
	59.4	61.3	67.2	61.3	60.9
	56.7	59.0	65.3	60.3	60.7
	56.3	57.6	60.3	58.1	59.1
	55.8	57.2	60.3	58.1	58.9
	55.8	56.3	58.5	57.6	56.2
	55.4	55.4	54.4	57.6	55.9
	53.5	55.4	54.0	57.2	54.9
	52.6	54.4	52.2	57.2	54.2
	51.7	54.4	51.3	56.7	53.8
	51.7	54.4	51.3	55.8	52.8
	49.9	51.7	50.8	55.4	51.3
	49.0	48.5	50.8	54.0	49.2
	47.6	48.1	49.9	52.6	48.4
	43.1	41.3	45.4	51.7	46.0
				48.5	
Mean	52.8	53.9	55.1	56.1	54.4
SD	4.32	5.12	6.28	3.32	4.60
SE	1.15	1.37	1.68	0.86	1.23

Table 3 Proportions of discerned plant fragments in 13 fecal samples collected from Fortymile caribou during March and April 1992 (n = 6) and 1993 (n = 7). Collection sites are depicted in Figure 5.

Plant genus or group	Mean % (± SD) of discerned plant fragments		
	1992	1993	Both years
Lichens	72 ± 22	81 ± 4	77 ± 15
Mosses	9 ± 8	7 ± 4	8 ± 6
Ledum	7 ± 5	5 ± 2	6 ± 4
Equisetum	7 ± 14	3 ± 2	5 ± 8
Picea	2 ± 1	2 ± 1	2 ± 1
Grass/Sedges	1 ± 1	1 ± 1	1 ± 1
Forbs	3 ± 5	0	1 ± 4
Dryas	1 ± 3	0	1 ± 2
Salix	0	1 ± 1	1 ± 2

APPENDIX Values and calculations used to model caribou population dynamics, Fortymile Herd, 1994-1995

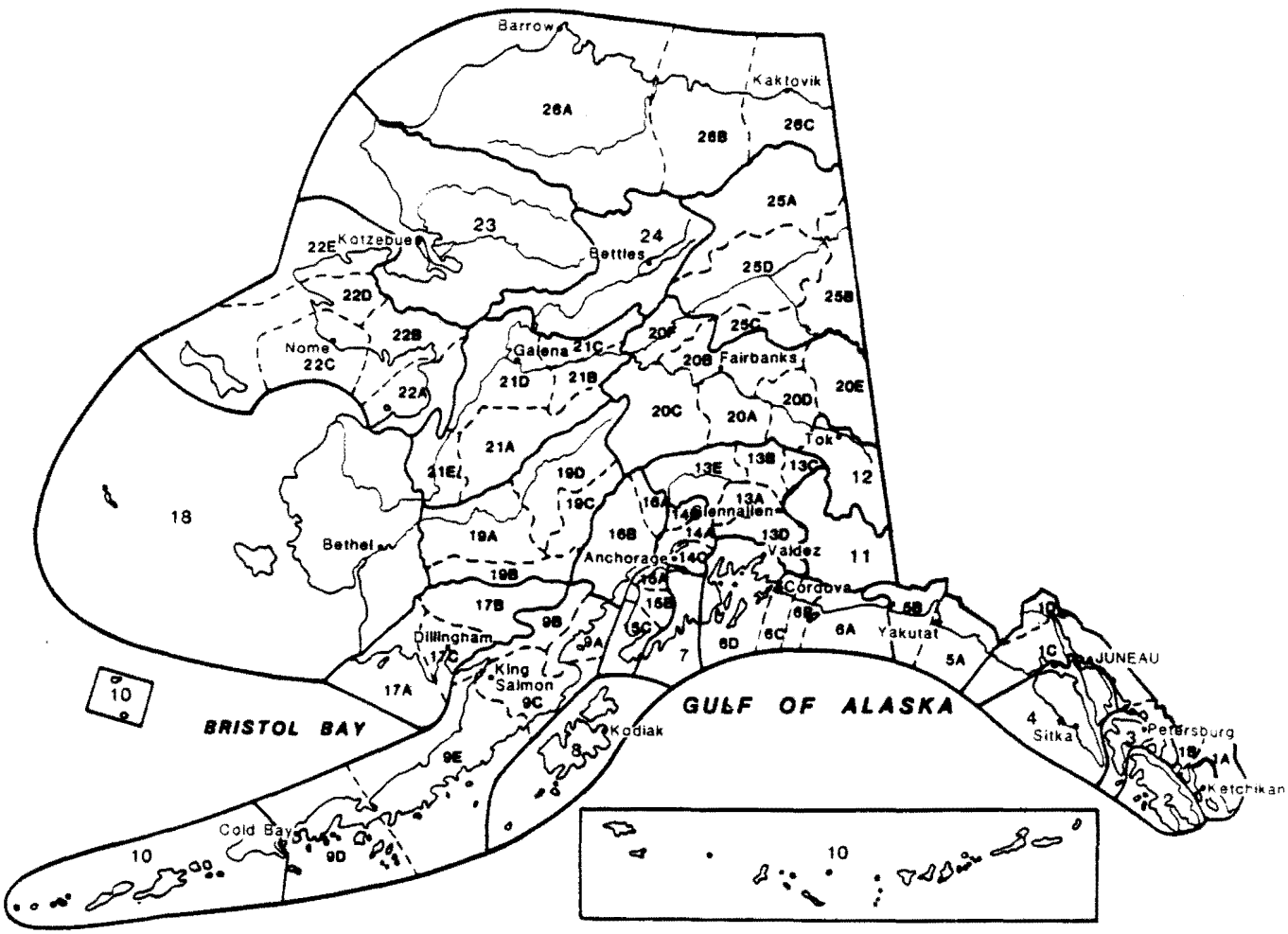
Estimated parameters, date, calculations	Observed or calculated values
Number of cows ≥ 24 months old in early May 1994; percent cows in herd in October 1993 when randomly mixed (0.58) x estimated herd size in early May 1994 (20,000).	11,600
Number of 24-month-old cows in early May 1994; percent calves in herd in October 1992 (0.17) x estimated herd size in early May 1993 (20,000) x survival rate from 12 to 24 months old (0.90) x proportion of females (0.5).	1530
Number of cows ≥ 36 months old in May 1994 (11,600-1530).	10,070
Number of calves produced in May 1994 (10,070 x 0.82).	8260
Number of calves dying by 10 May 1995 (8260 x 0.71).	5860
Number and cause of calf deaths, 11 May 1994-10 May 1995.	
Wolf (0.382 x 5860)	2240
Grizzly bears (0.324 x 5860)	1900
Other predators (0.147 x 5860)	860
Nonpredation (0.147 x 5860)	860
Number of caribou ≥ 12 months old in early May 1994.	20,000
Number of nonhunting deaths among caribou ≥ 12 months old from May 1994-May 1995 (20,000) (11 ÷ 108).	2040
Number and cause of nonhunting deaths among these 2040 caribou.	
Wolf (0.84 x 2040)	1710
Nonpredation (0.11 x 2040)	230
Grizzly bear (0.05 x 2040)	100

APPENDIX Continued

Estimated parameters, date, calculations	Observed or calculated values
Annual harvest of adults and yearlings May 1994-May 1995.	335
Herd size 11 May 1994.	20,000
Herd size 10 May 1995 (20,000 + 8260 - 5860 - 2040 - 335).	20,025
Herd trend approximately stable.	

NOTES

Alaska's Game Management Units



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

PAT COSTELLO