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Testing Socially Acceptable Methods of Managing Predation:

Reducing Predation on Caribou and Moose Neonates by Diversionary Feeding of Predators, Macomb Plateau, 1990–94

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PROGRESS REPORT (RESEARCH)

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SUMMARY

The purpose of this study is to test whether artificial feeding of grizzly bears (*Ursus arctos*), black bears (*Ursus americanus*), and wolves (*Canis lupus*) can reduce predation on newborn moose (*Alces alces*) and/or caribou (*Rangifer tarandus*). If successful, this technique could provide a means to enhance moose or caribou populations without resorting to lethal methods to control predation. The Alaska Department of Fish and Game (ADF&G) is obligated to investigate alternatives to lethal predator control because of the high economic, political, and social costs of lethal predator control.

We distributed 26 and 16 metric tons of bait from 14 May to 5 June 1990 and 1991, respectively, in a 1,650-km^2 area, hereafter referred to as the "treated area." Bait consisted largely of train-killed or winter-killed moose unsalvageable for human consumption.

Bears (mostly grizzly bears) and wolves consumed 79% of the bait by 14 June 1990, as evidenced by dismembered skeletons and aerial observations of bears and wolves at baits. In 1991, grizzly bears were the major scavengers, as evidenced by tracks, at 50% of 30 sites investigated on 3-4 June. Grizzly bears and wolves were common in the treated area.

Treatment resulted in enhanced moose calf survival in November 1990; moose calf survival was the highest recorded (42 calves:100 cows $\geq$2 years old) in the area compared to similarly derived 1981-89 pretreatment values (19-38, Δ = 25, SD = 9, $\underline{n}$ = 8) when

winters were less severe. At least 3 treatment years are needed to test whether the increase in calf survival following treatment is statistically significant. Moose will be surveyed in fall 1991 to test the effects of the May 1991 treatment.

Other data suggest the 1990 treatment increased moose calf survival. For example, elevated 1990 moose calf survival was not widespread. Untreated control moose populations and adjacent, partially treated moose populations experienced low calf survival in 1990 (11-31 calves:100 cows $\geq$2 years old).

Caribou calf survival was extremely poor following treatment in 1990 and 1991, yet survival was similar to control herds. Caribou calf telemetry studies in the Alaska Range Denali Herd indicate that poor environmental conditions favored high predation rates and resulted in declines in caribou calf survival in recent years (L. Adams, unpubl. data). Increased wolf numbers are associated with current elevated predation rates in Denali National Park and eastcentral Alaska (T. Meiers, National Park Service, and D. Grangaard, ADF&G, unpubl. data; this study). Feeding of predators apparently cannot deter high predation rates on Macomb caribou calves under these conditions.

If moose calf survival is again elevated after the 1991 feeding program, we recommend concentrating baits at lowland sites in 1992 or 1993 to evaluate more fully the effectiveness of diversionary feeding for improving moose calf survival. Also, we recommend collaring 40 newborn moose calves to determine when calves are dying and the major cause of mortality.

Key Words: Alaska, baiting, bears, calf survival, calving, caribou, diversionary feeding, feeding, moose, predator-prey relationships, wolves.

CONTENTS

BACKGROUND

Humans manage wildlife populations to influence a desired outcome. For example, humans sometimes want more ungulates than occur naturally. The elevated numbers of ungulates may be important to help protect habitat from competing land uses and/or to provide for consumptive and/or nonconsumptive uses of wildlife.

Moose (*Alces alces*) populations in much of Alaska and the Yukon are limited below food-limited densities by predation (Gasaway et al., 1990). For example, predation limits moose populations at chronically low densities where moose are a primary prey of lightly exploited wolf (*Canis lupus*), black bear (*Ursus americanus*), and grizzly bear (*Ursus arctos*) populations. In areas where wolves and bears are at near-natural densities, the mean density was only 155 moose/1,000 km^2 ($\underline{n}$ = 20 areas, range = 45-417, SD = 86), compared with a mean of 647 moose/1,000 km^2 ($\underline{n}$ = 16 areas, range = 169-1,447, SD = 389) in areas where humans maintain wolves and, in some cases, bears below food-limited densities (Gasaway et al. 1990).

Apparently moose do not occur at a high-density equilibrium without continued predator management, except where moose are: (1) preyed on by only 1 predator species (Messier and Crete 1985, Crete 1987, Bergerud and Snider 1988, Messier 1988), (2) preyed on by

black bears and grizzly bears (wolves extirpated) with or without alternate ungulate prey (Houston 1968, Bailey 1978, Peterson et al. 1984), or (3) minor prey in wolf-bear multiprey systems (Crete 1987, Bergerud and Snider 1988). In Alaska, wolves, moose, and one or both species of bears occupy the same habitats. Caribou (*Rangifer tarandus*) are rarely the primary prey, except in portions of the Brooks Range and arctic coastal plain. Therefore, Alaskan moose populations can be expected to occur at low densities, except where wolf and/or bear populations are strongly manipulated by humans.

To manage for elevated densities of caribou, managers must also usually counter strong natural processes (Bergerud and Elliot 1986). Although some Alaskan caribou population have periodically increased with little human intervention (Skoog 1968), caribou population growth is often limited at low densities by predation, and increases are temporary (Bergerud 1980, Bergerud and Elliot 1986). Mainland caribou densities (i.e., $\leq$400 caribou/1,000 km^2 in areas where wolves are nearly unexploited) are frequently well below those where food limitation caused a reduction in caribou populations (Bergerud 1980, Skogland 1986).

Reductions in predator populations by the public (e.g., same-day-airborne shooting) and/or the Alaska Department of Fish and Game (ADF&G) have contributed to recent increases in many Alaskan caribou herds (e.g., Nelchina, Delta, and Fortymile) (Gasaway et al. 1983, Ballard et al. 1987, Boertje et al. 1987, Valkenburg and Davis 1988). Recent controversy over these methods highlights the need for socially acceptable alternatives to lethal control if moderate caribou densities are to be maintained.

The Division of Wildlife Conservation is obligated to provide long-term conservation of large carnivore populations throughout Alaska as well as reduce the controversy surrounding the management of large carnivores. As a first step, the Division established a framework for citizen involvement in developing a strategic wolf management plan. Integral to this process is the evaluation of non-lethal ways to manage predator-prey relationships in areas where the public requests ungulate-predator systems to be managed for increased human use of ungulates (Boertje and Kelleyhouse, in press).

Several alternatives to intense, lethal, government-conducted or public predator control have been proposed for managing predator-prey relationships (Gasaway et al. 1990, Boertje and Kelleyhouse 1992). This study assesses if, and to what extent, diversionary feeding of predators reduces predation and facilitates management of caribou-moose-predator relationships. Preliminary evidence indicates that diversionary feeding of predators may increase survival of caribou and/or moose neonates.

During May and June 1985, we air-dropped approximately 12-15 tons of train-killed moose and scrap meat to attract grizzly bears for collaring purposes in and near Mosquito Flats, an important moose calving area north of Tok. We observed that grizzly bears, wolves, and black bears consumed much of this meat and that fall moose calf:cow ratios were higher than normal. The 1985 early winter calf:cow ratio was 53:100 ($\underline{n}$ = 17

cows), compared with a range of 11-15:100 (n = 26-39) during the 3 preceding years and a range of 26-36:100 (n = 25-27) during 1986 and 1987. Also, the 1985 response was not observed in untreated adjacent areas (10-19:100, n = 25-70); however, some of the increase in calf survival may have resulted from immobilization and slow recovery of bears (4-5 days), rather than the introduction of meat.

Other circumstantial evidence also suggests that diversionary feeding for 1 month during and immediately following the calving season may increase caribou and moose calf survival. Most mortalities among caribou and moose populations in central and southern Alaska and the Yukon occur on neonates during the first 2-3 weeks of life. Predation is the major cause of these mortalities (Franzmann et al. 1980; Ballard et al. 1981; Boertje et al. 1987, 1988; Adams et al. 1988; Larsen et al. 1989).

The Macomb Caribou Herd has been small (≤800 caribou, 200 caribou/1,000 km^2) for 2 decades or more, yet management goals for the herd call for increasing the herd to 1,000-1,500 caribou by 1997. The herd's location along the road system makes it ideally suited to this study. Substantial public benefits would be incurred from increased caribou, moose, and wolves in this area. Since intensive wolf removal during winter 1980-81, the herd may have grown from 500-600 caribou to about 800 during October 1988; however, neonatal calf mortalities have remained high since wolf removal ceased. Causes and chronology of these mortalities are probably similar to those recently documented in the Denali Caribou Herd from 1984 to 1988 predators (i.e., primarily grizzly bears) killed about 39% of calves by 1 June (Adams et al. 1988).

OBJECTIVES

To estimate the change in survival of neonate moose and density of the moose population resulting from diversionary feeding of wolves and bears on and adjacent to the Macomb Plateau from 1990 to 1994.

To estimate the changes in the survival of neonate caribou and size of the caribou population resulting from diversionary feeding of wolves, bears, golden eagles (*Aquila chrysaetos*), and bald eagles (*Haliaeetus leucocephalus*) on and adjacent to the Macomb Plateau from 1990 to 1994.

STUDY AREA

We distributed food for predators in a 1,650-km^2 portion of the Alaska Range and adjacent lowlands between elevations of 400 and 1,550 m (Fig. 1). This treated area includes the calving ground of the Macomb Caribou Herd (Fig. 2) and portions of the Knob Ridge and Robertson River moose calving grounds. The treated area is centered around 63°35'N latitude and 144°30'E longitude.

Moose populations used as controls in this study include the Central Creek and eastern Subunit 20E moose populations, which are 80 km north and 120 km east of the treated area, respectively. Caribou herds used as controls include the Denali and Delta herds, which are 290 km west and 160 km west of the treated area, respectively. The Macomb, Denali, and Delta herds share the northern slopes of the Alaska Range.

A subarctic and continental climate occurs in the treated and control areas. "Winter" includes the months of October through April. Leaves emerged on most shrubs on the Macomb Plateau during 26-27 May 1990 and 15-20 June 1991, and leaves usually fall in late August. Total annual precipitation averages 24 cm at Tok, 60 km east of the plateau (National Oceanic and Atmospheric Administration 1986).

Wolves, black bears, and grizzly bears occur at near-natural densities in treated and control areas; i.e., predator-prey relationships had not been strongly manipulated by humans during the 8-9 years before this study. One exception is that grizzly bear density has been reduced by harvest in recent years in the Delta Herd's range (Reynolds 1990). Moose, caribou, and Dall sheep (*Ovis dalli*) are the major prey in the treated and control areas, except the Central Creek and eastern Subunit 20E areas where there are no sheep. Minor prey in these areas include snowshoe hares (*Lepus americanus*), beavers (*Castor canadensis*), hoary marmots (*Marmota caligata*), and, except in the Central Creek and eastern Subunit 20E control areas, arctic ground squirrels (*Citellus parryii*).

METHODS

Carcass Collection and Storage

During winter 1989-90, 26 metric tons of bait were collected. The Alaska Railroad Corporation collected 60 train-killed moose, using a crane or ditcher mounted on a railroad car. These carcasses were stored in the town of Willow until they could be transported to Cummings' Sawmill (Fig. 1). An additional 30 unsalvageable carcasses were collected near Delta Junction and Fairbanks; most of these carcasses were winter-killed moose calves. About 4% of the bait were spawned red salmon carcasses collected from the Paxson Hatchery; carcasses were frozen and stored in Fairbanks until April. Upon arrival at the sawmill (Jan-Apr 1990), bait was covered with sawdust for cold storage until distribution.

During winter 1990-91, 16 metric tons of bait were collected. A large majority of this bait consisted of unsalvageable starved or road-killed moose collected in and around Fairbanks by a local volunteer organization, the Moose Mobile. In addition, the Alaska Railroad Corporation collected several unsalvageable train-killed moose. Twenty adult and 43 calf moose carcasses were collected by these 2 methods. Less than 5% of the bait consisted of outdated, unsalvageable dog food contributed by Kobuk Feed Company of

Fairbanks. Carcasses were stored at Cummings' Sawmill under sawdust from April until distribution in May and early June.

Bait Distribution and Use Monitoring

During 1990, bait (n = 87 baits, Δ = 300 kg) was distributed using Army UH-1 helicopters (40 flight hours) on 14 and 15 May (n = 29 baits), 21 and 22 May (n = 25 baits), and 30 May 1990 (n = 33 baits). We baited in a 1,650-km^2 area around Macomb Plateau near calving caribou and moose (Figure 1). To aid relocation of carcasses, we directed the helicopters to each bait site using light fixed-wing aircraft (Bellanca Scout or Piper Super Cub). One bait was deposited at each site (n = 61 sites) and replenished as necessary during successive baiting periods; some sites received up to 3 baits (Fig. 1).

To monitor 1990 bait use we made several low passes over bait sites using light fixed-wing aircraft at 4- to 10-day intervals through 14 June. We deemed a bait "largely consumed" when it was over 50% gone. In a majority of these cases, only hair and scattered bones remained, but in a few cases hides and a low percentage (<20%) of meat remained.

In 1991, bait (n = 68 baits, Δ = 256 kg) was distributed using ADF&G equipment, including a DeHavilland Beaver aircraft, riverboat, and 4 x 4 pickup truck. Baits were distributed 14-17 May (n = 16), 21-24 May (n = 28), 28-31 May (n = 20), and 5 June (n = 4) in the 1,650 km^2 treated area (Fig. 2). We monitored bait use along the Alaska Highway and Tanana River before distributing new baits. Some sites (n = 43 total) received up to 3 baits (Fig. 2).

Between 15-30 May 1991, we distributed chemical scents throughout the treated area at weekly intervals to distract predators from preying on calves. We used skunk essence and Carman's Canine Call Lure (CCCL) and distributed the scents on rocks (n = 67) and cotton-tipped arrows (n = 85) along the Alaska Highway and Tanana River. We also placed about 4 cc of CCCL and 10 cc of water in water balloons (n = 94) and distributed these across the subalpine portions of the treated area using a DeHavilland Beaver aircraft. In addition, scent was placed adjacent to carcass sites along the Alaska Highway and Tanana River (n = 25, Figure 2).

Monitoring Moose Calf Survival

Between 18 October and 12 November 1990, moose surveys were flown in the Knob Ridge treated area, the upper Robertson River partially treated area, and the Central Creek and eastern Subunit 20E control areas. The Knob Ridge and Central Creek survey areas were 181 km^2 and 161 km^2, respectively, and were flown at 1.5 to 1.9 min/km^2 as prescribed by Gasaway et al. (1986). In contrast, the Robertson River and eastern Subunit 20E survey areas were much larger (350 and 900 km^2, respectively) and flown less intensively, about 0.8 min/km^2.

Monitoring Caribou Pregnancy and Survival

1990 Methodology

Using a Piper Super Cub and Bellanca Scout, we examined the 18 adult (≥3 years old) radio-collared Macomb caribou on 14 and 20 May for evidence of pregnancy; i.e., retention of antlers and presence of extended udders. Pregnant collared caribou were radio-tracked after 20 May at 2- to 6-day intervals through 8 June to determine calving distribution and survival of calves. Using a Hughes 500 helicopter on 14 June and 9 October, 600 and 734 caribou were classified, respectively.

1991 Methodology

Using a Piper Super Cub, we examined 16 radio-collared Macomb caribou for evidence of pregnancy or newborn calves on 16, 21, and 23 May and 11 June. We also used a Hughes 500 helicopter on 11 June to classify 319 caribou as either calves, females ≥1 year old, or males ≥1 year old.

RESULTS AND DISCUSSION

Consumption of Bait

Most observations on bait consumption occurred during 1990. Scavengers largely consumed 76 (88%) of the 87 baits by 14 June 1990 (Fig. 3). Approximately 45-50% of the baits were largely consumed within 10 days of distribution, and an additional 30-40% during the following 10 days. Bears (mostly grizzly bears) and wolves ate 79% of the baits, as evidenced by observations of these animals at baits and dismembered moose skeletons. Bait removal and/or burial occurred at 44% of the 87 drop sites, indicating grizzly or black bear use; however, because bears did not always move or bury baits, they may have consumed >44% of the baits. We estimated that golden and bald eagles consumed 9% of the baits. During 1991, we observed grizzly bear sign at 15 of 30 sites checked during 3-4 June. Black bears, wolves, and eagles were minor scavengers at several of these sites.

Predator Densities

Grizzly bears and wolves are common in the treated area. In 1990, 13 different grizzly bears ≥2 years old were observed in 1,000 km^2 on or near the Macomb Plateau (8 adult bears, 4 3-year-olds, and 1 2-year-old). This is a high density for grizzly bears in the Alaska Range (Reynolds 1990) and adjacent Fortymile River drainage (Boertje et al. 1987).

We observed wolves ranging within the treated area in fall 1989 and 25 in fall 1990. Ten percent of these were single wolves (Mech 1973). The wolves range over a 2,000-2,500 km^2 area, indicating a high wolf density relative to adjacent areas (Boertje et al. 1987, Gasaway et al. 1990). One pack was radio-collared in April 1990 to help distinguish packs in the study area.

Moose Calf Survival

Bait treatment resulted in enhanced moose calf survival in November 1990; moose calf survival was the highest recorded (42 calves:100 cows $\geq$2 years old) in the area compared with similarly derived 1981-89 pretreatment values (19-38, Δ = 25, SD = 9, $\underline{n}$ = 8) when winters were less severe (Table 1). However, at least 3 treatment years are needed to test whether the increase in calf survival following treatment is statistically significant. Moose will be surveyed in October or November 1991 to test the effects of the May 1991 treatment.

Other data also suggest the 1990 bait treatment increased moose calf survival. For example, elevated 1990 moose calf survival was not widespread (Table 1). Untreated control moose populations and adjacent, partially treated moose populations experienced low calf survival during 1990 (11-31 calves:100 cows $\geq$2 years old).

Caribou Calf Survival

Caribou calf survival declined significantly in several Alaska Range herds, including the Macomb herd. Caribou calf survival remained low in 1991 (Table 2). Diversionary feeding of predators in 1990 and 1991 failed to improve Macomb caribou calf survival. In 1990, 15 (83%) of 18 collared female caribou $\geq$3 years old were pregnant and 12 calves (80%) survived to 8 June (Fig. 3). However, 1990 calf survival in the herd was poor (about 50% survival by 14 June, 32 calves:100 females, $\underline{n}$ = 600, Boertje et al. 1990). In 1991, 10 (83%) of 12 collared female caribou $\geq$3 years old were pregnant, but only 1 of the 10 calves was alive on 12 June. Calf survival in the herd was estimated at 25% on 12 June 1991 (64 calves:100 females $\geq$1 year old born and 16 calves:100 females alive on 12 June, $\underline{n}$ = 319).

Mortality studies of telemetered caribou calves in the Alaska Range Denali Herd indicate that calf birth weights declined in 1990 and 1991 possibly because of drier summers and/or deeper than average snowfall (L. Adams, unpubl. data). Average age of first reproduction also increased in the Denali herd. Poor conditions for caribou favored increased wolf numbers throughout central and eastcentral Alaska (T. Meiers, U.S. National Park Service, and D. Grangaard, ADF&G, unpubl. data). Initial declines in caribou numbers caused by poor environmental conditions can be exacerbated quickly by elevated wolf numbers and wolf predation. The result can be prolonged accelerated declines in caribou because of rapidly changing wolf:caribou ratios. Predation

management using diversionary feeding appears incapable of reversing this declining trend.

RECOMMENDATIONS

Recommendations for 1992 depend on results of fall 1991 moose surveys, which have not been completed at this writing. Assuming 1991 moose calf survival is elevated, I recommend a third year of feeding during 1992 or 1993. A one-year lapse in the treatment data (e.g., 1992) would serve well as a control, but 3 years of feeding are necessary to determine if moose calf survival during treatment years improves significantly compared with control years and control areas. Assuming feeding is conducted, emphasis should be placed on enhancing moose rather than caribou calf survival. Apparently, under current environmental conditions, diversionary feeding cannot increase survival of Macomb caribou calves.

If moose calf survival is not clearly elevated in 1991, then the study can be terminated because our experimental design requires that enhanced calf survival follow each treatment to achieve significant results. Collaring 40 newborn moose calves is recommended to determine when calves are dying and the major cause of mortality.

ACKNOWLEDGMENTS

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LITERATURE CITED

Adams, L. G., B. W. Dale, and F. S. Singer. 1988. Neonatal mortality in the Denali Caribou Herd. Pages 33-34 in Proc. Third North American Caribou Workshop. Alaska Dep. Fish and Game. Wildl. Tech. Bull. No. 8. Juneau.

Bailey, T. N. 1978. Moose populations on the Kenai National Moose Range. Proc. North Am. Moose Conf. Workshop 14:1-20.

Ballard, W. B., T. H. Spraker, and K. P. Taylor. 1981. Causes of neonatal moose calf mortality in southcentral Alaska. J. Wildl. Manage. 45:335-342.

_____, J. S. Whitman, and C. L. Gardner. 1987. Ecology of an exploited wolf population in southcentral Alaska. Wildl. Monogr. 98. 54pp.

Bergerud, A. T. 1980. A review of the population dynamics of caribou and wild reindeer in North America. Pages 556-581 in E. Reimers, E. Gaare, and S. Skjenneberg, eds. Proc. Second Int. Reindeer/Caribou Symp., Roros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim.

_____, and J. P. Elliot. 1986. Dynamics of caribou and wolves in northern British Columbia. Can. J. Zool. 64:1515-1529.

_____, and J. B. Snider. 1988. Predation in the dynamics of moose populations: a reply. J. Wildl. Manage. 52:559-564.

Boertje, R. D., and D. G. Kelleyhouse. In press. Evaluation of traditional and proposed techniques for decreasing wolf and bear predation on moose, Alaska. Wildl. Soc. Bull.

_____, W. C. Gasaway, D. V. Grangaard, and D. G. Kelleyhouse. 1988. Predation on moose and caribou by radio-collared grizzly bears in east central Alaska. Can. J. Zool. 66:2492-2499.

_____, _____, _____, _____, and R. O. Stephenson. 1987. Factors limiting moose population growth in Subunit 20E. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Restor. Prog. Rep. Proj. W-22-5. Juneau. 86pp.

_____, _____, P. Valkenburg, S. D. DuBois, and D. V. Grangaard. 1990. Testing socially acceptable methods of managing predation: reducing predation on caribou and moose neonates by diversionary feeding of predators on the Macomb Plateau. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Restor. Prog. Rep. Proj. W-23-3. Juneau. 11pp.

Crete, M. 1987. The impact of sport hunting on North American moose. Proc. Second Int. Moose Symp. Swedish Wildl. Res., Suppl. 1:553-563.

Franzmann, A. W., C. C. Schwartz, and R. O. Peterson. 1980. Moose calf mortality in summer on the Kenai Peninsula, Alaska. J. Wildl. Manage. 44:764-768.

Gasaway, W. C., S. D. DuBois, D. J. Reed, and S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biol. Pap. Univ. Alaska. No. 22. 108pp.

_____, R. O. Stephenson, J. L. Davis, P. E. K. Shepherd, and O. E. Burris. 1983. Interrelationships of wolves, prey, and man in interior Alaska. Wildl. Monogr. 84. 50pp.

_____, R. D. Boertje, D. V. Grangaard, D. G. Kelleyhouse, R. O. Stephenson, and D. G. Larsen. 1990. Factors limiting moose population growth in Subunit 20E. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Restor. Final Rep. Proj. W-22-3, W-22-4, W-22-5, W-22-6, W-23-1, W-23-2, and W-23-3. Juneau. 106pp.

Houston, D. B. 1968. The shiras moose in Jackson Hole, Wyoming. Grand Teton Natl. Hist. Assoc. Tech. Bull. No. 1. 110pp.

Larsen, D. G., D. A. Gauthier, and R. Markel. 1989. Causes and rate of moose mortality in the southwest Yukon. J. Wildl. Manage. 53:548-557.

Mech, L. D. 1973. Wolf numbers in the Superior National Forest of Minnesota. U.S. Dep. Agric. For. Serv., Res. Pap. NC-97, Northcent. For. Exp. Stn., St. Paul. 10pp.

Messier, F. 1988. Towards understanding the relationship between wolf predation and moose density in southwestern Quebec. Paper presented at the symposium on wolf-prey dynamics and management, May 10-11, 1988, Vancouver, British Columbia.

_____, and M. Crete. 1985. Moose-wolf dynamics and the natural regulation of moose populations. Oecologia (Berlin) 65:503-512.

National Oceanic and Atmospheric Administration. 1986. Climatological data annual summary, 1986. Vol. 72, No. 13. Natl. Climatic Data Center, Asheville, N.C. 33pp.

Peterson, R. O., J. D. Woolington, and T. N. Bailey. 1984. Wolves of the Kenai Peninsula, Alaska. Wildl. Monogr. 88. 52pp.

Reynolds, H. V. 1990. Population dynamics of a hunted grizzly bear population in the northcentral Alaska Range. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Restor. Prog. Rep. Proj. W-23-2. Juneau. 63pp.

Skogland, T. 1986. Density-dependent food limitation and maximal production in wild reindeer herds. J. Wildl. Manage. 50:314-319.

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

Valkenburg, P., and J. L. Davis. 1988. Status, movements, range use patterns, and limiting factors of the Fortymile Caribou Herd. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Restor. Prog. Rep. Proj. W-22-6. Juneau. 25pp.

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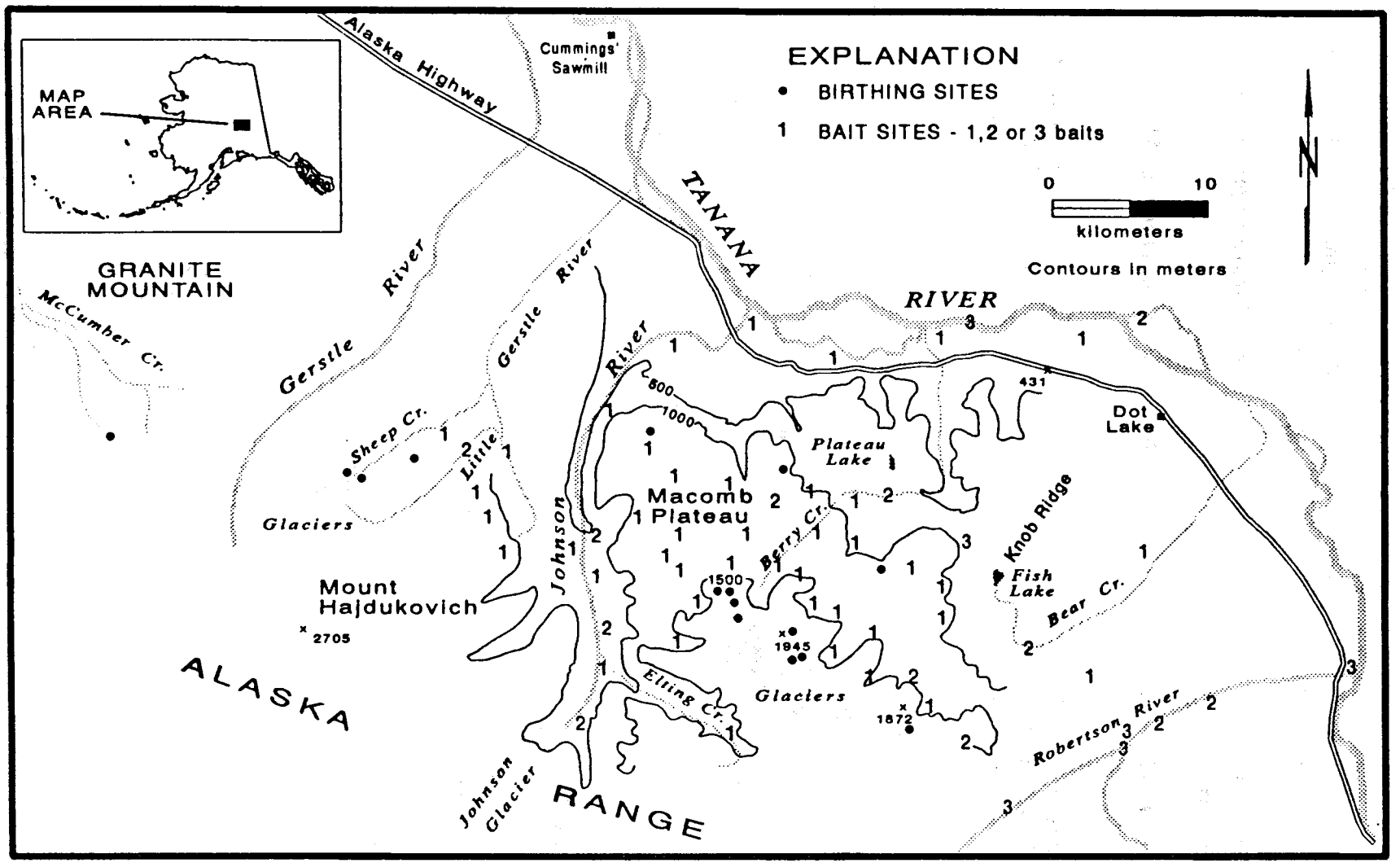

Figure 1. Birthing sites (.) of 15 adult radio-collared Macomb caribou and location of bait sites (1, 2, or 3 baits), eastcentral Alaska, May 1990. Bait sites (n = 87 baits, x = 300 kg).

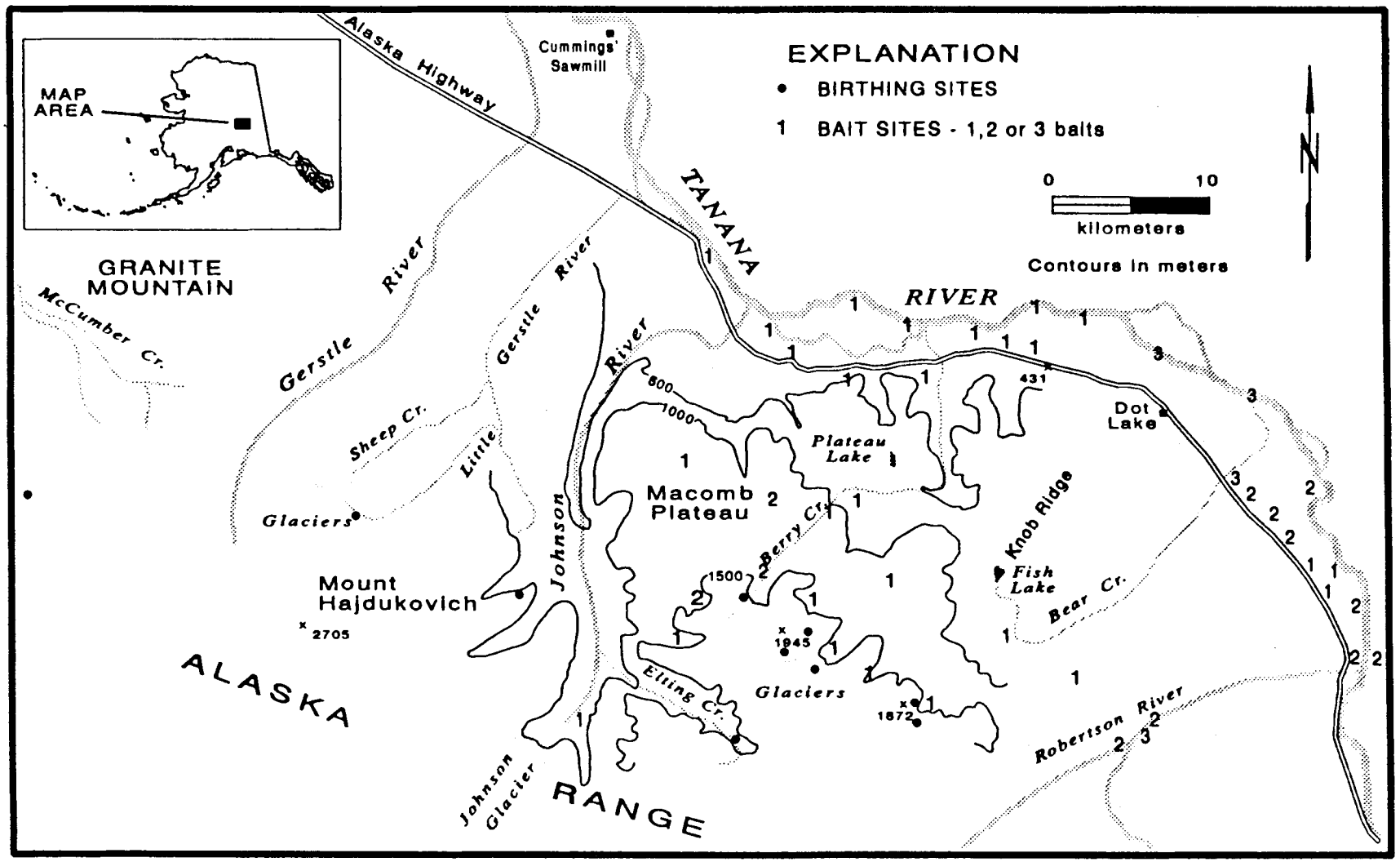

Figure 2. Birthing sites (.) of 10 adult radio-collared Macomb caribou and location of bait sites (1, 2, or 3 baits), eastcentral Alaska, May and June 1991. Bait sites (n = 43) were replenished up to 3 times at weekly intervals (n = 68 baits, x = 256 kg).

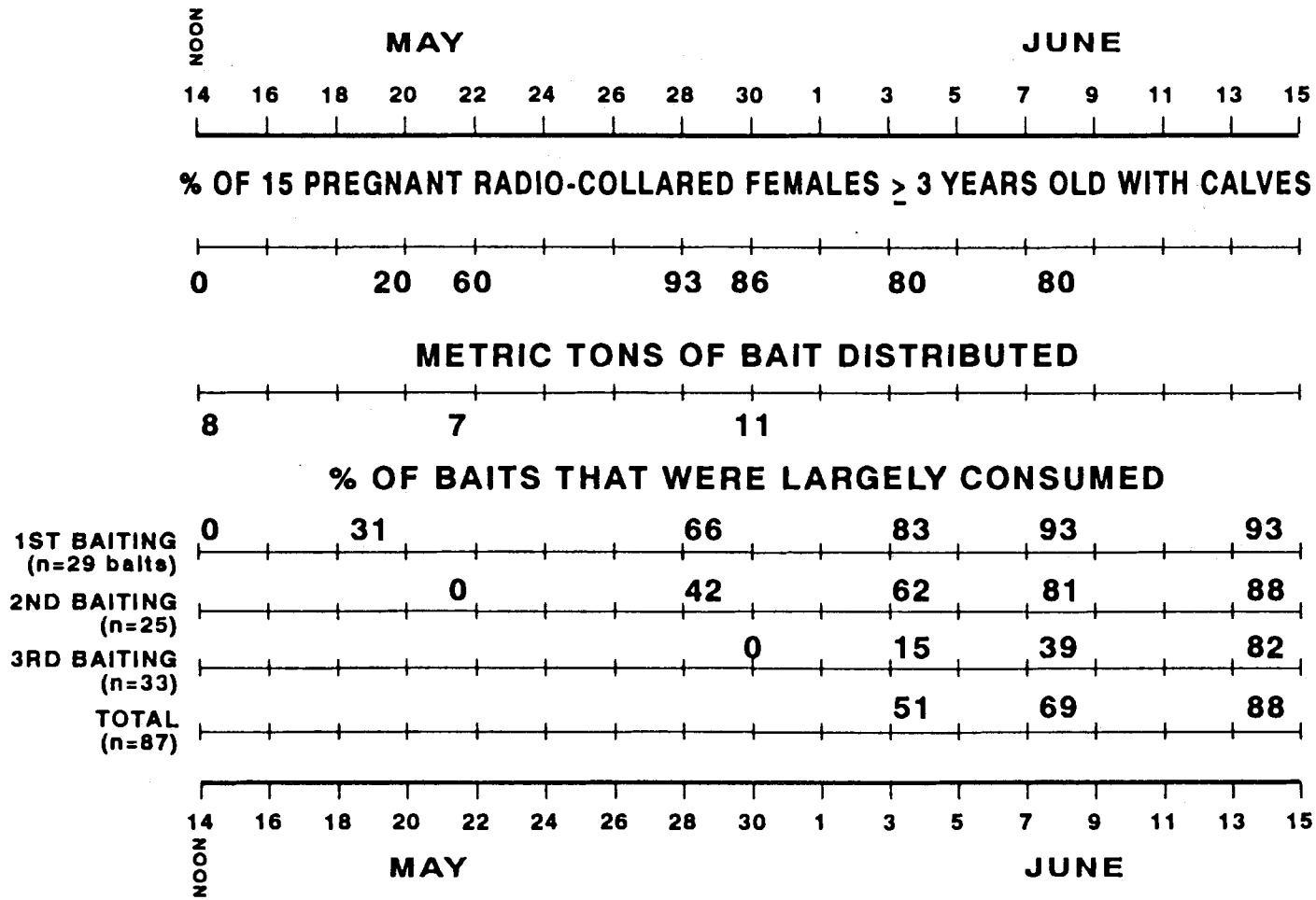

Figure 3. Chronology of caribou calving, calf survival of collared adults, baiting, and consumption of baits on and near the Macomb Plateau, eastcentral Alaska, 1990.

Table 1. Calves:100 cow moose ≥ years old in the treated, partially treated, and control survey areas during October or November, 1981-90, eastcentral Alaska. Dashes indicate no date were collected.

	Treated area		Partially treated area		Control areas			
	Knob Ridge		Robertson River		Central Creek		Subunit 20E East	
Year	Calves:100 females ≥ 2 yrs old	No. females ≥ 2 yrs old	Calves:100 females 2 yrs old	No. females ≥ 2 yrs old	Calves:100 females 2 yrs old	No. females ≥ 2 yrs old	Calves:100 females 2 yrs old	No. females ≥ 2 yrs old
Pretreatment								
1981	19	31	--	--	--	--	--	--
1982	19	51	16	43	--	--	--	--
1983	34	35	--	--	11	37	--	--
1984	31	64	14	49	12	52	--	--
1985	20	51	26	19	27	52	--	--
1986	12	75	28	78	--	--	17	133
1987	--	--	--	--	--	--	29	146
1988	29	79	48	71	13	90	23	144
1989	38	66	15	89	21	85	--	--
Treated								
1990	42	86	31	67	11	85	27	204

Table 2. Calves:100 cow caribou ≥ 1 year old in the Macomb, Delta, and Denali herds during September-November 1981-91, Alaska Range. Dashes indicate no data were collected.

	Treated herd		Control herds			
	Macomb		Delta		Denali	
	Calves: 100 cows	n	Calves: 100 cows	n	Calves: 100 cows	n
Pretreatment						
1981	33	445	41	1,451	--	--
1982	26	217	31	1,565	--	--
1983	24	238	46	1,208	--	--
1984	40	351	36	1,093	36	1,608
1985	31	518	36	1,164	28	1,205
1986	--	--	29	1,934	38	1,062
1987	--	--	31	1,682	37	1,221
1988	32	671	35	3,003	33	1,350
1989	34	617	36	1,965	30	1,504
Treated						
1990	17	734	17	2,411	17	1,307
1991	16[a]	319	20[a]	--	20[a]	--

[a] Data are from mid-June. Delta and Denali data were estimated from radio-collared caribou. October 1991 data were not collected before writing this report.

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