FEDERAL AID
RESEARCH FINAL PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

PROJECT TITLE: Effects of oil field development on calf production and survival in the Central Arctic Herd

PRINCIPAL INVESTIGATOR: Stephen M. Arthur and Patricia Del Vecchio

COOPERATORS: ConocoPhillips Alaska, Inc.; U.S. Bureau of Land Management; U.S. National Park Service; and U.S. Fish and Wildlife Service.

FEDERAL AID GRANT PROGRAM: Wildlife Restoration

GRANT AND SEGMENT NR: Initiated under W-27-5, completed under W-33-4

PROJECT NR: 3.46

WORK LOCATION: GMU 26A&B, North Slope of the Brooks Range

STATE: Alaska

PERIOD: 1 July 2001–30 June 2006

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

Beginning with development of the Meltwater prospect during 2001, the area of industrial activity within the range of the Central Arctic caribou herd (CAH) recently has been extended southward along the western side of an area that was used extensively for calving during the 1990s. Although the Meltwater project included a plan to mitigate disturbance to caribou, some displacement of caribou cows may occur during the calving and immediate postcalving periods. Other projects that are likely to occur may further extend development into the herd's intensive calving areas. In addition, exploration and extraction of oil in the range of the neighboring Teshekpuk caribou herd (TCH) has begun. Environmental permits for these and future developments will likely include stipulations for measures to reduce disturbance of caribou. These requirements will be based largely on studies of the CAH, although much remains to be learned about the effects of industrial development on this herd. Of particular importance are the needs to identify specific mechanisms through which disturbance might affect caribou population dynamics (e.g., by reducing body condition, reproductive success, and/or survival), and to evaluate the effectiveness of established mitigation measures.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

The CAH has been the subject of research aimed at assessing potential effects of industrial development since the herd was first identified during the 1970s (e.g., Cameron and Whitten 1979; Fancy 1983; Whitten and Cameron 1983*a*; Jakimchuk et al. 1987). This is largely because the calving and summer ranges of the CAH encompass the major oil fields near Prudhoe Bay and the lower reaches of the Kuparuk River on Alaska's Arctic coastal plain (Fig 1). Most research during the 1980s and 1990s focused on identifying effects of industrial infrastructure (pipelines, roads, drill pads, and related structures) and human activity on caribou movements, activity patterns, and calving distribution. Several studies suggested that during the calving season (late May–late June), pregnant caribou cows and those with newborn calves avoid areas of disturbance associated with oil exploration and extraction (Dau and Cameron 1986; Cameron et al. 1992; Nellemann and Cameron 1996). For example, during the 1990s, the area of greatest concentration of calving by the western segment of the CAH shifted southward as development of oil-related infrastructure occurred in what was originally a major calving area (Lawhead and Johnson 2000; Wolfe 2000). However, other studies indicated that caribou bulls and nonpregnant cows may tolerate some levels of oil field activity (Curatolo and Murphy 1986; Pollard et al. 1996), especially after the calving season (Cronin et al. 1998*a*). Furthermore, despite evidence of reduced reproductive success during some years (Cameron et al. 2005), the CAH increased from approximately 5000 caribou in 1975 (Whitten and Cameron 1983*b*) to almost 32,000 in 2002 (Lenart 2003). Because of the observed increase in herd size, Cronin et al. (1998*b*, 2000) questioned whether disturbance due to industrial activity had any significant population-level effects on the CAH.

Caribou herds throughout northern Alaska evidently were well below carrying capacity when studies of the CAH began during the late 1970s, and 3 of the 4 Arctic caribou herds showed dramatic increases in numbers during the 1980s and 1990s (Griffith et al. 2002). Thus, population-level effects of disturbance on the CAH may have been masked by the herd's responses to weather, range conditions, insect activity, or other environmental factors. The theoretical connections between effects of disturbance on individual caribou and potential effects on the population have been described (Cameron 1983; Murphy and Curatolo 1987; Murphy et al. 2000, Cameron et al. 2005), and some effects of disturbance may be evident only when combined with other adverse environmental influences (National Research Council 2003). Thus, despite the increase shown by the CAH during the period of oil field development, continuing concerns about effects of anthropogenic disturbance on caribou populations have led to the establishment of mitigation measures to be included in oil field development plans (Cronin et al. 1994) and the exclusion of some areas from petroleum development (U.S. Bureau of Land Management 1998).

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: Estimate annual pregnancy and birth rates of caribou cows.

Pregnancy and birth rates were assessed by locating radiocollared cows annually during early June 2001–2006. Annual parturition rates were 91% (2001, $n = 35$), 87% (2002, $n = 54$), 96% (2003, $n = 54$), 89% (2004, $n = 77$), 85% (2005, $n = 34$), and 96% (2006, $n = 54$).

OBJECTIVE 2: Estimate survival of female calves to yearling age class and determine causes of mortality.

Calves were captured and radiocollared annually during June 2001–2006. Calves were monitored at approximately 2-week intervals during June–September, then located again in March and June of the following years to estimate survival rates. Perinatal survival rates (birth–15 Jun) ranged from 0.81–1.0 and 0.89–1.0, respectively, for calves from the eastern and western calving areas (Fig 3). Survival of calves during summer (16 Jun–6 Sep) ranged from 0.83–0.97 for eastern calves and from 0.77–0.97 for western calves (Fig 4). Winter survival rates (7 Sep–31 May) ranged from 0.64–0.95 (eastern calves) and 0.46–0.90 (western calves; Fig 5). Annual post-calving survival rates (16 Jun–31 May) ranged from 0.53–0.82 (eastern calves) and from 0.38–0.87 (western calves; Fig 6). Survival rates did not differ significantly ($P > 0.21$) between calving areas except for the June–September 2004 interval (eastern: 0.97, western: 0.77; $z = 2.45$; $P = 0.004$).

OBJECTIVE 3: Estimate rates of growth and weight gain by calves during summer.

Radiocollared calves were captured, weighed, and measured during June, September, and March of each year to assess growth rates. Data are provided in the project interim technical report.

OBJECTIVE 4: Assess changes in location, physiography, and vegetation of calving sites among years.

Location and vegetation types were recorded and photographed at initial capture sites of calves. These data will be analyzed to detect changes in location and habitat use that may occur over time.

OBJECTIVE 5: Monitor movements of caribou to determine winter and summer distributions.

Radiocollared calves were located at 2-week intervals during June–September. In addition, radiocollared cows were located during late February and early March 2002–2006 to record winter concentration areas. Detailed information is provided in the project interim technical report.

OBJECTIVE 6: Estimate size of the herd at 2–year intervals using a complete aerial photocensus.

An aerial photocensus was conducted during July 2002. The herd was estimated at 31,857 caribou.

IV. MANAGEMENT IMPLICATIONS

Concerns about displacement of caribou from preferred ranges during the calving period are based on the assumption that physical characteristics of areas used for calving have some influence on caribou reproductive success. Specifically, quality of habitat used during the first few weeks after calving might affect the rate at which a calf grows and gains body mass and the ability of the calf's mother to provide nutrition for her calf, maintain or improve her own body condition, and prepare for her next pregnancy (Cameron et al. 1993; Créte and Huot 1993). Also, exclusion from preferred calving areas might increase exposure to predators, and thus reduce calf survival (Griffith et al. 2002). However, calf growth and survival rates also are influenced by habitat conditions, weather, insect activity, and perhaps other processes that occur after the calving period (White 1983). The relative importance of seasonal differences in habitat use and quality are unknown.

Previous studies have suggested that body condition of cows affects both birth rates and perinatal calf survival (Cameron et al. 1993, 2000, 2005; Cameron and Ver Hoef 1994; Gerhart et al. 1997). Furthermore, Wolf (2000) concluded that the western calving area of the CAH was lower-quality habitat than the eastern area. Although we did not assess body condition of cows, the differences we observed in birth mass and metatarsus length between calves from the 2 calving areas suggest that cows using the eastern area were in better condition than those that used the western area. Cows using the lower-quality calving range may have had reduced ability to replenish body reserves and prepare for a subsequent pregnancy, leading to lower pregnancy rates (Cameron et al 2005) and reduced fitness of calves that were produced. Smaller calves may also require a longer nursing period, increasing the energetic cost to the mother and further reducing her ability to prepare for her next pregnancy (Gerhart et al. 1997; Russell and White 2000). Distributions of caribou cows and calves using the 2 calving areas differed during the calving season, but overlapped extensively during the remainder of the summer and were identical during winter. Furthermore, cows showed a strong tendency to return to the calving area they used during the previous year. Thus, differences in habitats used during the calving season likely were at least partly responsible for the differences we observed in calf size at birth. These results suggest that quality of habitats used during the calving period may affect body condition of caribou mothers, which in turn may affect the ability of their calves to attain sufficient size and mass to survive their first winter. Thus, efforts to minimize displacement of caribou during the calving season should help reduce impacts of development within the range of the CAH.

The dramatic increase in population size shown by the CAH during the 1980s and 1990s also raises the possibility that density-dependent reduction of habitat quality may be important. If habitat conditions were limiting on winter ranges rather than on calving ranges, then density dependent effects should be equally evident among caribou using both calving areas. However, if calving habitat were to become scarce, demographic effects likely would first be evident in the western calving area, because some calving habitat there has been replaced by high-density industrial infrastructure. If the reduction in calf size we noted in the western area is primarily due to caribou density rather than the shift in calving distribution, then a similar reduction would be expected to occur in the near future on the eastern calving area, where high-quality habitat is presumably more abundant at present.

We did not find significant differences in survival rates between areas, despite the observed differences in calf size and the relationship between calf mass and survival. However, variances of our survival estimates were relatively large, especially during winter, when much of the mortality occurred and when effects of reduced body condition would likely be most important. Thus, these comparisons would be unable to detect small differences in survival rates, although among ungulates, such small differences in survival can have significant effects on population trends (Nelson and Peek 1984; Eberhardt 1985; Hern et al. 1990; Crête et al. 1996; Walsh et al. 1995; Arthur et al. 2003). Physical parameters, such as body condition, provide more sensitive measures with which to test for effects of disturbance and differences in habitat quality between areas or time periods.

V. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN FOR LAST SEGMENT PERIOD ONLY

JOB 1: <u>Estimate annual pregnancy and birth rates of caribou cows</u>.

Radiotracking surveys were conducted on 29 May–8 June 2006 to determine the proportion of cows that gave birth and the distribution of cows during the calving period. Sixty-one radiocollared adult (≥3 years old) cows, including those with both GPS and VHF radiocollars, were located during this period. Parturition rate was 71% for 3-year-old cows (n = 7) and 96% for older cows (n = 54).

JOB 2: <u>Estimate survival of female calves to yearling age class and determine causes of mortality</u>.

Sixty-eight neonatal calves were captured and radiocollared during 1–10 June 2005. Thirty-two calves were captured in the eastern and 36 in the western calving areas, including 22 calves (10 female, 12 male) of GPS-collared cows and 46 female calves of uncollared cows. Eight calves died between 1–10 June (5 from the eastern and 3 from the western calving areas) and 7 died between 16 June and 7 September (2 eastern and 5 western calves). An additional 13 calves died between September 2005 and June 2006 (5 eastern and 8 western calves). Kaplan–Meier estimates of calf survival from 16 June through 7 September were 0.92 (SD = 0.05), and 0.82 (SD = 0.07) for calves captured in the eastern and western areas, respectively. Survival until the age of 1 year was 0.43 (0.16) and 0.34 (0.08) for eastern and western calves. Thirty-two calves were captured during 1–8 June 2006 and will be monitored during FY07. These included 23 calves (9 female, 14 male) of GPS-collared cows, 1 female calf of a cow with a conventional (VHF) radio collar, and 10 female calves of uncollared cows. No calves were injured during captures; however, disturbance during capture may have contributed to some deaths that occurred within a few days following capture. These included 8 and 2 calves that died within a week of capture during June 2005 and 2006, respectively. Proximate causes of these deaths were predation, congenital defects, lack of care by the mother, and hypothermia/drowning in an ice-covered tundra pond.

JOB 3: <u>Estimate rates of growth and weight gain by calves during summer</u>.

Weights and metatarsus lengths were recorded for all calves captured in June, September, and March. Forty-six calves (36 female, 10 male) were captured by net gun during September 2005. Four cows and 27 calves (19 female, 8 male) were captured during March

2006. The cows were equipped with GPS collars. During the September captures, 1 calf suffered a broken leg and was euthanized, another died of a broken neck, and 1 collared cow that was not being captured was euthanized after it broke a leg while running from the helicopter. Two calves bit their tongues during capture, but both recovered. During the March 2006 captures, 1 previously uncollared cow was euthanized after suffering a broken leg during capture. Mean weights during early June 2005 for female calves from the eastern and western calving areas were 6.7 and 6.4 kg, respectively. Mean weight gain from June to September 2005 was 33.0 (eastern calves) and 32.0 kg (western calves). Mean weight gain from September 2005–March 2006 was 5.7 kg (eastern calves) and 4.1 kg (western calves). Mean metatarsus lengths during June 2005 were 26.5 (eastern calves) and 26.0 cm (western calves). Change in metatarsus lengths averaged 6.6 from June through September 2005 for calves from both areas and 2.3 (eastern calves) and 2.0 cm (western calves) from September 2005–March 2006. Mean weights of calves captured during June 2006 were 6.8 and 6.5 kg for eastern and western calves, respectively, and mean metatarsus lengths were 26.9 (eastern calves) and 26.1 cm (western calves).

JOB 4: Assess changes in location, physiography, and vegetation of calving sites among years.

Locations of captures during early June were assumed to indicate birth location, because captured calves exhibited physical and behavioral traits characteristic of newborn caribou (lack of coordination, small size, appearance of umbilicus, hooves, posture), and because caribou usually do not travel far during the first week following birth of calves. These locations were mapped and will be compared to similar data during each year of project 3.49 which continues this study. Vegetation at each site was classified and photographed for future, more detailed analysis.

JOB 5: Monitor movements of caribou to determine winter and summer distributions.

Radiocollared calves were located by aerial radiotracking at approximately 2-week intervals from June through September. Distributions of collared calves were recorded and mapped using fixed kernel utilization distribution models encompassing 50% and 99% of the utilization distributions. During July, August, and September, many calves from both calving areas moved east of the Dalton Highway and ranged across western portions of the Arctic National Wildlife Refuge as far east as the Hulahula River. However, caribou use of areas east of the Dalton Highway was not as extensive as during summer 2004. Data from GPS collars on caribou cows were used to document migration routes, and radiocollared cows and calves were located in March 2006 to document the herd's winter distribution. Fifty-four percent of the CAH wintered in the southern Brooks Range between the Middle and East Forks of the Chandalar River during 2005–2006, while the remainder wintered in the northern Brooks Range foothills between the Ribdon and Canning Rivers. The CAH winter range overlapped extensively with that of the Porcupine herd in the area around Arctic Village, Alaska.

JOB 6: Estimate size of the herd at 2–year intervals using a complete aerial photo census.

A photo census was planned for this period but was postponed because the herd did not form the dense aggregations needed to conduct the census. The photo census has been rescheduled for summer 2007 under project 3.49.

JOB 7: Analyze and publish results.

A preliminary anaysis of survival, weight, and metatarsus data through March 2006 was completed (see project interim technical report), and a presentation was prepared for the 2006 annual meeting of The Wildlife Society. A digital vegetation map of the study area was obtained and plans for habitat analyses are being finalized.

VI. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THE LAST SEGMENT PERIOD, IF NOT REPORTED PREVIOUSLY

During field work in March 2006, caribou fecal and urine samples were collected from sites of intensive caribou activity. These samples were provided to the University of Alaska–Fairbanks for use in a study of caribou nutrition and winter energy balance.

VII. PUBLICATIONS

None.

VIII. RESEARCH EVALUATION AND RECOMMENDATIONS

Because of other changes that occurred during the period of oil field development, it is not possible to determine whether the shift in calving distribution during the 1980s was a response to development or an effect of the increase in herd size or some other cause. Thus, the differences we noted between calves from the 2 calving areas do not necessarily imply effects of industrial activity. However, our results suggest that there is sufficient variability in habitat quality across the coastal plain to affect calf size, which may in turn affect calf recruitment. If further increases in levels of anthropogenic disturbance cause caribou to reduce their use of preferred habitats, it should be possible to detect effects of these changes by measuring birth weights and growth rates of calves. If similar changes do not occur in less-disturbed areas, then this may be taken as evidence of possible effects of disturbance.

IX. PROJECT COSTS FROM LAST SEGMENT PERIOD ONLY

FEDERAL AID SHARE $87,452 + STATE SHARE $29,151 = TOTAL $116,603

Additional project support was provided by the U.S. Bureau of Land Management ($97,100), U.S. Fish and Wildlife Service ($2,000), and National Park Service ($7,500).

X. APPENDIX

XI. PREPARED BY:

Stephen M. Arthur
Wildlife Biologist III

Patricia Del Vecchio
Wildlife Technician IV

SUBMITTED BY:

Mark E. McNay
Research Coordinator

Laura A. McCarthy
Publications Technician II

APPROVED BY:

Thomas W. Paul, Federal Aid Coordinator
Division of Wildlife Conservation

Matthew H. Robus, Director
Division of Wildlife Conservation

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