ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
Wildlife Restoration Grant

GRANT NUMBER: W-33-8

PROJECT NUMBER: 1.65

PROJECT TITLE: Age-specific natural mortality rates of male vs. female moose

PROJECT DURATION: 1 July 2006–30 June 2011

REPORT PERIOD: 1 July 2009–30 June 2010

REPORT DUE TO HQ: 1 September 2010

PRINCIPAL INVESTIGATOR: Rodney D. Boertje

WORK LOCATION: Game Management Unit 20A

COOPERATORS: Layne G. Adams (U.S. Geological Survey) and Brad Griffith (University of Alaska Fairbanks)

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

No prior data existed on age-specific survival rates of adult male moose (*Alces alces*). Our previous studies documented that female moose annual survival rates were near 100% in the 2- to 6-year-old age classes (Boertje et al. 2009). Managers wanted to know whether medium-antlered males (mostly 2–6 years old) had similar high survival rates (e.g., ≥98% excluding harvest by hunters). This has important management implications because in areas of Alaska with relatively high hunter access or hunter density, hunters are usually restricted to hunting mostly large-antlered males to maintain minimum acceptable male:female ratios. If males aged 2–6 years old had low survival rates because of predation or other non-human causes, then hunters would be foregoing substantial hunting opportunity because relatively few males would reach the large-antlered, older age classes. One might hypothesize that older males had lower survival rates than females, because yearling males had lower survival rates than yearling females in our 2000–2005 study.

The Unit 20A moose population is among the highest density moose populations for any 5000-mi^2 area on the continent. The moose population began a strong increase to high densities simultaneous to the Alaska Department of Fish and Game's (ADF&G) wolf control activities during 1976–1982 and has maintained a high density in the presence of lightly-harvested wolf (*Canis lupus*), black bear (*Ursus Americanus*), and grizzly bear (*Ursus arctos*) populations (Boertje et al. 1996). In contrast, Gasaway et al. (1992) concluded that moose populations in much of inland Alaska are maintained at a low-density dynamic equilibrium largely resulting from combined predation by lightly-harvested grizzly bears, black bears, and wolves. Maintaining moose in Unit 20A above this common low-density dynamic equilibrium would be a significant wildlife management achievement. For example, elevated consumptive and nonconsumptive uses of moose would be ensured without repeated intensive predator control programs. We are documenting birth and death rates to 1) determine when and why moose population fluctuations are occurring in this high-density population, and 2) to, ultimately, continue convincing citizen advisory committees to allow liberal harvests of female moose, as necessary to limit moose population growth. In addition, we have the opportunity to investigate reproductive senescence among the oldest known-age female moose (≥15 years of age).

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

We published models of moose population dynamics using earlier data on moose births and deaths (Boertje et al. 2009). However, we can refine these models with data on birth rates of older females and survival rates of males. Layne Adams (USGS, Denali National Park) and Mark Keech (ADF&G, McGrath) collected comparative data on age-specific birth rates of well-nourished female moose, whereas moose in Unit 20A have a relatively low nutritional status (Boertje et al. 2007).

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

We previously radiocollared approximately 35 short-yearling female moose in each of 6 cohorts (1996–2001) to monitor survival rates. Likewise, we previously radiocollared approximately 25 male short-yearlings in each of 5 cohorts (2003–2007) to monitor survival rates. We replaced radio collars, before the batteries expired, to allow monitoring over the entire expected life-span of a moose.

Study through FY11 or, with an extension, through FY12 will allow a comparison of whether males, like females, have high annual survival rates from age 2 to age 7. As of August 2010, male and female moose aged 2–5 years old had similar high survival rates, excluding hunter-related mortalities. Our oldest male cohort is now 7 years of age (n = 7) as of August 2010. We expect few males to survive to age 9, in part because of high harvest rates of older males. In contrast, our oldest known-age females are 14 years of age, and we expect these to succumb by age 18, based on moose ages from sectioned teeth.

In addition, we used radiocollared moose to estimate causes of mortality and birth rates. We regularly radiotracked moose and we examined death sites to evaluate causes of death. We used these data in basic modeling exercises to evaluate numbers of moose added to the population each May and numbers of moose dying from various causes during the following 12 months. These data allowed us to explain to the public why moose population fluctuations were occurring, which was essential to convince skeptical advisory committees to approve liberal harvests to halt further growth of this high-density moose population.

IV. MANAGEMENT IMPLICATIONS

Moose birth rates in our study area remain among the lowest measured on the continent. Also, moose numbers remain well above the population objective. As a result, we are continuing to encourage liberal harvests of female moose to keep the moose population from increasing. Advisory groups remain skeptical of approving female moose harvest, so continued studies of moose birth and death rates is integral to the process of encouraging liberal harvests.

In recent years, ADF&G issued a limited number of any-male permits to allow increased harvest of males while monitoring the male:female ratio. It appears hunters are now taking maximum numbers of male moose from the study area. Any additional harvest of male moose will lead to a decrease in the male:female ratio below the objective of 30 males:100 females posthunt. Our work to date shows that hunters are largely responsible for deaths among males 2–5 years of age. Relatively few males 2–5 years of age were killed by predators or succumbed from nonhuman causes. Continued work will determine if hunters are the chief cause of death for male moose >5 years of age or whether other sources of mortality become important. Also, further work will determine the maximum typical life span of known-age male moose in Unit 20A.

V. SUMMARY OF WORK COMPLETED ON JOBS FOR LAST SEGMENT PERIOD ONLY

JOB/ACTIVITY 1: Literature review
Accomplishments: We continued weekly literature reviews using web-based search engines through ARLIS.

JOB/ACTIVITY 2: Estimate reproductive/condition parameters
Accomplishments: We documented the birth rate among 60 female moose aged 6–14 years old by radiotracking individuals on alternate days during 11 May through mid-June. We observed a 65% birth rate and a 5% twinning rate. These are among the lowest values observed since these studies began in 1996. We need additional data to determine if birth rates of female moose ≥15 years of age (n = 18 moose with ages from tooth sectioning) is lower than in other cohorts ≥4 years of age. Moose reached sexual maturity at 4 years of age in this population.

JOB/ACTIVITY 3: Assess causes and rate of mortality of moose
Accomplishments: We continued collecting mortality data at least bimonthly during summer and monthly during winter. Excluding mortality from human causes, moose survival rates remained high for 2-year-old males (97%, n = 97), 3-year-old males (99%, n = 87), 4-year-old males (98%, n = 65), and 5-year-old males (100%, n = 41). We have insufficient data to determine the age at which these rates begin to decline. Causes of death among 43 radiocollared male moose ≥2 years of age were as follows: hunters killed 37 (86%), wolves killed 3 (7%), a grizzly bear killed 1 (2%), and disease or malnutrition killed 2 (5%).

JOB/ACTIVITY 4: Write reports and publications
Accomplishments: We completed the third peer-reviewed journal article based on data from this and related projects. We foresee at least 3 additional topics worthy of publication, when data sets are complete: 1) male versus female mortality rates, 2) age-specific reproductive rates of moose

with low nutritional status, and 3) accuracy of aging moose based on cementum annuli in canines and incisors.

VI. PUBLICATIONS

BOERTJE, R. D., M. A. KEECH, AND T. F. PARAGI. 2010. Science and values influencing predator control for Alaska moose management. Journal of Wildlife Management 74:917–928.

Literature Cited:

BOERTJE, R. D., M. A. KEECH, D. D. YOUNG, K. A. KELLIE, AND C. T. SEATON. 2009. Managing for elevated yield of moose in Interior Alaska. Journal of Wildlife Management 73:314–327.

BOERTJE, R. D., K. A. KELLIE, C. T. SEATON, M. A. KEECH, D. D. YOUNG, B. W. DALE, L. G. ADAMS, AND A. R. ADERMAN. 2007. Ranking Alaska moose nutrition: Signals to begin liberal anterless harvests. Journal of Wildlife Management 71:1494–1506.

BOERTJE, R. D., P. VALKENBURG, AND M. E. MCNAY. 1996. Increases in moose, caribou, and wolves following wolf control in Alaska. Journal of Wildlife Management 60:474–489.

GASAWAY, W. C., R. D. BOERTJE, D. V. GRANGAARD, D. G. KELLEYHOUSE, R. O. STEPHENSON, AND D. G. LARSEN. 1992. The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. Wildlife Monographs 120.

VII. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THIS SEGMENT PERIOD

We collected known-age teeth from moose carcasses and sent these to Matson's Laboratory to evaluate accuracy rate of counting cementum annuli. We published results of preliminary data in Boertje et al. (2009), but no moose teeth > 9 years of age were available during the preliminary analysis.

VIII. RECOMMENDATIONS FOR THIS PROJECT

Continue documenting mortality rates and causes of mortality among male moose until sample sizes diminish to <10. Continue documenting similar mortality data among females, as well as birth rates until sample sizes diminish to <10. As of 2 August 2010, 58 females (8–14 years of age) and 47 males (3–7 years of age) were radiocollared in Unit 20A as part of this study. All 105 collared moose have known-ages. We are not collaring new moose, but we continue to replace aging collars as needed to maintain battery power. All moose will have collars appropriate for prime-age adults by April 2011.

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Date: 2 August 2010