Alaska Department of Fish and Game
Division of Wildlife Conservation
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Age-specific natural mortality rates of male vs. female moose

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Research Annual Performance Report
1 July 2007–30 June 2008
Federal Aid in Wildlife Restoration
W-33-6
Study 1.65

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ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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PROJECT TITLE: Age-specific natural mortality rates of male vs. female moose

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COOPERATORS: Layne G. Adams (USGS) and Brad Griffith (University of Alaska Fairbanks)

FEDERAL AID GRANT PROGRAM: Wildlife Restoration

GRANT AND SEGMENT NO. W-33-6

PROJECT NO. 1.65

WORK LOCATION: Game Management Unit 20A

STATE: Alaska

PERIOD: 1 July 2007 – 30 June 2008

I. PROGRESS ON PROJECT OBJECTIVES SINCE PROJECT INCEPTION

OBJECTIVE 1: Continue literature review on (1) moose biology and ecology at high densities; (2) indices to nutritional status of ungulates; (3) models of ungulate population dynamics; (4) predator–prey ratios in relation to population dynamics of moose, caribou, sheep, wolves, and grizzly bears; (5) predator–prey relationships in multi-prey, multi-predator systems; and (6) population and harvest data on moose, caribou, sheep, wolves, and bears in Unit 20A.

We reviewed weekly citations from the ISI Web of Knowledge website through an Internet subscription with Thomson Scientific, Inc.

OBJECTIVE 2: Estimate causes and age-specific rates of mortality among radiocollared male and female moose in Unit 20A. These data are expected to be useful in determining whether male moose have high survival rates in the 2- through 6-year age-classes as documented among females. These data will also be useful in evaluating when and why changes occur in population density.

Results were accepted for publication during this reporting period (Boertje et al. 2008). Calves had the highest annual mortality rates (49%), followed by male yearlings (28%), and female yearlings (17%). Male and female moose 2–5 years of age had minimal annual mortality rates (0–3%). Older females had moderate annual mortality rates of 4–5% among 6- to 8-year-old females and 7–14% among 9- to 12-year-old females. Based on a precalving modeled population of about 12,500 moose, we estimated numbers of moose that died annually during 1996–2004 when the moose population was increasing. Hunters, grizzly bears, and black bears each killed about 800 moose annually. In contrast, wolves killed about 1800 moose annually. Disease, malnutrition, and accidents accounted for about 500 total deaths annually. Most predator-killed moose (75%) were calves.

OBJECTIVE 3: Continue to estimate and evaluate the usefulness of several reproductive and condition indices for moose in Unit 20A. In particular we need to complete age-specific reproductive rates for moose older than 9 years old and evaluate whether male and female short-yearlings have similar masses. These data will also be useful in determining when and why changes occur in population density.

We published data from 1996–2007 (Boertje et al. 2007, 2008). We visually examined known-age radiocollared female moose during 11 May–mid June each year to determine the presence of a calf or calves. Individual moose were located at 24- or 48-hour intervals until about 6 May and less frequently until mid May. Annual parturition rates averaged 30% among 3 year olds (n = 5 years). Cows did not twin until 5 years of age. Cows aged 4, 5, and ≥14 years of age produced fewer calves than moose 6–13 years of age. Age classes ≥48 months of age (n = 11 age classes) produced an average of 84 calves/100 cows annually during 1996–2007. Cows ≥36 months of age produced a weighted average of 75 calves/100 cows annually based on age-specific production rates of radiocollared cows and proportions of age classes in the population. Our total sample sizes remain low (≤25) for moose in age classes ≥13 years old. Data continue to indicate that moose are nutritionally stressed relative to all other wild, non-insular moose populations in North America, but less stressed than the island moose populations on Newfoundland and several penned moose populations (Boertje et al. 2007).

During this 12-year study of weights in early March, 135 males and 224 females each averaged 165 kg. We weighed 24–29 male short-yearlings during 2–4 March 2007 and 2008 to compare weights among study areas and to examine sexual and annual differences (Boertje et al. 2007). We also weighed 25 female calves and 23 male calves during 10–14 October 2006. Male calves were noticeably heavier than females in October, but differences were minimal among surviving individuals reweighed during 12–15 March 2007.

OBJECTIVE 4: Review literature, write annual progress reports, write final project report, and publish results in peer-reviewed journals.

To date, we have written 2 of 5 annual reports due on this project. The fifth and final report is due 1 September 2011. We published 2 papers recently and the citations are listed below. We collected data for these papers during 1996–2007, so data were primarily from earlier contiguous projects 1.51 and 1.57 in the study area.

II. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN THIS PERIOD

JOB/ACTIVITY 1A: Continue literature review.

I routinely reviewed new abstracts using a weekly Thomson Internet bibliographic service (ISI Discovery Agent). Desired references were retrieved through ARLIS or the UAF library. I estimated that 25 person-days were spent on this job during this reporting period.

JOB/ACTIVITY 2A: Continue to estimate and evaluate the usefulness of several reproductive and condition indices for moose in Unit 20A.

We captured 63 moose during this reporting period (29 male short-yearlings and 34 adult recaptures to renew collars). No capture-related deaths occurred. We radiotracked all moose (n = 150–170) at least monthly in winter and 2 or 3 times monthly in summer with fixed-wing aircraft. We deployed a helicopter to recover collars and to investigate causes of death. All data were entered into age-specific, sex-specific, and summary Excel spreadsheets using Kaplan-Meier staggered-entry design for mortality studies. No unusual mortality occurred during this reporting period. We combined annual data to characterize causes and rates of mortality data among years and to increase sample sizes. Adequate sample sizes (n = >25) now exist through the age of 12 years for females and 4 years for males. The oldest radiocollared female was 17 years old and the oldest male was 8 years old.

JOB/ACTIVITY 3A: Determine birth and twinning rates of known-age moose, particularly those older than 9 years old to complete data through the age of 14.
Blood samples indicated a pregnancy rate of 93% from 29 recaptured adult females that were ≥5 years of age in March 2008. Aerial observations of 71 adult cows ≥6 years of age in May 2008 indicated a parturition rate of 90%. Twinning rate was 10% (n = 63) during late May transect surveys of all females (no telemetry). Twinning rate was 9% based on observations (48-hr intervals from mid May through mid Jun) of 64 parturient radioed females ≥6 years of age.

JOB/ACTIVITY 3B: Weigh male short-yearlings to determine if male weights are significantly different than previously-collected female weights.

We weighed 29 male short-yearlings that averaged 169 kg in early March 2008. This was the third highest average weight since weighing began in 1997. A causative factor may be the relatively favorable winter that lessened weight loss. An improved growing season, partly related to the large 2001 burn in the study area, could also increase bodyweights.

JOB/ACTIVITY 4A: Review literature, write annual progress reports, write final project report, and publish results in peer-reviewed journals.

This report is the second of 5 annual reports due on this project. We wrote and submitted one paper during this reporting period and the citation is listed below. We currently envision 4 future papers using data from this and past study plans. Preliminary titles include:

(1) Comparative mortality rates of male versus female moose,
(2) Reproductive characteristics of nutritionally-stressed female moose,
(3) Bodyweights of short-yearling moose in a nutritionally-stressed population, and
(4) Accuracy of age estimation in moose from counting cementum annuli.

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

We developed a sightability correction factor for use in our Unit 20A population estimates (Boertje et al. 2008). This factor was based on whether radiocollared moose present in survey units were observed during early winter surveys.

We collected known-age teeth from carcasses and sent these to Matson’s Laboratory to evaluate the accuracy rate of counting cementum annuli (Boertje et al. 2008).

IV. PUBLICATIONS

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 antlerless harvests. *Journal of Wildlife Management* 71:1494–1506.

Boertje, R.D., M.A. Keech, D.D. Young, K.A. Kellie, and C.T. Seaton. 2008. Managing for elevated yield of Alaska moose and related moose demography. *Journal of Wildlife Management* 72: in press.

V. RECOMMENDATIONS FOR THIS PROJECT

As recommended in 2003, we changed the emphasis from females to males when collaring short-yearlings. This allowed us to investigate age-specific natural mortality rates of males, as we continue to investigate these rates for older females. No Alaska data exists on predation rates of male moose older than calves, and area biologists have frequently requested this information to see if predation is very low, as documented for females in our previous work. If predation is low among 2- through 6-year-old males, then antler-restricted hunting seasons will not strongly lower the numbers of bull moose ≥2 years old available to hunters.

We used the large numbers of radioed moose in our study area to test the sightability of moose during 3 recent population estimates (early winter 2004–2006; Boertje et al. 2008). We recommended in past years that this work be expanded and a project was begun in FY08 under the direction of Kalin Kellie.

VI. APPENDIX

MANAGING FOR ELEVATED YIELD OF ALASKA MOOSE AND RELATED MOOSE DEMOGRAPHY. *Journal of Wildlife Management* 72: in press (2008)

RODNEY D. BOERTJE, MARK A. KEECH, DONALD D. YOUNG, KALIN A. KELLIE, AND C. TOM SEATON

Given recent actions to increase sustained yield of moose (*Alces alces*) in Alaska, we examined factors affecting yield and answered related management questions. Prior studies concluded that yield and density of moose remain low in much of Interior Alaska and Yukon, despite high moose reproductive rates, because of predation from lightly harvested grizzly (*Ursus arctos*) and black bear (*U. americanus*) and wolf (*Canis lupus*) populations. Our study area, Game Management Unit (GMU) 20A, was also in Interior Alaska, but we describe elevated yield and density of moose. Prior to our study, a wolf control program (1976–1982) helped reverse a decline in the moose population. Subsequent to 1975, moose numbers continued a 28-year, 7-fold increase through the initial 8 years of our study (λ_{B1} = 1.05 during 1996–2004, peak density = 1,299 moose/1,000 km^2). During these initial 8 hunting seasons, reported harvest was composed primarily of males ($\bar{x}$ = 88%). Total harvest averaged 5% of the prehunt population and 57 moose/1,000 km^2, the highest sustained harvest-density recorded in Interior Alaska for similar-sized areas. In contrast, sustained total harvests of <10 moose/1,000 km^2 existed among low-density, predator-limited moose populations in Interior Alaska (≤417 moose/1,000 km^2). During the final 3 years of our study (2004–2006), moose numbers declined (λ_{B2} = 0.96) as intended using liberal harvests of female and male moose ($\bar{x}$ = 47% males) that averaged 7% of the prehunt population and 97 moose/1,000 km^2. We intentionally reduced high densities in the central half of GMU 20A (up to 1,741 moose/1,000 km^2 in Nov) because moose were reproducing at the lowest rate measured among wild, non-insular North American populations. Calf survival was uniquely high in GMU 20A compared with 7 similar radiocollaring studies in Alaska and Yukon. Low predation was the proximate factor that allowed moose in GMU 20A to increase in density and sustain elevated yields. Bears killed only 9% of the modeled postcalving moose population annually in GMU 20A during 1996–2004, in contrast to 18–27% in 3 studies of low-density moose populations. Thus, outside GMU 20A, higher bear predation rates can create challenges for those desiring rapid increases in sustained yield of moose. Wolves killed 8–15% of the 4 postcalving moose populations annually (10% in GMU 20A), hunters killed 2–6%, and other factors killed 1–6%. Wolf predation remained largely additive at the high moose densities we studied in GMU 20A. Annually during the increase phase in GMU 20A, calf moose constituted 75% of the predator-killed moose, and predators killed 4 times more moose than hunters killed. Predation and low moose reproduction had similar limiting effects on the high-density moose population in GMU 20A. Despite these limiting factors, elevated harvest-density was sustained because of high moose density, a sustainable harvest of female moose, and consistent favorable weather.

RECOVERY OF LOW BULL:COW RATIOS OF MOOSE IN INTERIOR ALASKA.
ALCES. 44:65–71 (2008)

DONALD D. YOUNG JR. AND RODNEY D. BOERTJE

ABSTRACT: During 1996–1999, hunters killed an estimated 24–30% of the prehunt bull moose (*Alces alces*) in Game Management Unit 20A. As a result, the 1999 posthunt bull:cow ratios declined to 24:100, well below the management objective of 30:100. During 2000 and 2001 we shortened the hunting season from 25 to 20 days to reduce the kill of bull moose by hunters, but kill rates of bulls remained high (23–27%) and ratios remained unacceptably low (22–26 bulls:100 cows). Subsequently, to recover bull:cow ratios to 30:100, hunters were restricted unitwide to taking bulls with: (1) spike-fork antlers, (2) antlers ≥50 inches wide, or (3) ≥3 brow tines on ≥1 antler. These restrictions were in place from 2002 through 2007, but results occurred rapidly. After only 2 years of antler restrictions, hunters killed an average of 36% fewer bulls compared with the 2-year average kill prior to antler restrictions ($\bar{x}$ = 715 during 2000–2001 and 455 during 2002–2003). Comparing these same 2-year periods, average kill rates of bulls declined from 25% to 12% of the prehunt bull population, average number of hunters declined 24% (1,568 to 1,187), and average hunter success rates declined from 34% to 29%. Bull:cow ratios increased from 26:100 to 32:100 with 2 years of antler restrictions. With an additional 2 years (2004–2005) of antler restrictions and high harvests of cow moose, bull:cow ratios reached 38:100. Modeling indicated the bull:cow ratio would have stabilized at 33:100 without the high harvests of cows. The recovery of bull:cow ratios to our objective of 30:100 with 2 years of antler restrictions allowed (1) bull seasons to be lengthened from 20 to 25 days beginning in 2004 and (2) a limited number of drawing permits for any bull to be offered during 2006–2007. Elsewhere, similar selective harvest strategies should also allow recovery of bull:cow ratios, unless total kill rates of bulls is higher than estimated here.

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