Spring Black Bear Density and Moose Calving Distribution in the U.S. Army's Tanana Flats Training Area, Game Management Unit 20A, Interior Alaska

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ABSTRACT

During 2010, we estimated black bear (*Ursus americanus*) density, determined presence and distribution of grizzly bears (*Ursus arctos*) and mapped moose (*Alces alces gigas*) calving distribution in the Tanana Flats Training Area (TFTA) in Interior Alaska. This project was jointly funded by the U.S. Army and the Alaska Department of Fish and Game to guide land and wildlife management decisions. We deployed noninvasive genetic sampling to identify individual black and grizzly bears from hair samples collected from systematically distributed hair traps baited with lure and used spatially-explicit capture-recapture models to estimate population density. Remote camera traps were installed at 7 hair trap sites to evaluate capture rates of dependent cubs and yearlings as part of family groups The TFTA black bear density was 59 individuals ≥1-year-old/1,000 km^2 (SE = 7.3; 95% CI = 46–75 bears). Our sampling protocol was not adequate to obtain a density estimate for grizzly bears but we verified the presence of 10 individuals (9 males; 1 female) including 1 male/female/offspring triad indicating a small resident population. Black bear abundance across the TFTA varied with concentration areas along portions of Salchaket Slough and Bear, McDonald, and Willow Creeks; grizzly bears were distributed throughout the study area. Our results compared to past research suggest that black bear numbers in the TFTA were stable during 1991–2010. We used daily aerial observation of radiocollared female moose to document calving sites. We documented 138 calving sites for 90 adult moose in the TFTA from 2010 to 2012. Moose calving began after 9 May and ended by 13 June with peak calving occurring 21–25 May. Within the TFTA, the majority of radiocollared moose calved between the Wood River Buttes and Blair Hills, and none calved east of Blair Hills. The spatial relationship between black bear distribution and moose calving sites had not been analyzed for this report but may not be directly comparable because black bear trapping did not begin until the end of calving season.

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INTRODUCTION

During 2010, the U.S. Army and the Alaska Department of Fish and Game (ADF&G) jointly funded and designed a study evaluating black bear (*Ursus americanus*) population size and distribution and identifying the presence and distribution of grizzly (*Ursus arctos*) bears in the Tanana Flats Training Area (TFTA) in Game Management Unit (GMU) 20A in Interior Alaska. The Army needed current bear population abundance and distribution estimates to better plan military training exercises and to meet the data requirements of the Integrated Natural Resource Management and the Integrated Cultural Resource Management Plans. In 2011, the agreement was revised to include the documentation of moose (*Alces alces gigas*) calving areas within the TFTA and examination of the spatial relationship of calving areas to black bear distribution. For ADF&G, monitoring black bear densities and distribution in the Tanana Flats is an important component of an ongoing intensive management program in GMU 20A. Black bears have been found to be the principal predator on calf moose in other areas of Interior Alaska (Osborne et al. 1991, Bertram and Vivion 2002, Boertje et al. 2009, Keech et al. 2011). Black bear population data are also necessary for area managers to evaluate ongoing black bear hunting season and bag limit regulations in GMU 20A. ADF&G is also monitoring calving of radiocollared moose to investigate the impact of nutritional limitation on age-specific reproduction (Boertje et al. 2007, 2009).

BEAR ABUNDANCE AND DISTRIBUTION

During 1988–1991, Hechtel (1991) estimated the black bear density in the Tanana Flats including portions of the TFTA to be 46–67 bears ≥1-year-old/1,000 km^2 based primarily on home range size and range juxtaposition of 25 radiocollared black bears. Because not all bears in the study area were radiocollared, Hechtel (1991:11) made subjective adjustments to the density estimate to include bears not radiocollared and recommended the estimate should be further refined once better population estimate techniques were available. Grizzly bears were known to frequent the TFTA but limited data precluded determining if there was a resident population or if the bears observed were primarily transient utilizing the area mostly during moose calving season (Reynolds and Boudreau 1992). Keech et al. (2000) described sources of neonate moose mortality in the Tanana Flats as part of a larger study evaluating life history characteristics of moose based on the effects of maternal condition of adult females. They found that predation mortality was evenly distributed between wolves (*Canis lupus*) and black and grizzly bears but at a lower overall rate compared to other areas in Interior Alaska and northern Canada.

Bear numbers are inherently difficult to estimate due to poor sightability, large movement patterns, and heterogeneous capture probabilities due to sex and age (Obbard et al. 2010). DNA mark-recapture methodology using hair traps (Woods et al. 1999) has been used to estimate bear abundance in forested habitats where aerial survey methods are not feasible (Dreher et al. 2007, Settlage et al. 2008, Tredick and Vaughan 2009, Coster et al. 2011). This method can provide rigorous bear population estimates if the sampling design takes into account capture heterogeneity within and between bear species. Because grizzly bears have much larger home ranges compared to black bears, we could not use the same sampling design for both species. We decided the best approach based on available funding and management needs was to obtain a black bear estimate and identify grizzly bear distribution and relatedness of individuals.

Boulanger et al. (2004) summarized how sample unit size, trap sites, and trapping period length relative to bear movement patterns and the lack of geographical closure can be accommodated for in a DNA-based mark-recapture population estimate study design to minimize capture heterogeneity bias and maximize precision. Black bear movement data (Hechtel 1991) indicated no geographical closure existed along the south and west boundaries of the TFTA and that there were heterogeneous capture probabilities between male and female bears. To account for closure violations and heterogeneous capture probabilities, we used spatial capture-recapture models that can overcome individual distribution and varying exposure to traps (Kendall et al. 2008, Efford et al. 2009, Gardner et al. 2010, Obbard et al. 2010).

We conducted the noninvasive DNA capture-recapture population estimate study using hair traps (Woods et al. 1999) in 2010 to obtain an unbiased and precise estimate of the density of black bears in the TFTA. Our study objectives were to estimate the density of black bears ≥1-year-old within ±25% at the 95% confidence level and to describe black bear distribution and presence of grizzly bears based on capture locations in traps.

Moose Calving Distribution

In early summer, moose calves are at their greatest risk of predation (Gasaway et al. 1983; Keech et al. 2000, 2011; Bertram and Vivion 2002; Poole et al. 2007). Likewise, maternal moose are also at peak aggression: first to distance themselves from their yearlings and then to defend both their calf and calving site for 7–8 days postpartum (Bogomolova and Kurochkin 2002). During this period, there is an increased risk of humans encountering aggressive female moose with young calves.

Areas used by moose in early summer are temporally and spatially predictable. Females exhibit high spatial fidelity to spring home range (Kellie 2005), and sometimes calve < 200 m from sites used in previous years (MacCracken et al. 1997, Testa et al. 2000, Bogomolova and Kurochkin 2002). Further, moose calving occurs over a short period adapted to synchronize with forage availability (Keech et al. 2000). Previous studies have documented high densities of moose calving in the TFTA (Gasaway et al. 1983, Kellie 2005, Boertje et al. 2007). Our study objectives were to document timing and distribution of calving on the TFTA, and to compare these areas with black bear densities estimated from the DNA capture-recapture study.

STUDY AREA

Our black bear trapping grid covered 981 km^2 of the Tanana Flats Training Area in GMU 20A in Interior Alaska (Fig. 1). This area included portions of the Tanana River and Bear, McDonald, Clear, and Willow Creek drainages. Spring moose locations were obtained throughout the Tanana Flats Training Area. Topography, habitat, and climate found in the Tanana Flats Training Area in Interior Alaska has been described in Hechtel (1991), Gasaway et al. 1983, and Keech et al. (2000).

METHODS

BLACK BEAR

Field Sampling

In general, we followed the DNA-based mark-recapture methods described by Woods et al. (1999) to estimate black bear abundance and distribution. We designed our sampling protocol using simulations based on results of previous studies conducted in Canada and southeastern United States (Dreher et al. 2007; Settlage et al. 2008; Tredick and Vaughan 2009; Coster et al. 2011; J. Boulanger, unpublished data, British Columbia, Canada) and seasonal movement data collected by Hechtel (1991) and Keech (ADF&G unpublished data, Fairbanks). Specifically, we subdivided the 981 km^2 study area into 157 2.5×2.5 km (6.25 km^2) systematically distributed sample units each (Fig. 1). We deployed 1 hair trap in black bear habitat as close to the center of each sample unit as possible and baited with liquid lure. We conducted 5 8-day sampling periods during10 June–27 July 2010. Sampling was initiated concurrent with increased movement patterns by females with cubs (M. Keech, personal communication). Due to the small size of the study area and sample units (described below) relative to brown bear home range sizes and movement patterns (Reynolds and Hechtel 1988, Reynolds and Boudreau 1992), we were not be able to estimate the brown bear population but identified presence, gender, and relatedness of individuals that use the area.

Hair traps consisted of a single strand of 4-pronged barbed wire set 48–50-cm above ground around 3–6 trees to form an enclosure with a perimeter of 22–30 m. Three liters of liquid lure consisting of rotted salmon (2 liters) and rotted cow blood were poured on moss in a mound of forest debris that was elevated ~0.3–1 m above ground. Lure was rotted over 11 months in 55 gallon barrels. We also hung a cloth soaked with lure 3–5 m high in a tree to aid scent dispersion. Hair traps were rebaited at the end of sample period but were not relocated. We also added a secondary lure at each trap site during sample periods 2 (skunk), 3 (fermented egg), 4 (blueberry oil), and 5 (butterscotch and anise oils) to maintain trap novelty.

At the end of the 8-day sample period, we visited each site by helicopter or boat and collected hair. We followed hair collection protocol outlined in Kendall et al. (2008). We discarded any hair samples that were obviously not bear hair. Hair samples were sent to an independent lab (Wildlife Genetics, International, Nelson, British Columbia, Canada) specializing in bear genetic samples.

Genetic Sampling

Hair sample storage, laboratory analysis and genotyping error checking techniques have been thoroughly described in Poole et al. (2001), Paetkau (2003), and Kendall et al. (2008, 2009). We analyzed all bear samples with ≥1 guard hair follicle or ≥3 underfur hairs because of a high proportion of samples with low number of hairs. For our study area, grizzly and black bears were differentiated using the G10J microsatellite (Mowat et al. 2005, Kendall et al. 2008). The 6 additional microsatellite loci (markers) used to determine black bear individuality were: G10M, G10B, G1D, G10U, MU50, and MU59. Gender was determined based on a size polymorphism in the amelogenin gene (Enis and Gallagher 1994). In addition to the tests performed by the laboratory to eliminate genotyping errors (Paetkau 2003), we also sent blind samples of known bears to assess laboratory performance.

Assessment of Capture Dependency

To evaluate the effects of dependent bears in family groups on population and variance estimates, we determined relationships between captured bears by extending the genotypes to 23–markers (including the gender marker) and by installing motion detecting wildlife cameras at 7 different trap sites. We used the software PARENTE (Cercueil et al. 2002)) to conduct the parentage analysis which uses allele frequencies, predicted error rates, mutation rates, and gender to assign a probability that for any pair of individuals they are parent and offspring. Since age cannot be determined through hair samples and there is a possibility that related bears no longer associated with each other are captured, we identified possible dependency by comparing the capture history of related bears by trap and session looking for related bears that were caught at the same traps during the same periods. We also viewed all photographs taken of bears at the trap sites to determine if cubs (<1-year-old) were contributing to the population estimate. From the photographs, we identified cubs and verified where they contacted the barbed wire. We then checked to see if we collected a hair sample from that barb and if the hair sample was individually identified. We also looked at multiple captures at traps by session by non-related bears to gain some insight on the possibility of dependence due to breeding behavior.

Analysis

Black bear density was estimated with maximum likelihood based spatially-explicit capture-recapture (SECR) models (Efford 2004, Borchers and Efford 2008, Efford et al. 2009, Borchers 2010). These models directly estimate density as the intensity of a spatial point process thus overcoming complications when calculating density related to animals with home ranges extending beyond the study area boundaries (i.e., determining the “effective trapping area”). The models were performed using Program R package “secr” version 2.3.1; 12/16/2011 (Efford 2011). A set of candidate models was developed and model selection was performed using AIC for small sample sizes (AICc; Sugiura 1978, Hurvich and Tsai 1989) and Akaike weights (Burnham and Anderson 2002).

The spatial distribution of black bears relative to moose calving areas is currently being analyzed. A possible caveat is that our bear sampling was conducted primarily after most moose calving occurred and may not be indicative of bear distribution during peak calving. These data will be included a future report. For this report, we mapped capture success by sample unit as an indication of black bear concentration areas.

MOOSE

This study used adult female moose (>2-years old) on the TFTA that were radiocollared by ADF&G for long-term research on age-specific reproduction and mortality (Boertje et al. 2007, 2009). Each spring, from 2009 to 2012, we began aerial observations of radiocollared moose on 10 May. Once located, we searched the surrounding area (>30 m^2) for a neonate. We monitored individual moose until they were first seen with a neonate and we recorded this location as the calving site. We terminated radiotracking flights each year after 2 successive flights where no new neonates were observed, usually around 15 June. We used a PA-18 airplane to conduct the flights and recorded locations in WGS84 datum using a Garmin® (Garmin Ltd., Olathe, Kansas) GPSMap 60CSx. Locations were downloaded from GPS units, combined with biological information (e.g., presence of a calf, moose ID, comments) and appended to a Microsoft® Access (Microsoft Corporation, Redmond, Washington) database. We used ArcMap

10 (ESRI, Redland, California) to display moose locations. Additional information on aerial observation of calving sites in GMU 20A can be found elsewhere (Keech et al. 2000, Kellie 2005, Boertje et al. 2007).

RESULTS

BEAR POPULATION

The 5 8-day hair trapping sessions yielded 1,867 hair samples of which 825 were from black bears and 71 from grizzly bears. The remaining samples were either identified as other species or lacked suitable material for genetic analysis. We collected black bear hair at 63% of the hair traps (Fig. 1).

The 825 black bear samples were genotyped to 81 individuals (28 M, 53 F and the 71 grizzly bear samples to 10 individuals (9 M, 1 F). We caught 2.2 (SD = 1.5; range 1–7) unique individual black bears per successful trap. We had the greatest success rate and caught the greatest number of individual black bears during session 5 (20–27 July) and the lowest capture rate and fewest bears during session 2 (18–25 June). We caught the 81 black bears 285 times including within period recaptures at different traps; 25 of these bears were caught once and the other 56 2–14 times. Based on capture locations, it appears that black bear abundance varied across the TFTA (Fig. 1) and that grizzly bears are present throughout (Fig. 2). Black bear concentration areas were the upper Salchaket Slough and segments of McDonald, Bear, and Willow Creeks.

Of the 81 black bears, we identified 11 mother-father-offspring triads. These 11 litters were sired by 3 males. We detected minimal bias due to black bear cubs (<1 year old) travelling with their mothers but are still evaluating possible effects due to breeding pairs. On 4 occasions, females with 1–2 cubs visited a trap with a camera. On no occasions did these cubs leave hair on the wire as all walked underneath; however we photographed 1 cub grabbing the wire with its mouth. There was 1 grizzly bear triad in the study area.

All blind samples were correctly identified to individual bear and gender. Since we did not detect any false individual identifications and because of the results of exhaustive error testing by the lab and by an outside examiner (Kendall et al. 2009), we did not include genotype error rates in our models.

The population estimate was 59 bears ≥1-year-old/1,000 km^2 (SE = 7.3; 95% CI = 46–75 bears) with relative precision at the 95% confidence level = 24.2%. The best model factored in differences in the probability of detection by occasion (period) and sex and included a terms for individual heterogeneity.

MOOSE CALVING

From 9 May to 15 June 2010–2012, we obtained 1,701 moose locations and found 138 calving sites for 90 adult female moose in the TFTA (Table 1). In 2010, all calving locations in the TFTA were between Wood River Buttes and the Blair Hills (Fig. 3). However, 3-year-old moose were added to the sample in 2011 and 2012, including some moose that calved west of Wood River Buttes (Figs. 4 and 5). The area east of Blair Hills in the TFTA contained very few moose locations and no calving sites during the calving seasons 2010–2012. The temporal peak of calving was 21–25 May (Fig. 6).

DISCUSSION AND RECOMMENDATIONS

BEARS

Our sampling methods were successful in obtaining a precise estimate of black bears ≥1-year-old on the TFTA (59 bears ≥1-year-old/1,000 km^2). Compared to other black bear population estimation using DNA-based mark-recapture studies across North America bear (Boulanger et al 2002), our results are in top 10% in terms of precision. Based on our density estimate and results from Hechtel (1991), the black bear population trend in the TFTA appears to be stable indicating that current black bear harvest and season regulations have not caused excessive mortality. Black bear densities in the TFTA are low compared to the upper Kuskokwim (89 bears ≥1 year-old/1,000 km^2; Keech et al., unpublished data) and the Yukon Flats (164 bears ≥1-year-old/1,000 km^2; Caikoski et al., ADF&G unpublished data, Fairbanks). The low density of black bears may explain the lower predation rates by black bears on moose in the Tanana Flats (Keech et al. 2000) relative to other areas in Interior and Southcentral Alaska and in Yukon, Canada, with higher densities of black bears (Boertje et al. 2009).

The precision of our results met our study objectives and are adequate for the Army to use to plan field training operations. Our data show that even though black bear and grizzly bear abundance is lower in the TFTA compared to other areas in Interior Alaska, black and grizzly bears can be found throughout the training area. Encounters with bears by Army personnel during ground exercises should be expected.

Recommendation

A bear safety class should be required prior to field exercises informing troops how to reduce bear encounters and how to react if an encounter occurs.

MOOSE

In early summer, resident moose in the TFTA are joined by migratory moose that winter in the surrounding hills, increasing local densities 2- to 4-fold (Gasaway et al. 1983). This high density, in combination with heightened aggression of maternal moose (Bogomolova and Kurochkin 2002), increase the risk of negative moose-human encounters. We provide both spatial and temporal boundaries for this high-risk period for use in planning field operations for the TFTA.

Recommendation

We recommend educating troops on the dangers of maternal moose if ground operations are scheduled for the area between Wood River Buttes and the Blair Hills from 10 May through 15 June.

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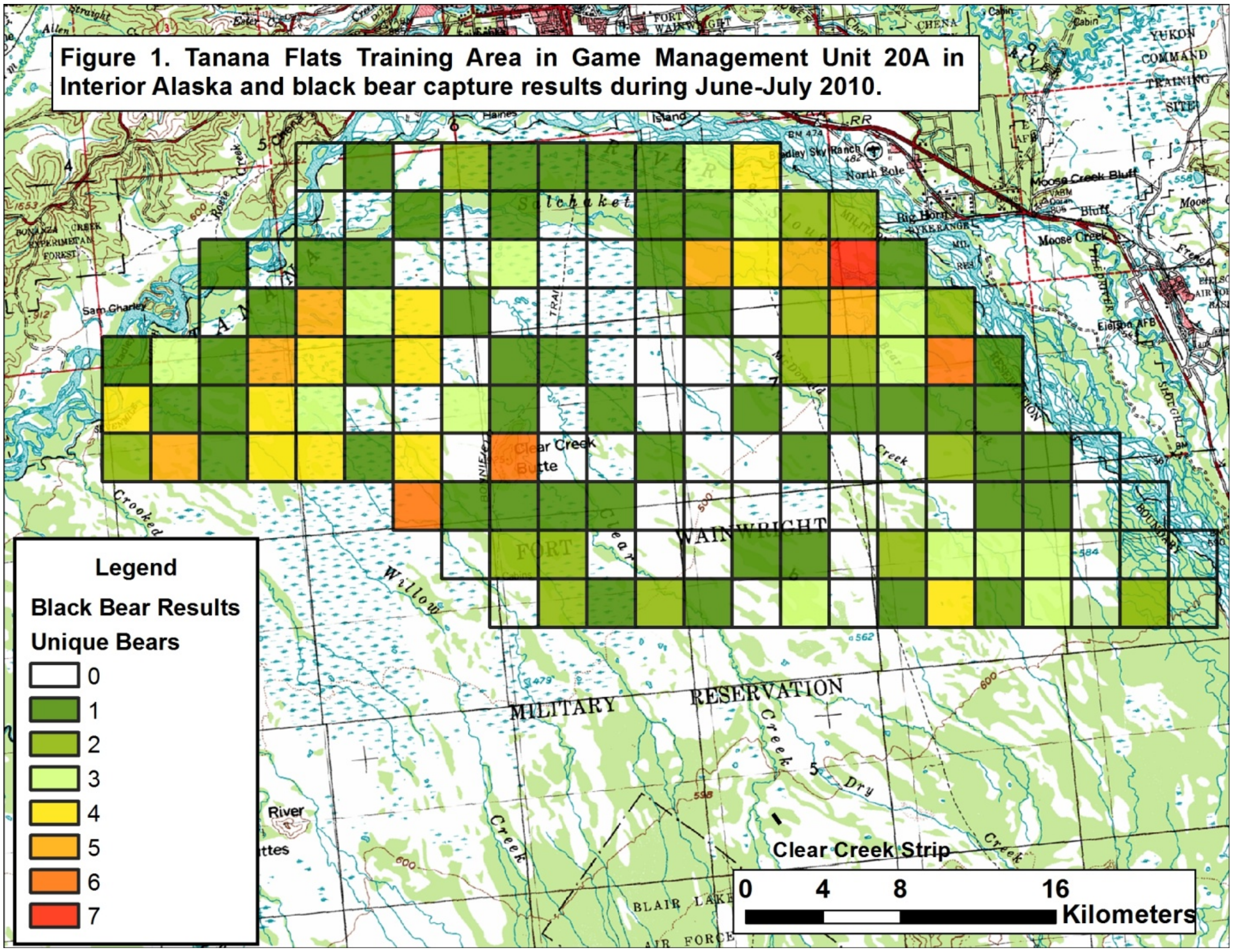

FIGURE 1. Tanana Flats Training Area in Game Management Unit 20A in Interior Alaska and black bear capture results during June–July 2010.

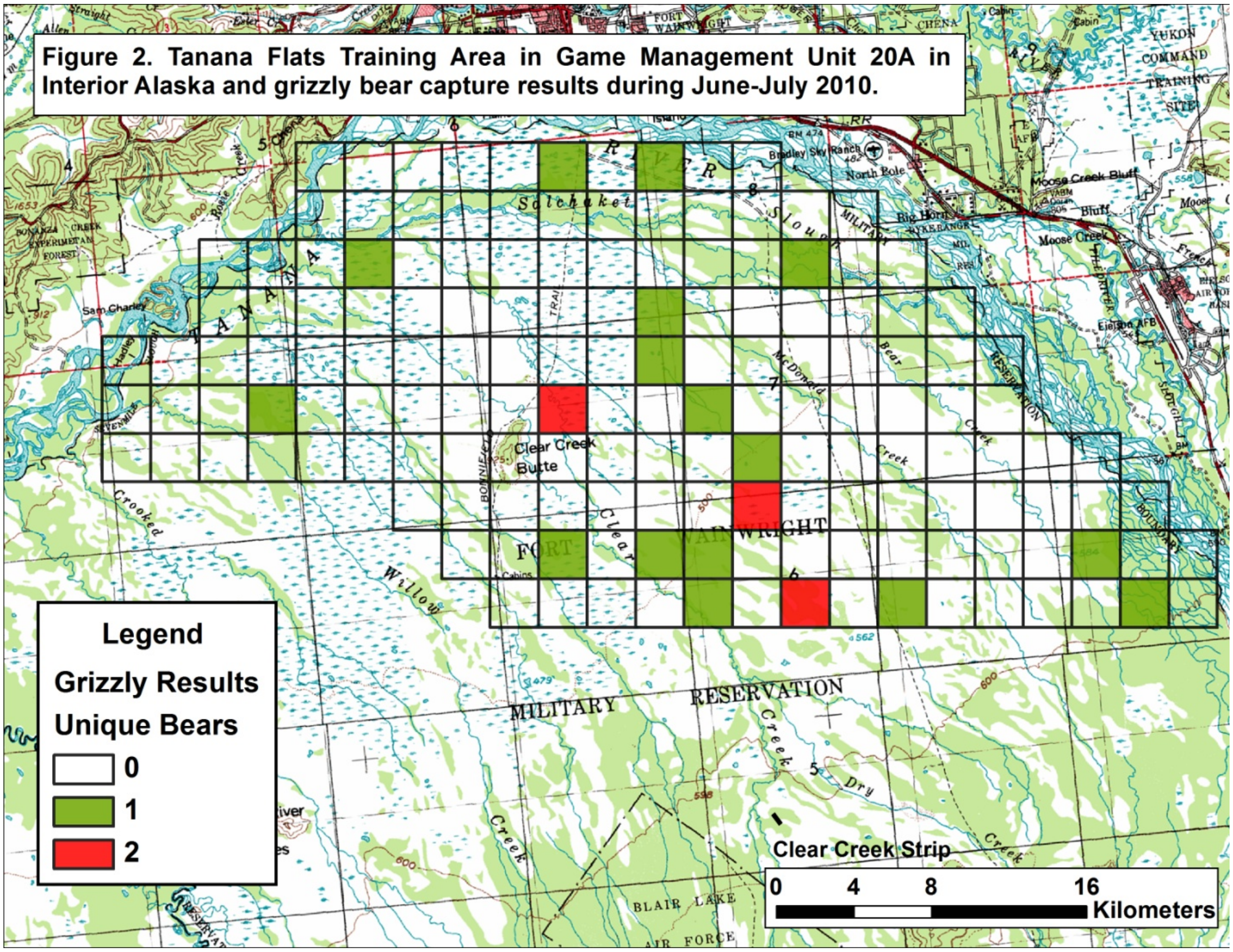

FIGURE 2. Tanana Flats Training area in Game Management Unit 20A in Interior Alaska and grizzly bear capture results during June–July 2010.

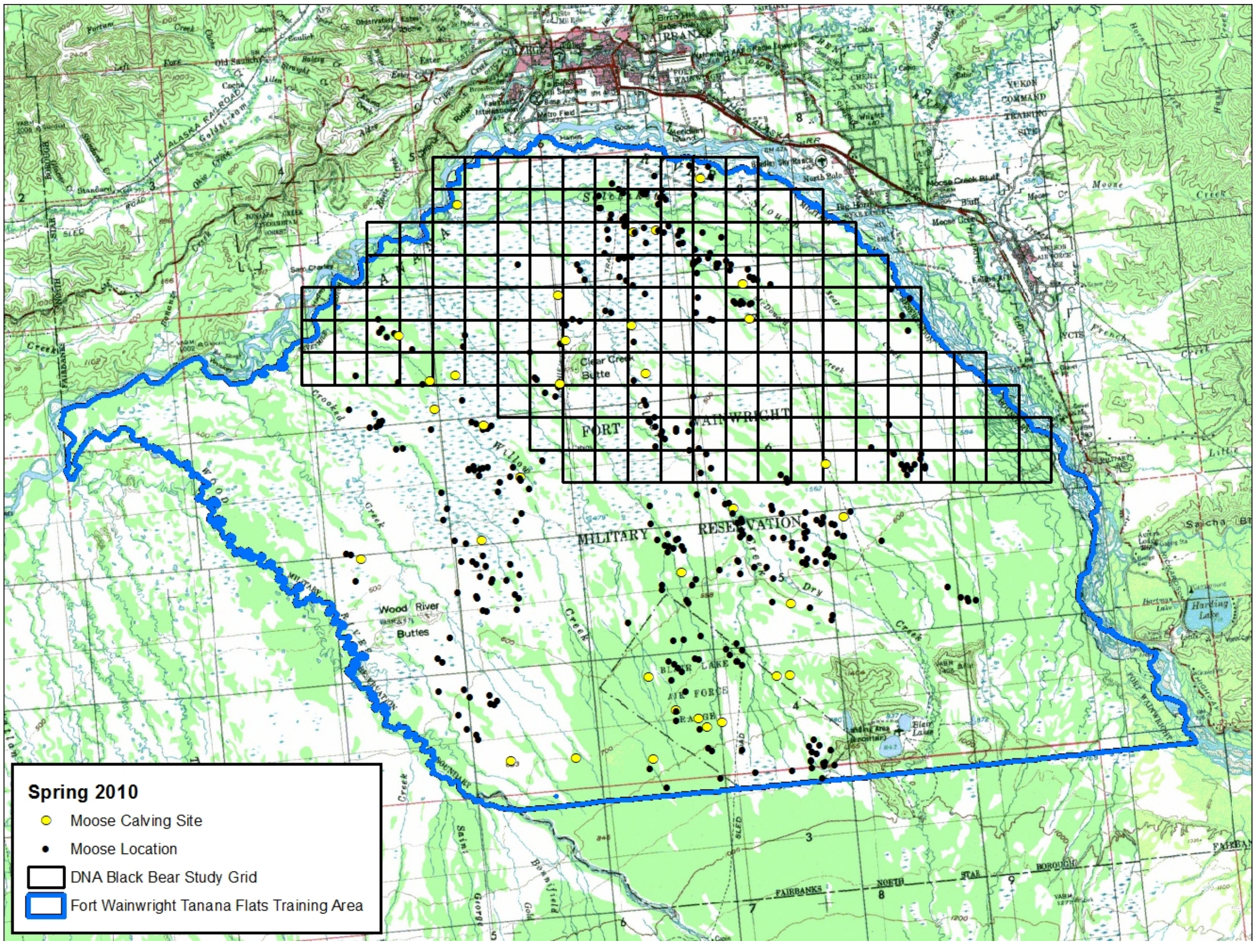

FIGURE 3. Locations and calving sites for radiocollared adult moose in the Tanana Flats Training area within Game Management Unit 20A in Interior Alaska during spring 2010.

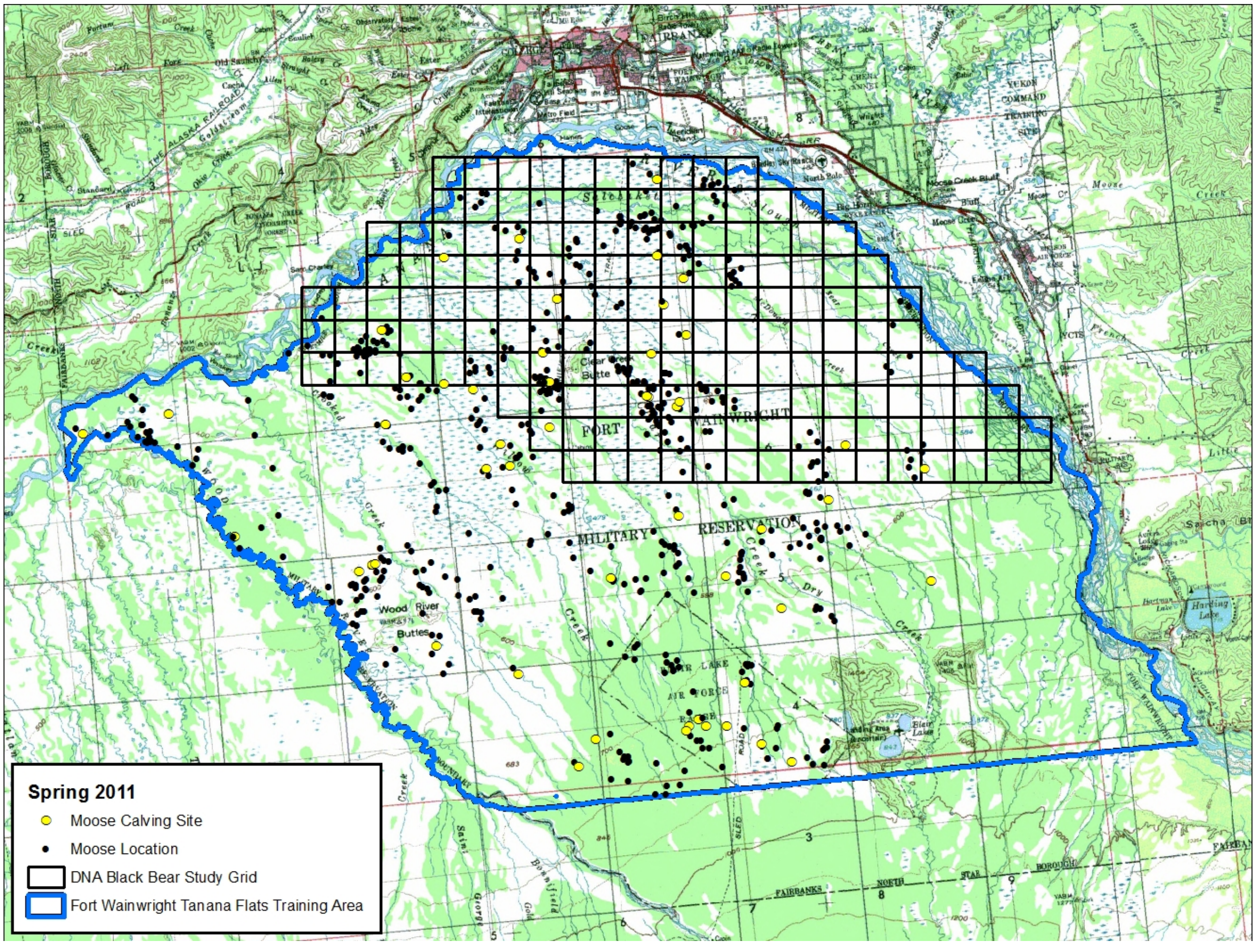

FIGURE 4. Locations and calving sites for radiocollared adult moose in the Tanana Flats Training area within Game Management Unit 20A in Interior Alaska during spring 2011.

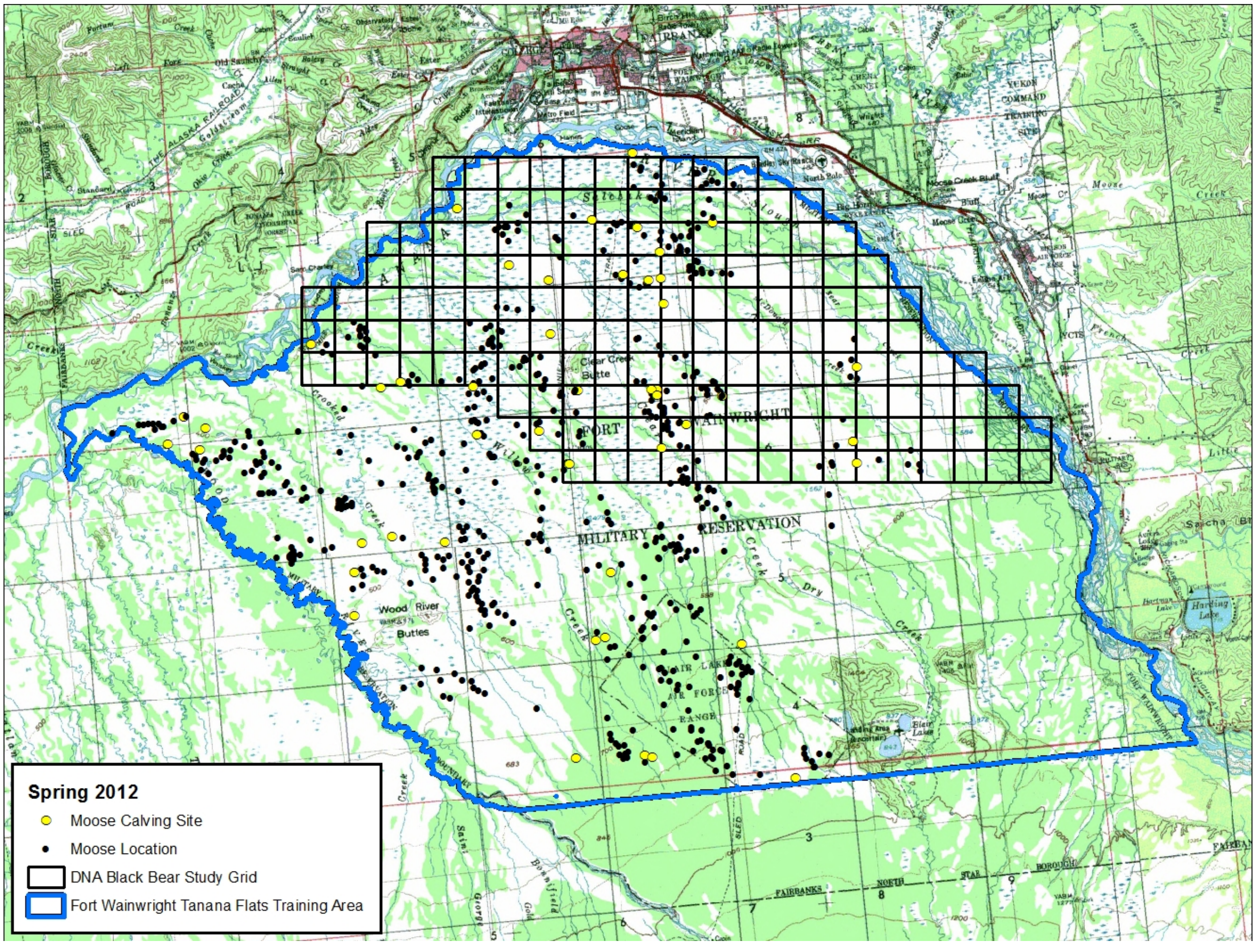

FIGURE 5. Locations and calving sites for radiocollared adult moose in the Tanana Flats Training area within Game Management Unit 20A in Interior Alaska during spring 2012.

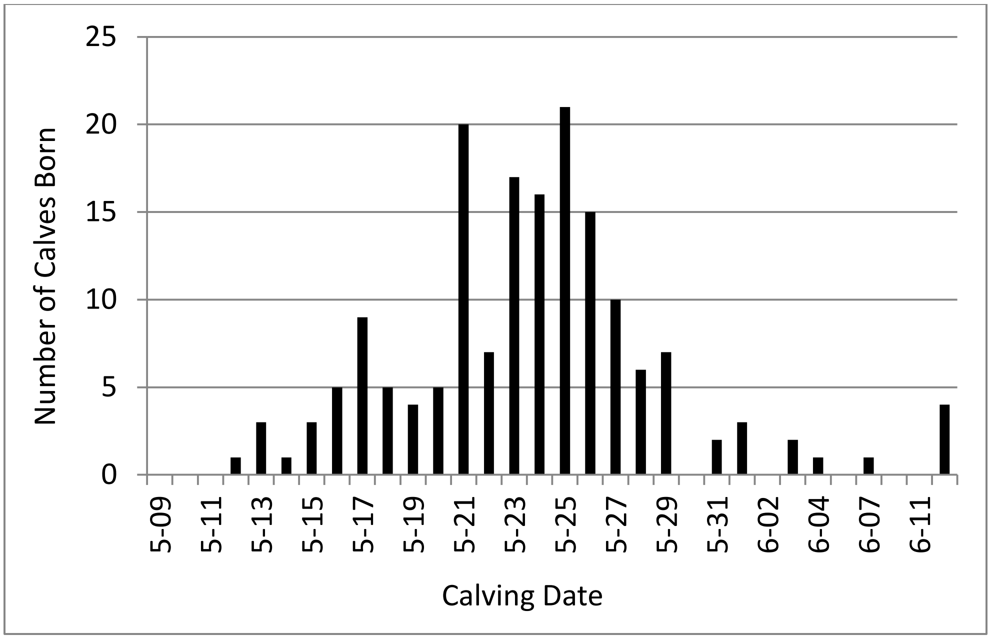

FIGURE 6. Timing of moose calving in spring 2010–2012 based on 138 calving events recorded for 90 radiocollared females recorded inside the Tanana Flats Training Area within Game Management Unit 20A in Interior Alaska.

TABLE 1. Summary of location information acquired for adult female moose during 9 May–15 June in the Tanana Flats Training Area within Game Management Unit 20A, Alaska.

Year	No. moose	No. locations	No. calving sites
2010	56	437	40
2011	90	613	51
2012	76	651	47