FEDERAL AID FINAL RESEARCH PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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Alaska Department of Fish and Game
Wildlife Restoration Grant

GRANT AND SEGMENT NO.: AKW-10 Wildlife Restoration FY2016

PROJECT NO.: 1.74

PROJECT TITLE: How do regenerating burns influence moose populations and harvest in Interior Alaska?

PERFORMANCE PERIOD: 1 July 2012–30 June 2016

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COOPERATORS: Todd Brinkman (University of Alaska Fairbanks/Scenarios Network for Alaska and Arctic Planning), Liz Neipert (University of Colorado/U.S. Army), and Casey Brown (Ph.D. Candidate/UAF).

WORK LOCATION: Game Management Unit 20D

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

Moose (*Alces alces*) provide a considerable food resource to Alaskans (Rausch et al. 1974; Nelson 1983; Ballew et al. 2006; Titus et al. 2009) and moose harvest also contributes to the economy of Alaska (Miller and McCollum 1994; Regelin and Franzmann 1998; Colt 2001). The state of Alaska recognizes the importance of moose to its residents by including the species in laws designed to elevate harvest through intensive management (AS 16.05.255, sections e–g and k) and in regulations setting population and harvest objectives for moose (5 Alaska Administrative Code [AAC] 92.106, 5 AAC 92.108). In accordance with this law, the Alaska Department of Fish and Game (ADF&G) has developed plans to increase moose densities through predator removal in some areas (5 AAC 92.113-127) and habitat enhancement in other areas (Boertje et al. 2010). However, no strategy exists for utilizing naturally-occurring burn scars to increase moose density and maximize harvest.

Regardless of moose population density, the relative concentration of moose on the landscape is affected by local abundance of forage (Best et al. 1978; Lynch and Morgantini 1984; Jandt 1992; Miquelle et al. 1992; van Beest et al. 2011). Where burns are absent, concentrations of moose are generally sporadic on the landscape because early-successional habitats occur in small, sometimes linear, footprints such as creek drainages and river bars (Seaton 2002). However, from 2001–2010 a vast 76,000 km^2 area of Interior Alaska was converted from mature forest to early seral stage habitat through wildfire (Alaska Fire Service 2012). The total area burned during this period was 3 times higher than the previous 2 decades (Kasischke et al. 2010). As a result, 10–30 years post-fire (Spencer and Hakala 1964; Maier et al. 2005; Shenoy et al. 2011) these burns will yield relatively large patches of early-successional habitat where plant species preferred by moose are regenerating. This regime-shift in the dominance of early-successional habitat on the landscape is likely to redistribute moose and concentrate them in patches of regenerating habitat (Chapin et al. 2004; Chapin et al. 2010). However we currently lack predictive models for ranking burns, or portions of burns, based on their potential production of moose forage and potential for increased moose density.

ADF&G needs to develop a strategy of moose management to actively utilize concentrations of moose in recent and future burns. Although the timing and location of large burns is uncertain, a post-fire evaluation of potential moose habitat and harvest is achievable. Specifically, ranking burn scars 2–4 years post-fire based on criteria such as potential browse regeneration, distance from hunter access, and moose population density could prioritize burns where intensive management could enhance moose harvest. We should develop evaluation criteria and tools to enhance harvest, ideally providing managers with options for manipulation 5–10 years prior to peak browse production. For example, burns meeting certain criteria could be flagged for developing access to areas that are likely to produce abundant moose browse, and moose at high density could be reduced through harvest to prevent overbrowsing of new growth before it is established. In other areas, predator removal could be timed with burn succession to coordinate a rapid increase in available browse with a similar increase in moose abundance. Similar plans have been developed elsewhere for other species (e.g., Gullion 1984).

Before we can develop active management policies to utilize large burns, we must quantify the relationships between moose and burns. It is generally accepted that fire can have positive effect on moose populations through the rejuvenation of habitat (Bailey 1978; Loranger et al. 1991; Weixelman et al. 1998). In addition, burn characteristics such as fire size, timing, and severity are known to influence plant composition in a regenerating burn. However, these general relationships have not been tied quantitatively to predictions of population-level change in moose nutrition, density, and distribution or to spatial predictions of where changes are most likely to occur. Further, although harvest is central to moose management, no connections exist between increasing moose density and changes in the availability of moose for harvest (e.g., moose movement, visibility in different habitat types, and access for hunting). For management to capitalize on the positive effects of wildfire for moose, we need to quantify numeric and functional responses of moose to burns at the individual, burn, and population levels. Ultimately, the design of long-term burn management plans hinges upon predicting where and when we will see elevated abundance of browse and how the moose population will respond.

In this study, we quantify the effects of a 20-year-old burn on adult male moose at the individual level. We examine links to landscape-level forage dynamics and burn characteristics important to moose. Finally, we discuss the effect of those areas on population-level abundance and harvest. ADF&G collaborated with the University of Alaska Fairbanks on many aspects of this research. We also examined moose-hunter dynamics relative to access.

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

Game Management Unit (GMU) 20 provides the majority of moose harvest for Interior Alaska residents (Fig. 1). Widespread fires that occurred in GMUs 20A, 20B, and 20C during 2001-2010 (Fig. 2) will likely increase the availability of early-successional browse for moose in these popular hunting areas 10-30 years post-fire (i.e., starting in 2016). The Hajdukovich burn is located in the southwest portion of GMU 20D (southwest GMU 20D; Fig. 3) burned approximately a decade prior to the widespread increases in fire across GMU 20, creating an opportunity to measure, interpret and manage burn-moose dynamics before they occur elsewhere in the Interior. Habitat regeneration in the Hajdukovich burn has been studied extensively (Michalek et al. 2000; Johnstone and Kasischke 2005; Kasischke and Johnstone 2005; Lord 2008; Shenoy et al. 2011), providing a rich background for understanding the ecology of moose in burned habitats. The Hajdukovich burn has had a major role in the overall high moose density measured in southwest GMU 20D. November moose counts in portions of the Hajudkovich burn were among the highest recorded during winter surveys (Fig. 4). Near the peak of moose density in spring 2007, browse production was > 3 times higher in the Hajdukovich burn than in the remainder of southwest GMU 20D (Lord 2008; Paragi et al. 2008). In addition to high browse production in the Hadjukovich burn, Paragi et al. (2008) found that browse removal rates were similar between the burn and the rest of Southwest GMU 20D. This suggests that moose were highly concentrated in the Hajdukovich burn during winter. In addition to substantial research on fire ecology and browse dynamics in the Hajdukovich burn, 2 years of locations were collected twice monthly on 25 adult moose using the Hajdukovich burn during October 2009-2011 (Kellie et al. 2011, Appendix A). These locations provided baseline information on seasonal range that was useful for determining the specific areas and season for deployment of GPS radiocollars (Fig. 5).

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

OBJECTIVE 1: <u>Document the effect of the Hajdukovich burn on individual moose</u>.

During mid-October 2012 we deployed 25 radio collars equipped with GPS units on adult male moose in GMU 20D. Radiocollars were divided into the Hajdukovich Creek Burn (HAJ, n = 15) and Johnson River (JRV, n = 10) study areas (Fig. 5). We radiocollared adult male moose between the hunting and aerial survey periods. Close alignment of our capture with these key periods should have ensured a high percentage of collared males that used the study areas during these key periods. The Johnson River study area was chosen as a control area because of the significantly lower level of access for hunting and the mature, un-burned habitat. We contracted CLS America (Collection Location Satellites America, Inc., Landham, MD) and ABR (Alaska Biological Research, Inc., Fairbanks, AK) to download, process and archive incoming spatial data as they were collected by the collars. GPS units were programmed to obtain coordinates every two hours during the majority of the year, except during 15 August through 01 October when location fixes were increased to one per hour to obtain finer-scale temporal data surrounding the hunting season. To examine browse selection of male moose, we contracted the Salcha-Delta Soil and Water Conservation District (SDSWCD, Delta Junction, AK) to complete a LANDSAT image-based vegetation classification that was originally developed by SDSWCD for Colorado State University for the portion of the Hajdukovich Burn occurring within the Gerstle River Training Area (Fig. 6).

Although adult male moose in both study areas spent significant time outside the original study areas, movement patterns paralleled drainages and there was little spatial overlap between the annual ranges of the HAJ and JRV sample groups (Fig. 7). None of the HAJ or JRV moose left GMU 20D. Use of the Hajdukovich burn by adult males varied throughout the calendar year and timing of use differed between the first and second year of the study (Fig. 8). The highest proportion of our sample within the Hajdukovich burn occurred within the first 2 weeks post-capture. Apart from peak use immediately following capture, the highest use of the burn by radiocollared adult males occurred from late summer through early winter. During the first year (15 Oct 2012 – 14 Oct 2013), around half of the HAJ moose left the burn shortly after capture in mid-October and did not return until after the 2013 hunting season (Fig. 8). Burn use increased again during the 2013 rut, but then quickly dropped off to < 50% of the HAJ moose using the burn by early November and remained low until late January, 2014. During this second study year, a higher percentage of male moose returned to the burn in late winter and, after a brief decline during calving season, returned to the burn for the remainder of the summer and through the 2014 hunting season (Fig. 8). During both study years, there was an exodus of collared bulls from the Hajdukovich burn in November, when aerial surveys are conducted to obtain estimates of abundance (Kellie and DeLong 2006; Bruning 2012).

Brown (2016) analyzed locations of adult males relative to burn severity classes within the Hajdukovich burn. In winter, she found that moose showed a preference for burned habitat (Fig. 9). However, a 7-day running average of the percentage of collared males using the burn illustrates relatively low use of the burn (i.e., < 50% of collared moose) from December through April during the first study year (Fig. 8). Within the burn, males showed a strong selection for low severity or unburned patches of habitat during the winter months (Fig. 10) and Brown (2016) assumed this was due to the higher biomass of preferred winter forage in low-severity areas, though differences in biomass among burn severity classes could not be statistically confirmed due to small sample sizes. In summer, adult males used the burn less than in the winter months (Fig. 9), likely because there was greater availability of woody browse in the burn in winter. When males used the burn in summer, they selected patches in areas that were high-severity relative to low-severity areas, possibly because of the shade provided by deciduous and shrub species (Fig. 10, Brown 2016).

During hunting season, collared adult males shifted away from access corridors within the Hajdukovich burn, but this pattern was not evident in the less-accessible Johnson River study area (Brown 2016). Activity rates for adult male moose using the Hadjukovich Burn were higher during the hunting season than for those inhabiting the Johnson River area (Fig. 11; Brown 2016). This indicates a higher level of straight-line movements associated with traveling among moose in the burn. During both years, large peaks in activity of adult males were observed in both study areas on the first and last day of hunting season (Fig. 11). During these noticeable peaks in moose activity, large numbers of hunters were traveling along access corridors (Brown 2016).

OBJECTIVE 2: <u>Link individual moose dynamics to landscape-level dynamics</u>.

There was some disconnect between analyses of individual and landscape-level forage preference for moose. Within the burn, radiocollared males preferred low-severity and unburned habitats over high- and moderate-severity habitats (Fig. 10). However, at the landscape level, browse analyses conducted by Brown et al. (2016) found that browse removal rates were higher for high-severity habitats, similar to Lord and Kielland (2015) for both sexes in the same burn during 2007, although the sample sizes in our study were too small for any statistical differentiation of browsing rates among burn severity classes (Seaton et al. 2011). This disconnect may be due to sampling differences between individuals and the landscape. For example, we examined preference for burn severity classes for adult male bulls at the individual level, but browse surveys measure winter browse removal on the landscape for all sex and age classes of moose. Nevertheless, at the landscape level, browse production was > 3 times higher in the

Hajdukovich burn than in the remainder of southwest GMU 20D in 2007 (Paragi et al. 2008; Lord and Kielland 2015), and was 5% higher within the Hajdukovich burn in 2013 versus 2007 (Brown 2016). We did not measure browse removal rates outside the burn in 2013, but if we assume browse removal rates remained uniform across Southwest 20D in 2013, as they were in spring 2007 (Lord 2007, Paragi et al. 2008), then the Hajdukovich burn continues to host elevated densities of moose relative to the rest of Southwest 20D.

The exodus of moose from the burn during the November aerial survey season observed in 2013 and 2014 (Fig. 8) likely did not affect the overall estimation of abundance in Southwest 20D. Radiocollared moose still remained within the Southwest 20D survey area throughout the November survey season. Further there was no directionality to movements of adult moose that could confound aerial surveys that began in one region of the survey area and ended in another. This agrees with previous studies conducted at a coarser temporal resolution (Kellie et al. 2011). Thus, although the significant redistribution of male moose in early winter would have a large effect on density estimation within the burn, it is unlikely that these movements create variation in abundance and harvest estimation for Southwest 20D.

There was substantial movement of collared males in and out of the burn from 1 September through 5 December (Fig. 8). There were ~ 30% fewer radiocollared males using the burn during the 2013 hunting season (Fig. 8), and spatial summaries of harvest by UCU showed that fewer males were harvested in Hajdukovich burn UCUs during the 2013 versus 2014 hunting seasons (64 versus 75 moose). Although the data are too few to draw conclusions, data from the individual and landscape scales concur and annual variation in fine-scale patterns of harvest may be linked to moose movements. Further, because access for hunting is not uniform throughout Southwest 20D (Fig. 5), movements out of accessible areas may result in overall changes in harvest success rates.

OBJECTIVE 3: <u>Measure the impact of burn-level dynamics on population-level abundance and harvest</u>

The Hajdukovich burn contains a relatively extensive network of trails used to access moose during the fall hunting season (Fig 5). This level of access allowed us to examine moose-hunter interactions that effect hunter success, such as the response of moose to motorized activity, and quantify moose availability for hunting in burned habitats. Brown et al. (2015) and Brown (2016, Chapter 4) analyze some of these interactions. Unfortunately, at the population level, our ability to assign proportion of moose harvested in the Hajdukovich burn was limited by the coarse resolution of harvest locations reported by hunters. Uniform Coding Units (UCUs), to which harvested moose are assigned by ADF&G staff, are often quite large and the Hajdukovich Burn intersected several. Present access and changes in access since the Hajdukovich area burned in 1994 are also imperfectly mapped. These spatial limitations make it challenging to quantify the impact of wildfires on harvest of moose in GMU 20D. However, examination of moose harvest across GMU 20D during two distinct time periods, before and after 3 major burns in Southwest 20D (Fig. 3), provide some insight to the combined role of fire and access in the harvest of moose. During a 9-year period from 1985-1993, before any of the burns in Southwest 20D were producing the high levels of biomass typical of 10-30 years post-fire, harvest of moose in GMU 20D was somewhat equally divided between Southern 20D (56%) and Northern 20D (42%). Three major wildfires transformed large expanses of Southwest GMU 20D from 1987 to 1994 (Fig. 3). During a 9-year period from 2005-2013, ≥ 6-26 years after these burns, the proportion of moose harvested in Southern GMU 20D was far higher (77% versus 20% in Northern 20D; Fig. 12). Increases in early -successional browse interacted with increased access to elevate harvest in Southwest GMU 20D (Brown et al. 2015). It is probable that access for hunting in Southwest 20D increased between the first and second periods. After the first period, trail systems likely grew in density and area as a result of fire management and subsequent logging of burned timber, habitat enhancement for grouse using shear blading techniques (Paragi and Haggstrom 2007), and because the lack of vegetation in burned areas made it easier to create new trails.

Winter browse removal rates by moose within the Hajdukovich burn declined by 10% from 2007 to 2013 across all burn severity classes (Brown et al. 2016). In contrast, forage production within the burn increased slightly (5%) from levels measured by Lord (2008). Between these two browse surveys, there was an almost 50% decline in moose abundance in Southwest 20D from 2007-2009 (Fig. 13). This was a deliberate reduction in population size through increased harvest designed to mitigate observed declines in nutritional condition by reducing competition for resources such as winter browse (Bruning 2012). It is likely that this substantial reduction in the population size played a major role in the observed declines in browsing within the burn. Given the increases in browse biomass, it is more likely that decreased browsing pressure was related to reduced moose density rather than deteriorating browse quality as was hypothesized by Brown et al. (2016). We cannot determine whether decreases in browsing were part of a decline in browsing pressure across Southwest 20D because the 2013 browse survey was limited to the Hajdukovich burn study area.

OBJECTIVE 4: Collaborate with Casey Brown (Ph.D. student, UAF) to model burn characteristics important to moose and predicting their occurrence on the landscape.

C. Brown provided a small amount of discussion to modeling and prediction of moose habitat in burns in the second chapter of her dissertation (Brown et al. 2016). However, because validation of burn severity classification was largely unavailable, and because information on moose density was available at only at a coarse scale, she chose to focus the majority of her analyses on the ecology and hunter interactions for adult male moose in Southwest 20D.

OBJECTIVE 5: Collaborate with Casey Brown and Todd Brinkman (UAF, SNAP program) to quantify moose-hunter interactions.

At the time of this report, analyses related to moose-hunter interactions have largely focused on activity data obtained from GPS collars as it relates to hunter activity along trail systems (Brown 2016, Chapter 4) and landscape-scale comparisons of harvest between areas with high and low levels of access (Brown et al. 2015). Efforts to examine moose-hunter interactions with regard to thermal signature of habitats by T. Brinkman was discontinued due to lack of significant results during pilot study testing in GMU 20A.

IV. MANAGEMENT IMPLICATIONS

Prior to this study, it was largely assumed that high-severity areas of wildfires were the most desirable areas for winter foraging by moose. In high-severity areas, the insulating layer of organic matter is burned away, leaving bare mineral soil that is most easily revegetated by early successional plants preferred by moose (Lord 2008). However, during winter, we found that male moose within the Hajdukovich burn preferred areas that were unburned or burned at a very low severity, despite the 20-year-old burn falling squarely within the 10-30 year window of peak browse production (Maier et al. 2005; Shenoy et al. 2011; Spencer and Hakala 1964),. Brown et al. (2016) suggests that this may be related to the maturity of fast-growing browse species such as aspen and birch, and the greater degree of brooming in the high-severity sites. However, although sample sizes are too small to provide any statistical comparisons, measured biomass production and removal rates at individual high-severity sites were generally higher than at the low-severity sites. Other studies are needed to confirm the somewhat surprising preference of individual moose for unburned and low-severity areas in winter during the peak years of post-fire browse production (i.e., 10-30 years post-fire). The preference of individual male moose for low-severity and unburned areas over high-severity sites in winter is not large (Fig. 10), and may be a spurious result of a burn severity classification that was verified in a small portion of the burn and with relatively small sample sizes per burn class (Kasischke and Johnstone 2005). We were able to obtain browse abundance and removal rates from those test sites, but sample sizes were too small for comparisons among burn classifications (Brown et al. 2016). Future studies should include ground verification of burn severity within 1-2 years post-fire, as well as browse composition, abundance and preference at >20 sites per burn classification, as recommended by Seaton et al (2011).

The proximity of a rich source of winter browse in the margins surrounding nearby agricultural fields was a large, unforeseen complication to measuring foraging dynamics in a nearby burn. Although browse production remained high in the Hajdukovich burn during our study period, many of our GPS-collared moose left the burn for the majority of the winter (Fig. 8) and wintered in the shrub margins of agricultural fields north of the Alaska Highway (Fig.7). In Southwest 20D, agricultural areas provided an alternative wintering areas containing winter browse biomass that may be more desirable than a 20-yr-old burn. This combination is fairly unique to Southwest 20D and the seasonal movement patterns of adult bulls in 10-30 year-old-burns may be very different in other areas of Interior Alaska.

Activity of bull moose peaked on specific days of the hunting season during both years of our study. This suggests that adult male moose (i.e., those available for harvest) are reacting to moose hunters, at least by sound, and responding to that encounter with movement. Although we see no cause for alarm, this result does suggest that redistribution and heightened activity of adult male moose is greatest at the very beginning and end of the hunting season. Ultimately, this increased activity may increase the probability of harvest early in the hunting season, especially where trail access is extensive and activity along one trail pushes moose into other accessible areas.

Perhaps the most critical finding from this project is that the combination of access and 3 recent burns coincided with a > 300% increase in the harvest of moose within Southwest 20D (Fig. 14). At the landscape level, this supports our general understanding that recent burns are associated with elevated moose density (e.g., Maier et al. 2005). More importantly, access for harvest of both moose and their predators can result in large benefits to nearby communities (Brown et al. 2015). However, we caution that increased browse biomass through burns must be coupled with moderate to high recruitment to achieve increases in population abundance (Gasaway et al. 1992). Otherwise, burns may only serve to re-distribute moose on the landscape with no net increase in harvestable surplus.

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

During this segment, I provided critical review and co-authorship for 2 manuscripts related to data collected through this collaborative research (Brown 2016; Brown et al. 2016).

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

None.

VII. PUBLICATIONS

Brown, C. L. 2016. Socio-ecological drivers of resource selection and habitat use by moose in Interior Alaska. Ph.D. Dissertation. University of Alaska, Fairbanks, Alaska.

Brown, C. L., K. A. Kellie, T. J. Brinkman, E. S. Euskirchen, and K. Kielland. 2015. Applications of resilience theory in management of a moose-hunter system in Alaska. Ecology and Society 20(1)

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VIII. RESEARCH EVALUATION AND RECOMMENDATIONS

This research project has heightened awareness among staff regarding the lack of formal burn evaluation with regard to potential for elevated yields of moose. Presentations of preliminary data from this project spurred inclusion of burn evaluation in Federal Aid Project 25.0 (*Alaska wildlife habitat monitoring and enhancement*), to evaluate recent burns with regard to access for hunting, fire severity, fire size and moose density. This effort is designed to provide an early alert to managers when new wildfires occur that may especially benefit moose. We recommend the following improvements to the evaluation approach based on our findings:

1.) We found that the distribution of mature adult moose may not be consistent in burns during harvest and aerial survey seasons, especially where they occur near other attractive habitats (e.g., agricultural areas or river corridors). We recommend that the proximity of “alternate” sources of late fall forage be quantified in burn evaluation. If a burn is flagged for enhancement (e.g., increasing access or decreasing predation), monitoring programs should include mapping annual differences in distribution of adult males to account for distribution-related differences in annual harvest rates.

2.) Including fire severity in burn evaluation may be premature. The connection between moose preference for winter habitat and fire severity is still unclear. We found preference for low-severity and unburned at the individual level, but greater browse removal rates (at very low sample sizes) in high-severity areas. We do not recommend using fire severity to evaluate burns for moose habitat until burn severity, and classification accuracy, can be more firmly connected to moose preference. At the landscape level, further research is needed with particular attention to validation of severity classes and the harvestable segment of the population. In addition, the connection between moose density, browse biomass production, burn age, and burn severity should be explored at the meta-burn level for Interior Alaska using existing data from moose surveys, browse surveys (biomass offtake by moose) and burn severity mapping modeled by MTBS (Monitoring Trends in Burn Severity, www.mtbs.gov).

3.) Finer-scale moose harvest and density information will be needed to monitor responses to active management in burned areas. Although our study benefitted from the fine-scale information provided from GPS collars, our ability to understand the interactions of burns, moose and hunters was still limited by the spatial resolution of other data sources. To monitor the effect of active burn management, the current protocols for monitoring harvest and moose density will need to be enhanced.

4.) Beyond burn scar perimeters, there is no clear vegetation preference for adult male moose during key management periods that be used to predict moose distribution. At the individual level, the coarse scale of habitat data and our inability to couple burn severity with other vegetation categories such as vegetation type, stand age and percent cover, hampered our ability to understand how these characteristics may interact relative to the habitat preference of male moose. At the landscape level, sample sizes were too small to compare browse biomass and removal rates among burn severity classes or infer habitat relationships below the level of the burn. We recommend that browse survey information from burns across Interior Alaska be coupled with moose density information to better understand possible relationships.

5.) Evaluation of burned habitat should capture the effect of several burns acting on a landscape in combination. Southwest 20D included 3 large recent burns (Fig. 3) that likely interacted to produce the observed increases in moose harvest (Fig. 12). This is especially important when several burns occur within the spatial area that will be used to evaluate burn effects relative to moose abundance and harvest (e.g., Southwest 20D).

This research project provided key data and logistical support for several manuscripts and a doctoral degree in wildlife biology (Brown et al. 2015; Brown 2016; Brown et al. 2016). These publications were designed to address specific management questions concerning the effect of burns on harvesting moose. Additional publications from this collaboration examining the relationship between movement patterns of hunters and moose are still in preparation.

The moose location data collected during this project provide a unique source of information on the movements of adult male moose in Interior Alaska. Our two-year study period contained two of the most extreme growing seasons on record, allowing comparisons of movement between two very different weather regimes. Few datasets contain such accurate, frequent location information for a large sample of adult male moose. Further, these individuals were divided between an area of Alaska where human activity is relatively dense, and an area that contains relatively little human influence. It is our hope that these data will be used in additional research to further our understanding of the ecology of adult male moose through analyses of the foraging habits, age class differences and interactions with weather conditions.

PREPARED BY: Kalin A. K. Seaton

DATE: 15 August 2016

FIGURES

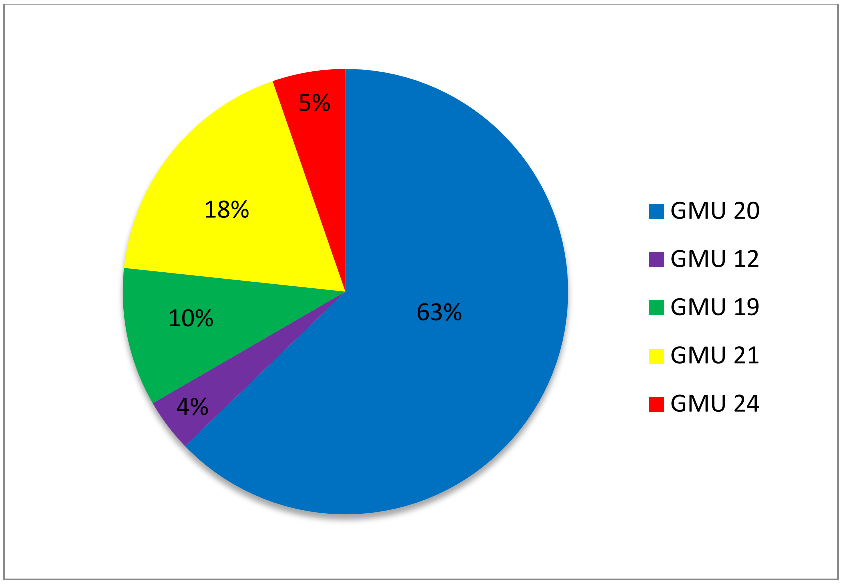

FIGURE 1. Percent moose harvest in Interior Alaska from 2000-2007 by Game Management Unit.

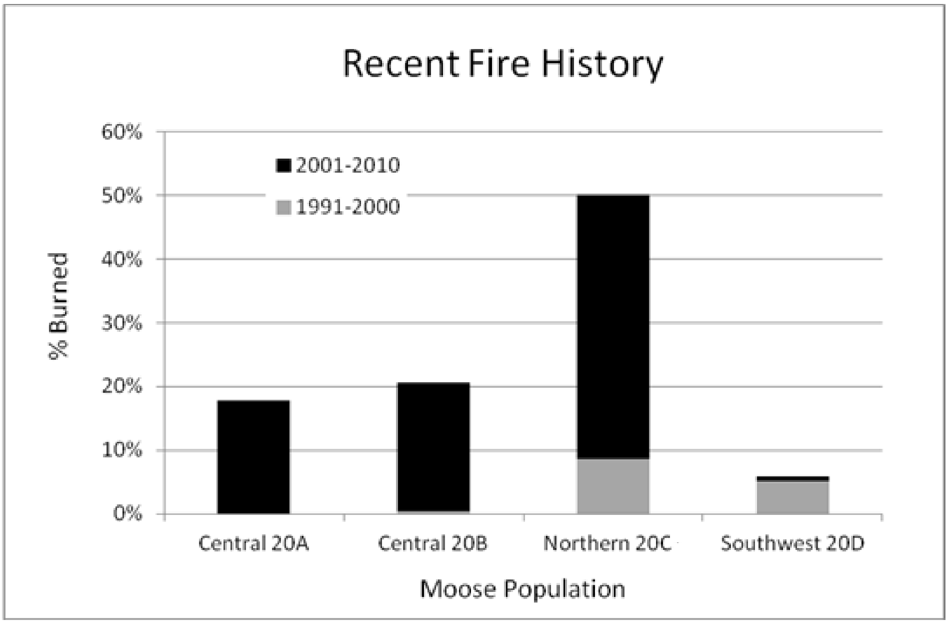

FIGURE 2. Recent fire history for 4 moose populations in Interior Alaska that are relatively accessible for harvest. Populations are described as portions of Game Management Subunits used by Alaska Department of Fish and Game to regulate moose harvest.

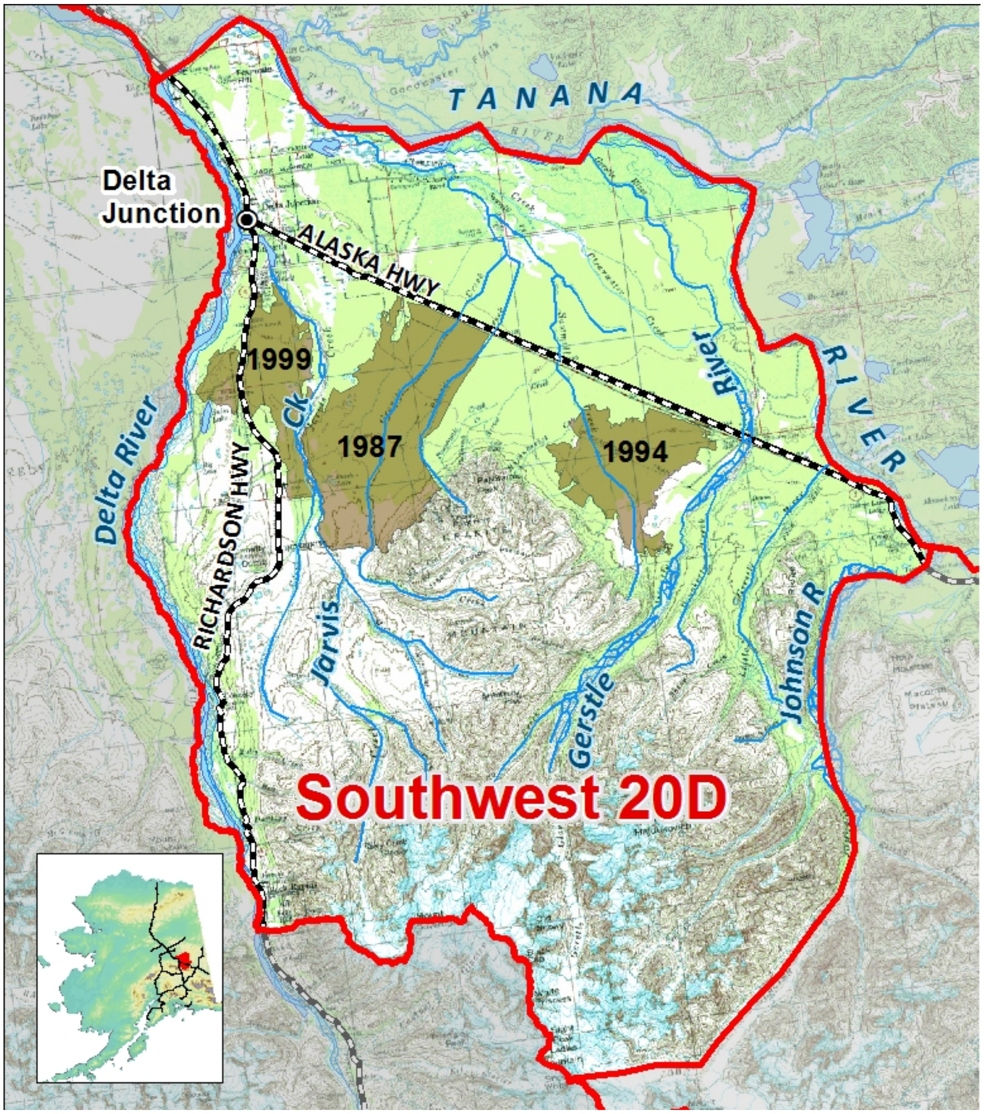

FIGURE 3. Southwest Game Management Unit (GMU) 20D includes the town of Delta Junction, Alaska and is bordered by the Tanana, Delta, and Johnson Rivers to the north, west and east, respectively, and the Alaska Range divide to the south. The area contains 2 major highways and 3 relatively recent burns: the Gerstle River burn (1987), the Hajdukovich burn (1994), and the Donnelly Flats burn (1999). Southwest GMU 20D also includes major tracts of land developed for agriculture between the Tanana River and the Alaska Highway. The Hajdukovich burn was the focus of this study.

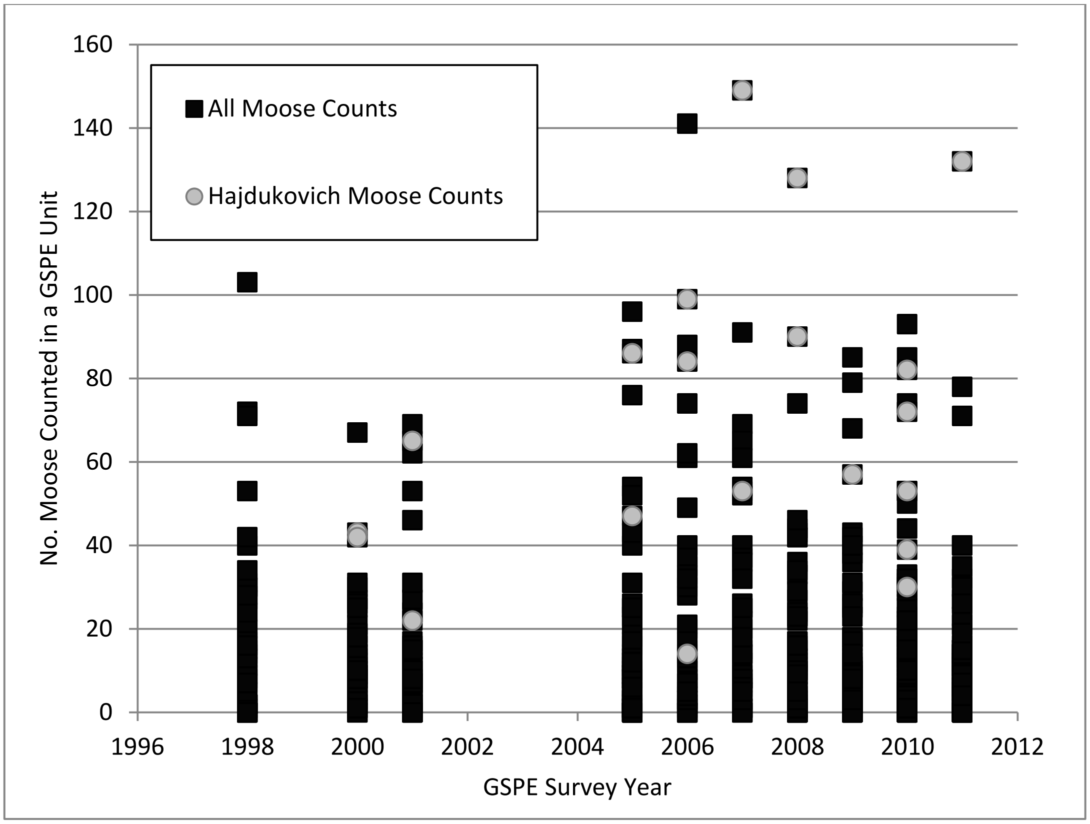

FIGURE 4. Moose counts measured during the November–December GSPE moose surveys of Unit 20D south of the Tanana River. Notice that counts in units over the Hajdukovich burn have been some of the highest counts in recent surveys.

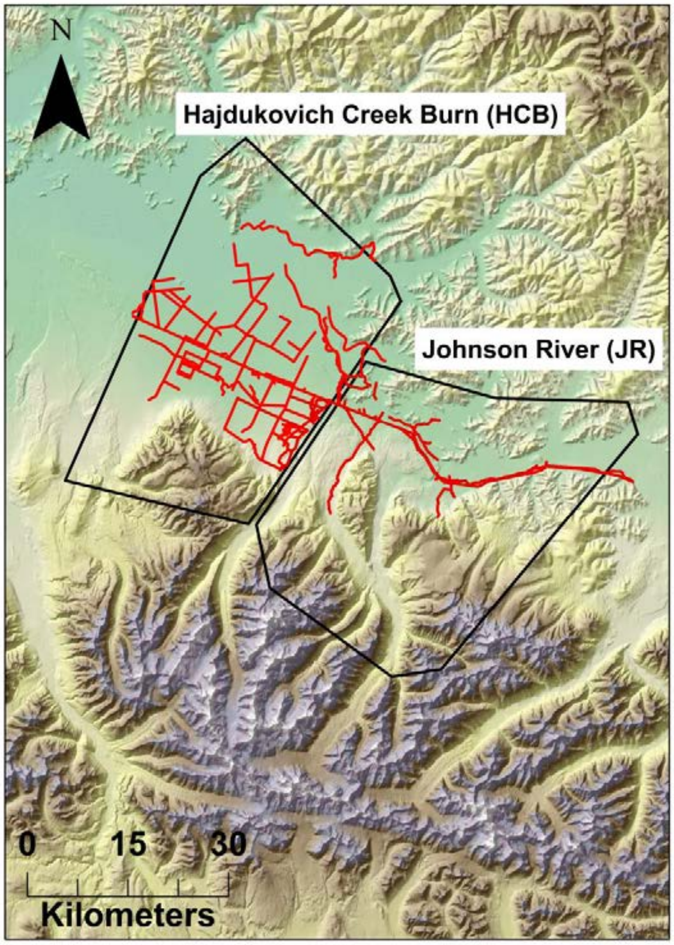

FIGURE 5. Study areas Hajdukovich Creek Burn and Johnson River located near Delta Junction, Alaska. These study areas were used for activity analyses. Trails for motorized vehicles are shown in red, see Brown (2016) for details.

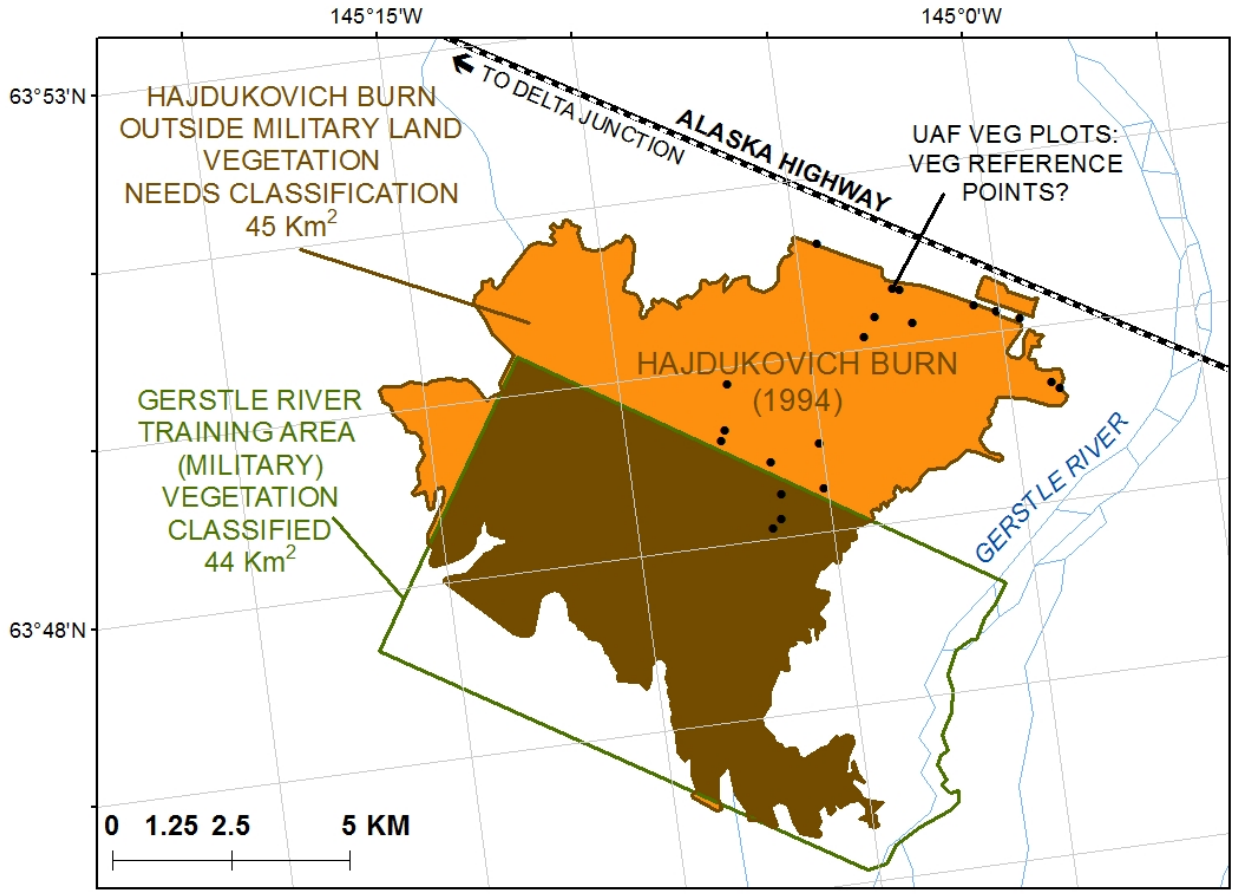

FIGURE 6. Vegetation classification for the Hajdukovich burn near Delta Junction, Alaska. SPOT imagery exists at 1-m resolution for the entire burn area. Vegetation on the Gerstle River Training Area (brown) has already been classified by the Salcha Delta Soil and Water Conservation District (SDSWCD) for the U.S. Army, Fort Wainwright. Areas of the burn outside the military land (orange) were classified by the SDSWCD during this study. Black dots depict UAF vegetation plots used by Brown (2016) to estimate browse production and winter offtake rates for moose.

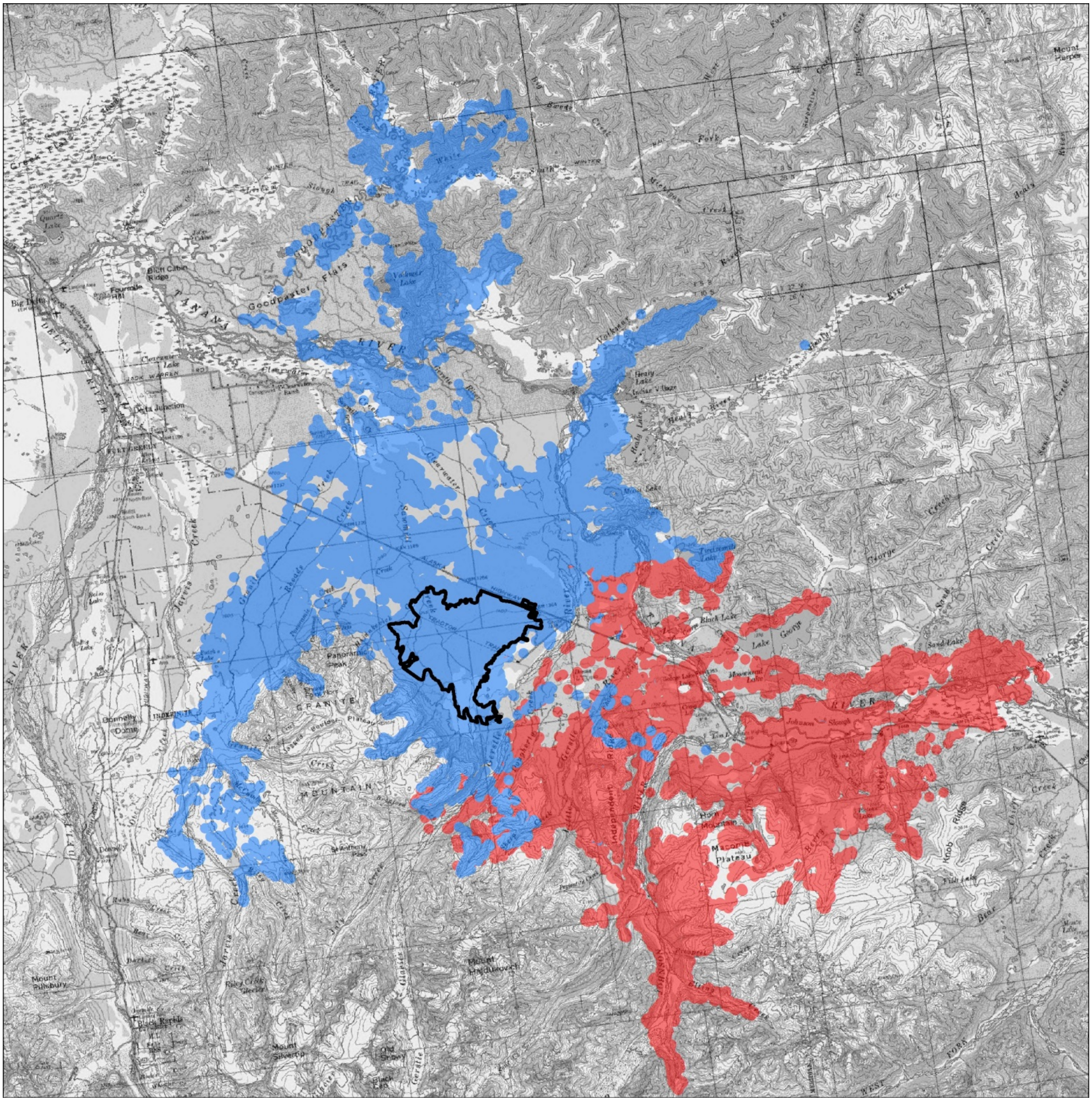

FIGURE 7. Distribution of GPS locations obtained from radio-collared adult male moose captured within the the Hadjukovich Burn (blue dots, n = 15) and captured East of the Gerstle River, South of the Alaska Highway (red dots, n = 10). Moose collared within the Hajdukovich burn (black outline) ranged into several distant drainages including the Goodpaster River, Volkmar River and Jarvis Creek. Moose collared East of the Gerstle River largely remained east of the river.

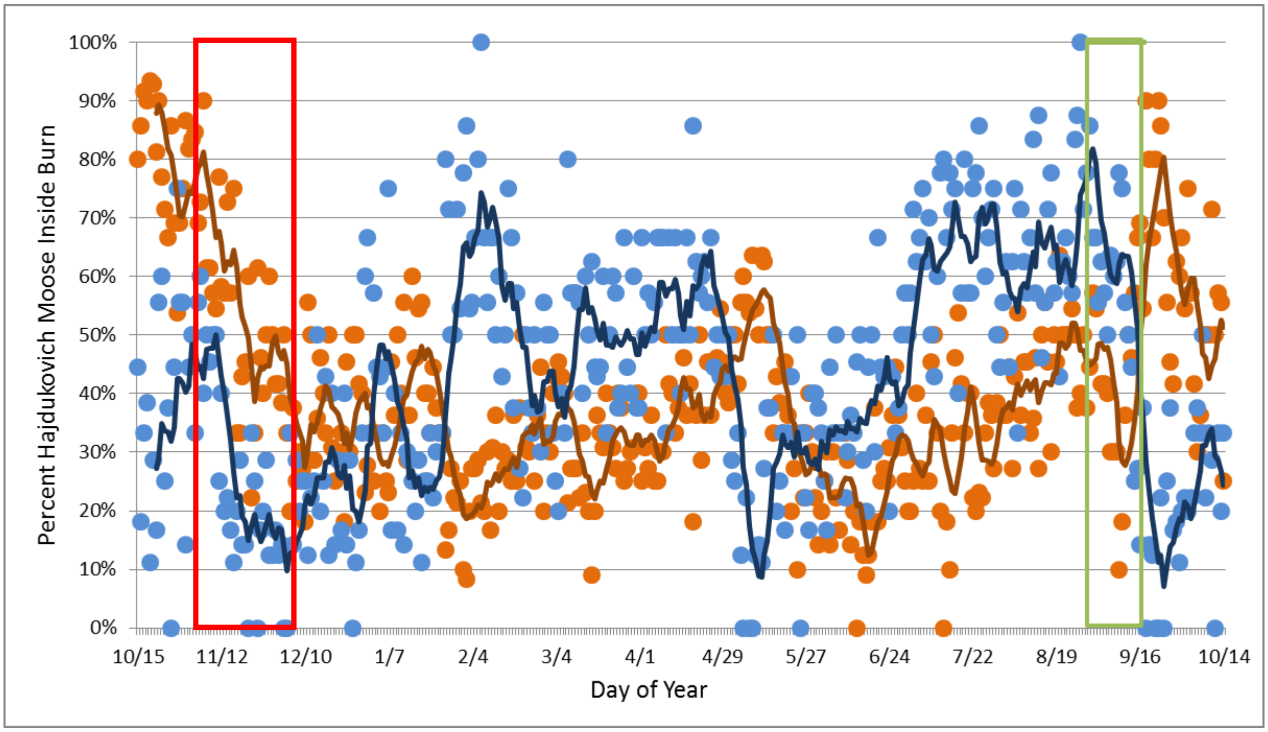

FIGURE 8. Daily percentage of radiocollared moose located within the Hajdukovich Burn near Delta Junction, Alaska within Game Management Unit 20D. Only adult male moose that used the burn during the study were included (n = 16). There were differences in the timing and amount of burn use between the first study year (15 Oct 2012 – 14 Oct 2013, orange points) and the second study year (15 Oct 2013 – 14 Oct 2014, blue points). A 7-day running average for each year is drawn to facilitate comparisons of burn use between the two years. During the first year, use of the burn increased to >50% of moose after the Sept 1-15 hunting season (green rectangle), but during the second year, use of the burn peaked in early July and remained high during the hunting season. During both study years, there was an exodus from the burn over the period that aerial surveys usually occur (red rectangle).

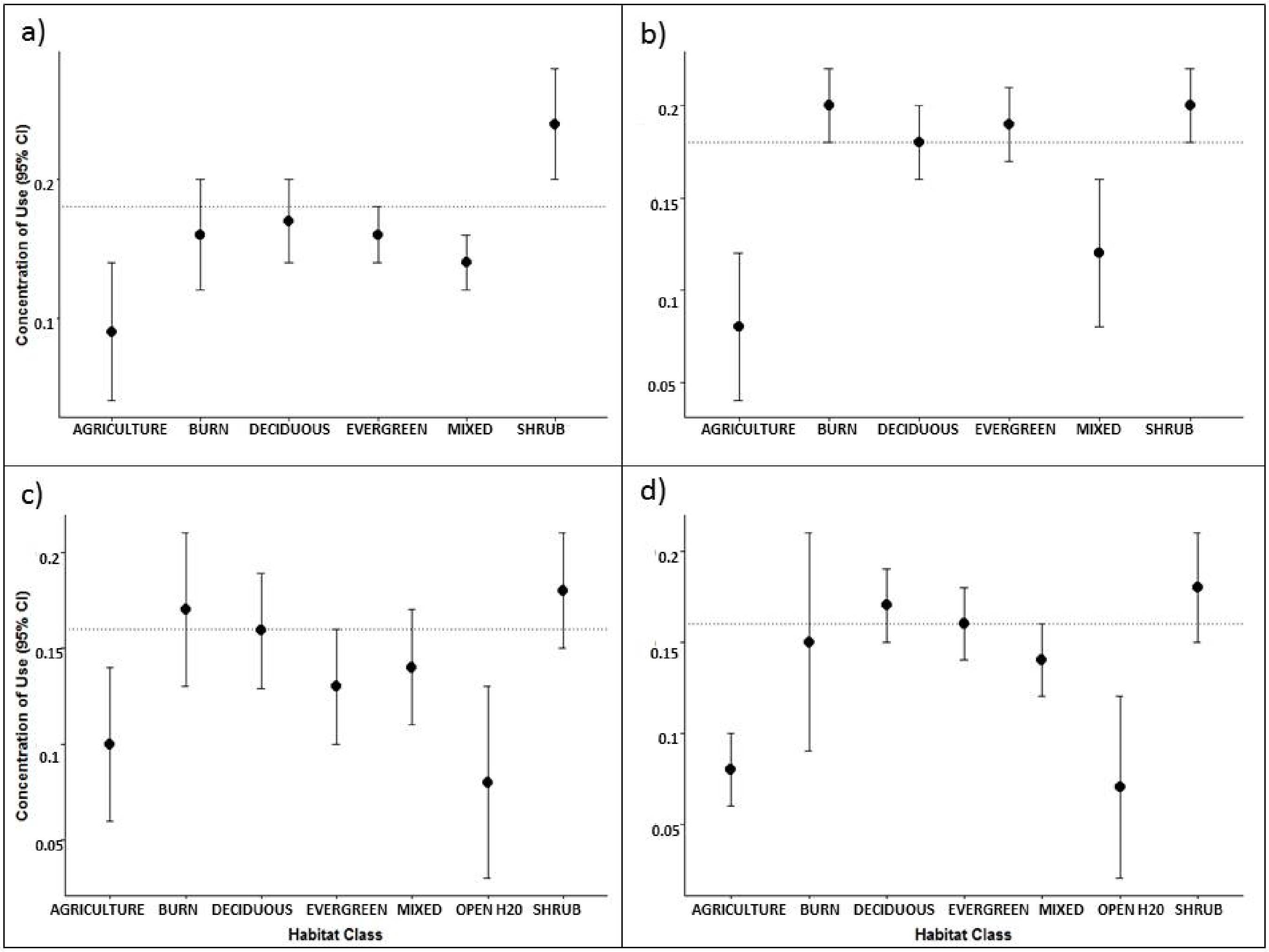

Figure 9. Concentration of use values for habitat types for the HAJ moose (*n* = 15) during winters 2013-14 and 2014-15 in the Southwestern portion of Game Management Unit 20D near Delta Junction, Alaska. Mean concentration of use values (95% CI) for: a) Winter home ranges; b) Winter core areas; c) Summer home ranges; d) Summer cores areas. The dashed line indicates mean probability of occurrence expected for random use of habitat types within home ranges given that all habitat types are included in each home range and core use area CI > mean probability of occurrence indicate the habitat type is selected. CI< mean probability of occurrence indicate the focal habitat type is avoided. Mean ± 95% CI (n=26 winters, 24 summers). Figure and caption are from Brown (2016).

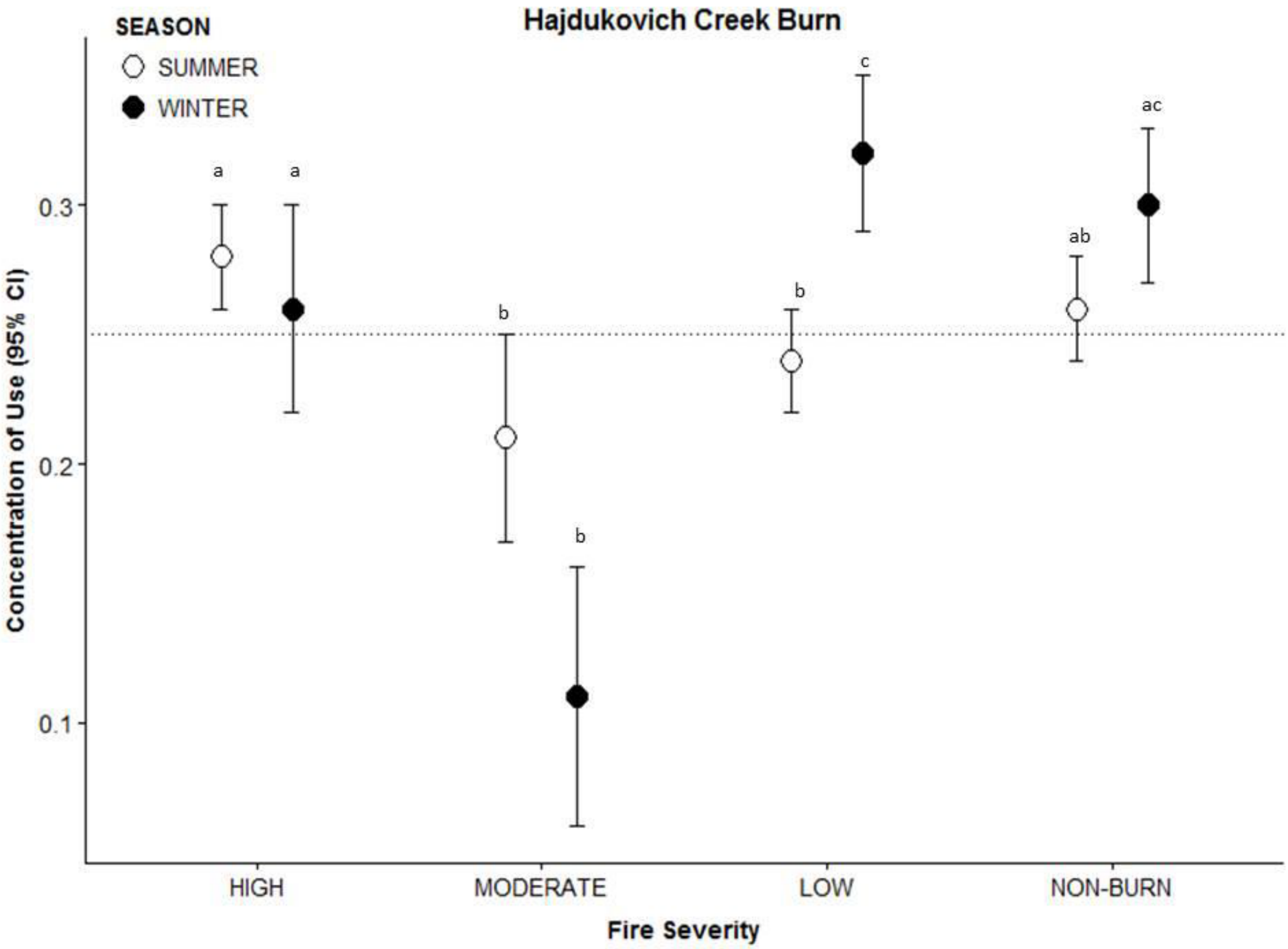

FIGURE 10. Concentration of use values for fire-severity within the Hajdukovich burn near Delta Junction, Alaska. Fire severity classes were first determined by post-fire satellite imagery and ground-truthed with field based comparisons of the degree of soil organic matter (SOM, Michalek et al. 2000). The *NON-BURN* variable refers to areas within the burn perimeter that were not consumed by fire. The sum of all core utilization distribution (UD) values associated with a fire severity class is the total probability of occurrence. The dashed line indicates mean probability of occurrence expected for random use of habitat types within home ranges given that all habitat types are included in each home range and core use area. We defined “preference” as a mean (+/- 95% CI) greater than the mean probability of occurrence for random use. We defined “avoidance” as a mean (+/- 95% CI) less than the mean probability of occurrence. Mean ± 95% CI (n=23 winters, n = 18 summers). Letters a, b and c represent statistically significant differences between fire severities for the winter and summer seasons. Figure and caption are from Brown (2016).

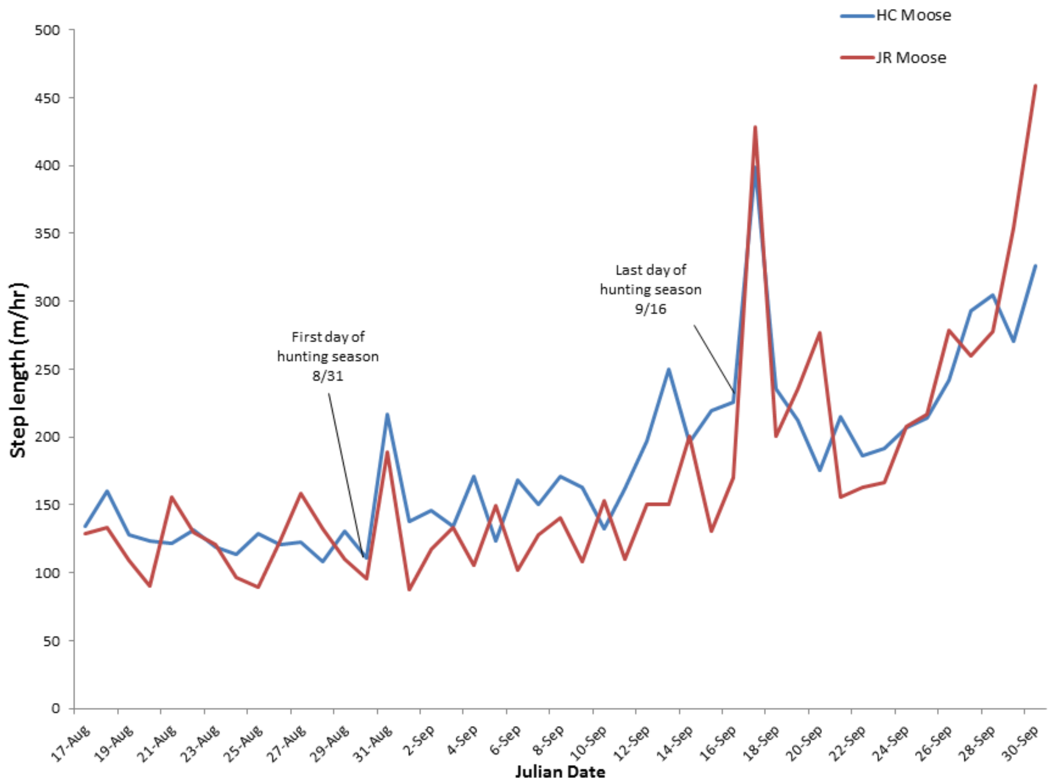

FIGURE 11. Moose activity patterns during the hunting season for adult male moose radiocollared in the Hajdukovich Burn ("HC", n = 25) and the Johnson River ("JR", n = 10) study areas near Delta Junction, Alaska. Figure is from Brown 2016.

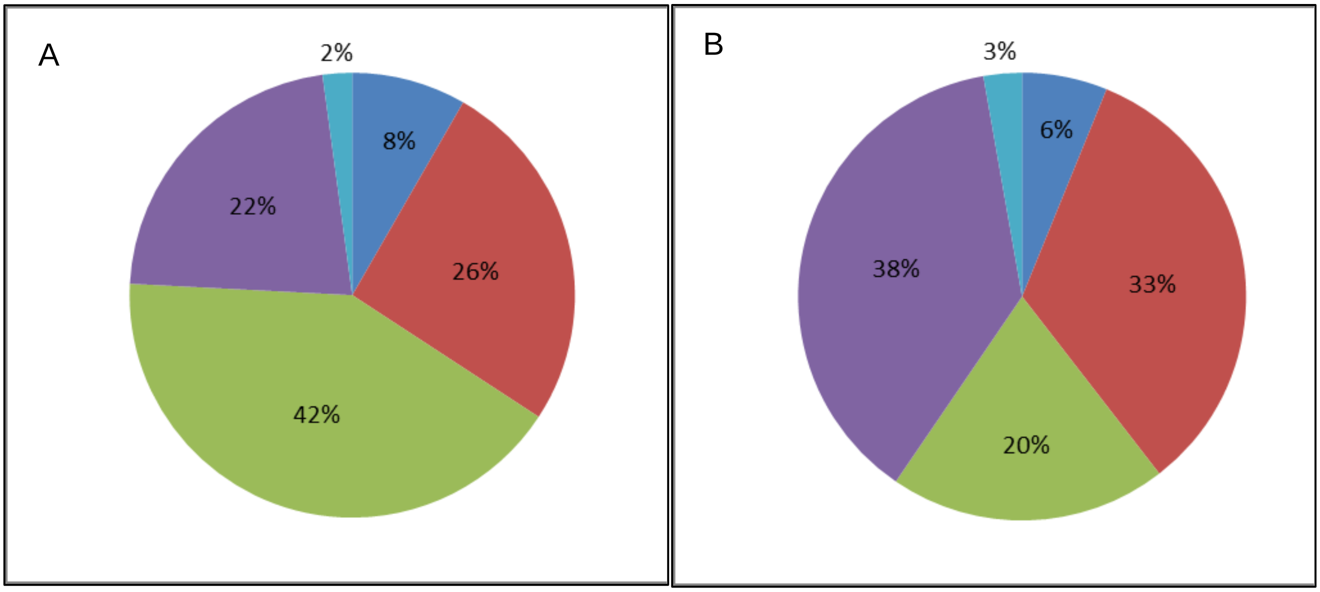

FIGURE 12. Proportion of moose harvest by section of Game Management Unit 20D during a 9-year period prior to the Hajdukovich Burn (A: 1985 – 1993) and a 9-year period when the Hadjdukovich Burn was ≥ 10 years old (B: 2005 – 2013). This second period was chosen because burns typically do not become a preferred area for winter foraging until at least 10 years post fire. Harvest was grouped into large time frames to examine long-term patterns rather than annual variation caused by changes in harvest regulations. The proportion of harvest in GMU 20D coming from North of the Tanana River (green) decreased between the two periods. Large increases in proportion of moose harvest were seen in SW GMU 20D (South of the Tanana and West of the Johnson River), both near or within the Hajdukovich burn (purple) and elsewhere in SW 20D (red), which contained 2 additional wildfires that were 18 and 6 years old at the beginning of period B. Between the two periods, there was little change in the proportion of harvest coming from South of the Tanana and East of the Johnson River (blue) or in the proportion of harvest that could not be assigned to subareas of GMU 20D (teal). Harvest was categorized based on Uniform Coding Units that were assigned to harvest reports submitted by hunters.

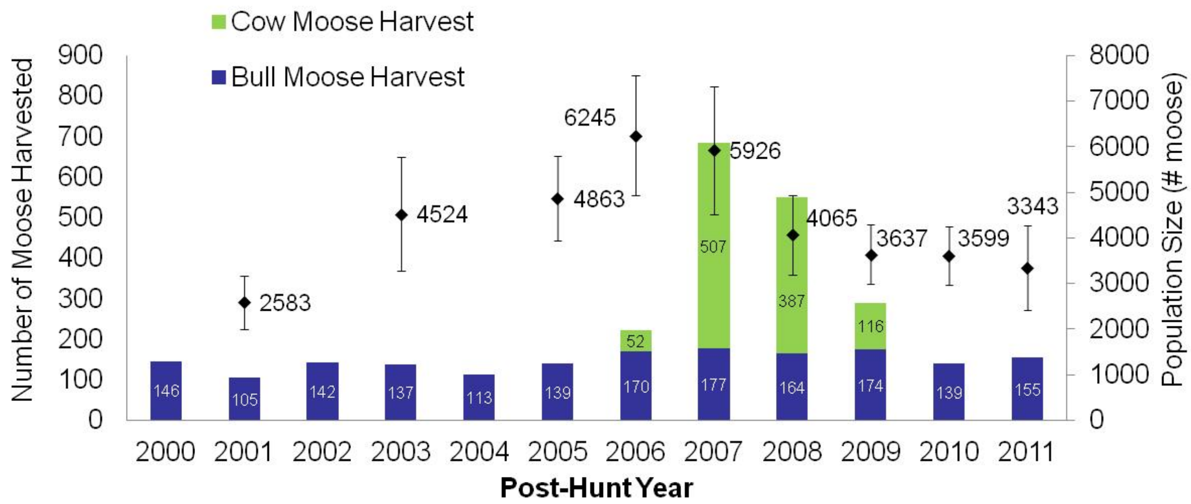

FIGURE 13. Moose harvest by sex and estimated population abundance in southwest Unit 20D near Delta Junction, Alaska from 2000–2011. Data from Bruning (2012).

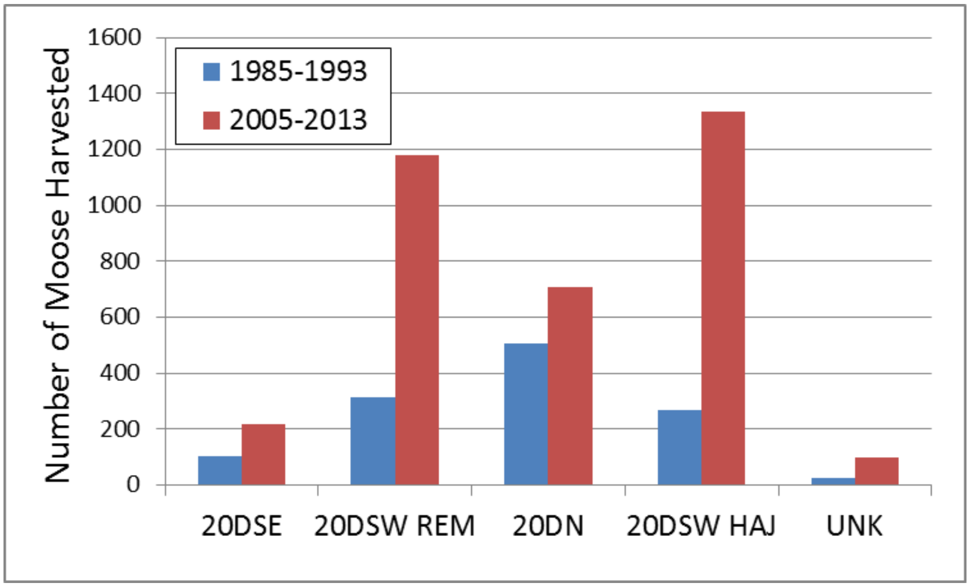

FIGURE 14. Harvest of moose in Game Management Unit 20D during a 9-year period prior to the Hajdukovich Burn (blue: 1985 – 1993) and a 9-year period when the Hajdukovich Burn was ≥ 10 years old (red: 2005 – 2013). This second period was chosen because burns typically do not become a preferred area for winter foraging until at least 10 years post fire. Overall harvest increased substantially in GMU 20D between the first and second period, largely due to increased harvest in Southwest 20D (20DSW). The largest change occurred for harvest in the area intersecting the Hajdukovich burn (20DSW HAJ), and the remainder of Southwest 20D (20DSW REM), which contained 2 additional wildfires that were 18 and 6 years old at the beginning of the second period. Less dramatic increases in harvest were seen in 20D South of the Tanana and East of the Johnson River (20DSE), North of the Tanana River (20DN) and among reported harvest that could not be assigned to an area within GMU 20D (UNK).

APPENDIX A.

Annual Movements of Moose around the Gerstle River Training Area and Healy Lake Village

Report to the Upper Tanana Intertribal Coalition by Kalin Seaton (kalin.seaton@alaska.gov)
23 January 2012

Overview:

To address concerns about potential past contamination on the Gerstle River Training Area and its long-term impact on moose as a subsistence resource, we conducted a study to determine whether moose available for hunting to the residents of the Healy Lake Village were feeding the Gerstle River Training Area during any portion of the year. To accomplish this, we captured and radiocollared male and female moose that were using these areas and located them twice a month for 1-1.5 years and plotted their annual movements. Prior to this study, very little information was available on moose movements and ranges in this area.

Project Objectives:

1.) Develop a boundary line to delineate the traditional moose hunting area used by residents of Healy Lake Village.

2.) Obtain hair and blood samples from the moose we capture for contaminants testing conducted in a sister project lead by the US Fish and Wildlife Service. This cooperative study will look for any trace of contamination in the moose themselves.

3.) Radiocollar moose in the area surrounding the Gerstle River Training Area (GRTA) and the Healy Lake Village Traditional Hunting Area (HLVTHA).

4.) Radiotrack these moose twice a month for at least one year to determine their annual ranges relative to the GRTA and the HLVTHA and determine whether moose hunted in September within the HLVTHA are using the GRTA during other parts of the year.

Develop Hunt Boundary:

A boundary delineating the Healy Lake Village Traditional Hunting Area was delineated on a map in cooperation with JoAnn Polston and Pat Saynor in March 2009. We put the HLVTHA in a digital format and mapped it along with the GRTA and other ADF&G boundaries (Figure 1) to determine where to capture moose for the project.

Moose Capture:

October 2009: We captured 42 adult bull moose around the GRTA and HLVTHA, as well as surrounding areas (Figure 2). We chose to put the majority of radiocollars on bull moose because they are the animals available for hunting. We put the collars out in mid October because we wanted to catch bull moose on their fall range but were also constrained by hot weather in early Sept (>50°F), hunting season in September and rut in early October. We darted bulls from a helicopter and used 3 super cub airplanes to scout for moose to collar. We radiocollared 13 bulls north of the Tanana River. It was particularly difficult to find bull moose inside the HLVTHA north of the Tanana River and we collared all 5 of the bull moose found. Almost all of the bull moose found north of the Tanana River were above treeline in the alpine hilltops surrounding the Healy River. We placed 8 collars on these bulls to see whether they moved down into the hunting area the following September. We collared 15 bulls in and near the GRTA. We also collared 12 bull moose in areas adjacent to the GRTA and HLVTHA to determine whether these moose are moving through the GRTA or the HLVTHA earlier in the fall when they would be available for hunting. We pulled a tooth and determined age of the bulls by counting rings in a cross-section of the tooth under a microscope. We also pulled hair and took blood samples and delivered these samples to the USFWS for contaminants testing.

March 2010: This capture was done through an ADF&G project designed to assess the nutritional condition of moose in Southwest 20D (south of the Tanana, between the Delta and the Johnson). For this nutritional assessment, 31 calves were captured and weighed throughout Southwest 20D and their weights compared with those in other moose populations. To get a broad overview of cow moose movements relative to the GRTA and HLVTHA, during the calf capture we also caught the adult cow associated with 18 of these calves and put on radiocollars. Only 2 of these cows were captured within the GRTA and none were in the HLVTHA, however most of the cows were close enough to these study areas that it was possible for their ranges to overlap during the hunting season. We pulled a tooth and determined age of the adult cows by counting rings in a cross-section of the tooth under a microscope. We also pulled hair and took blood samples and delivered these samples to the USFWS for contaminants testing.

Radiotracking:

We radiotracked collared moose from a super cub airplane twice a month starting in late October 2009. In March 2010, we added the 18 cow moose to the radiotracking. We continued to monitor moose through June 2011, when funding was terminated. We recorded presence of antlers on bulls and presence of calves at heel for cows. We conducted a total of 38 radiotracking flights and obtained 1,585 locations of moose over that time period.

Analysis:

We plotted moose locations obtained from radiotracking against the GRTA and HLVTHA to determine movement patterns relative to these areas. Eleven moose (4 females and 7 males) were located at least once in both the GRTA and the HLVTHA (Figure 3). Most of this overlap occurred during calving and summer seasons, when moose from the GRTA and other areas south of the Tanana moved into the flat lands surrounding Healy Lake. None of the bulls from the upper Healy River drainage descended down into the Healy Lake area during early spring and summer, instead remaining at high elevations throughout the monitoring period (Figure 4). <u>Only one radiocollared moose that was located at least once in the GRTA was found within the HLVTHA during the September hunting season.</u> This was a cow moose that was located just North of the Alaska Highway, but south of the Tanana River (Figure 3).

Report:

ADF&G wrote a report on the results of this research and submitted it to Fort Wainwright personnel. It includes the results presented here plus additional information gathered and analyzed during the study. The report is available upon request by e-mailing me at kalin.seaton@alaska.gov.

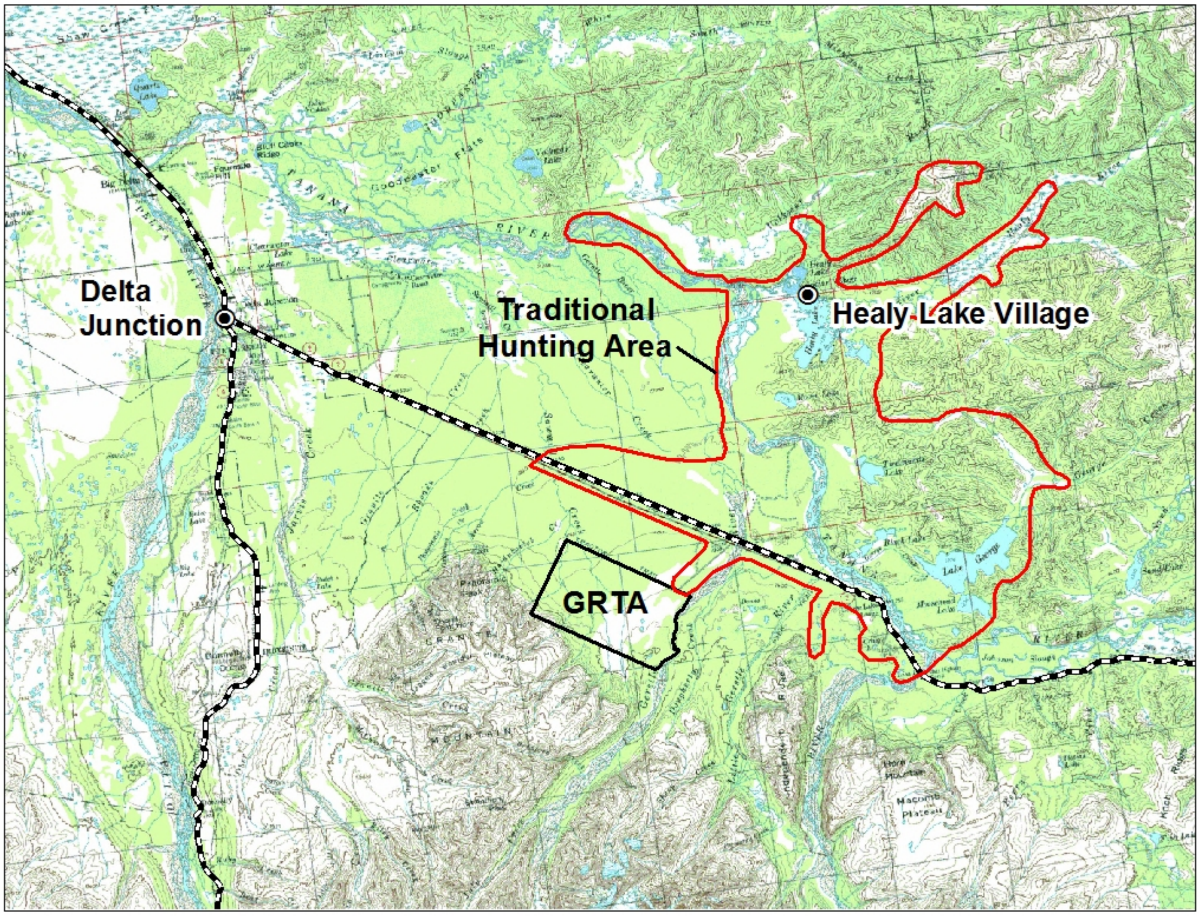

Figure 1. Healy Lake Village Traditional Hunting Area (HLVTHA, in red) and the Gerstle River Training Area (GRTA, in black) of Fort Wainwright delineated on a USGS 1:250,000 scale topographical map. The Alaska Highway runs along the southern side of the HLVTHA. Healy Lake Village and Delta Junction are depicted and labeled.

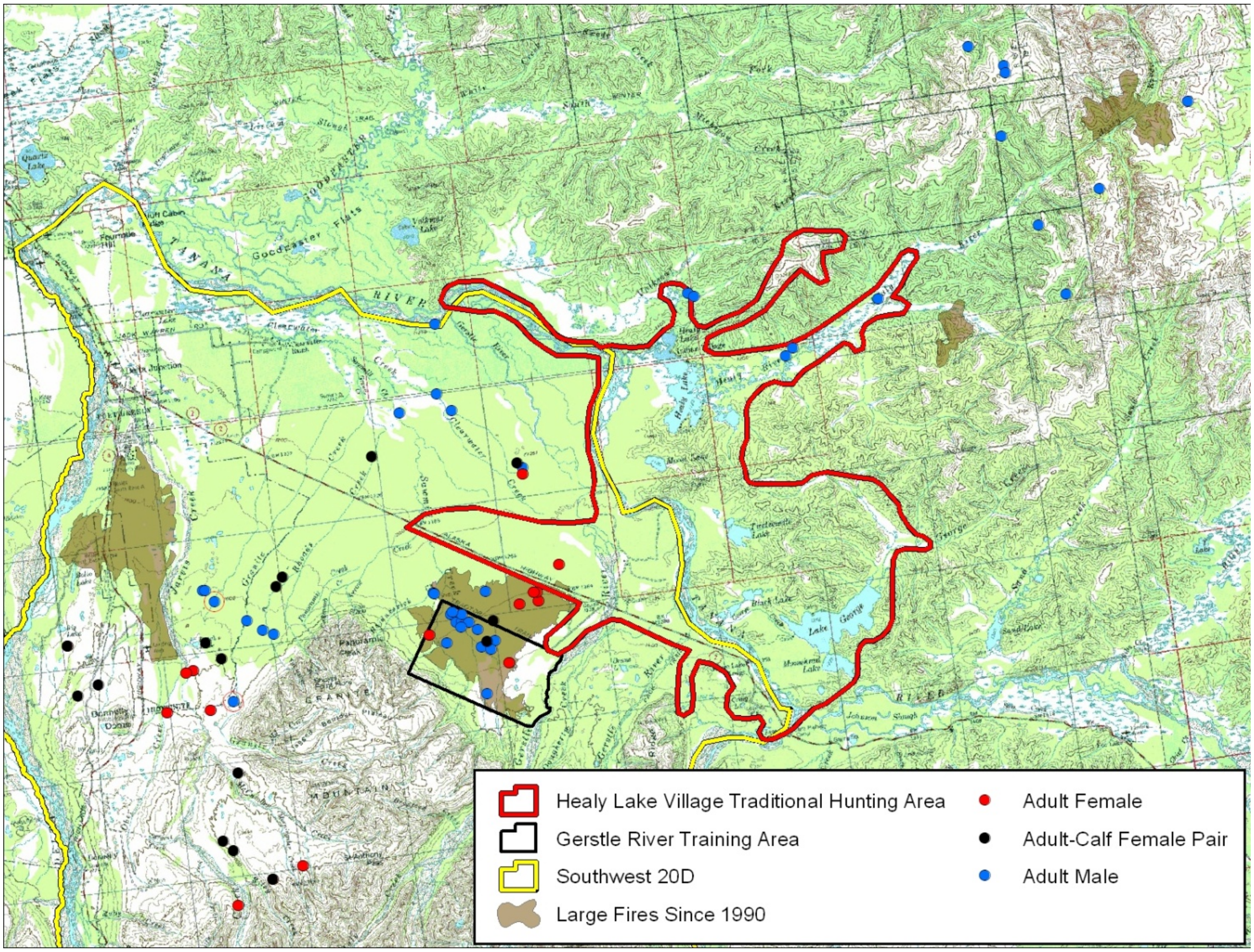

Figure 2. Capture locations for moose used in this study. In October 2009, 42 bull moose (blue) were captured. In late February, 18 Adult females captured along with their calves (black dots) and the adults were collared. Their calves were weighed for a sister study looking at moose nutrition. An additional 14 calves were captured and weighed (red dots) to increase the sample of calf weights and evaluate population nutrition.

Figure 3. Seasonal distribution of female (●) and male (●) moose captured in Southwest 20D that were located in both the Healy Lake Village traditional hunting area (HLVTHA, red) and the Gerstle River Training Area (GRTA, white) during the study. Seasons are described as calving (May); Summer (June – August); Hunting (September); Rut (October); Early Winter (November – December) and Late Winter (January – March). Moose used the HLVTHA in spring and summer and wintered in the GRTA. Only one moose that wintered on the GRTA was within the boundaries of the HLVTHA during the hunting season.

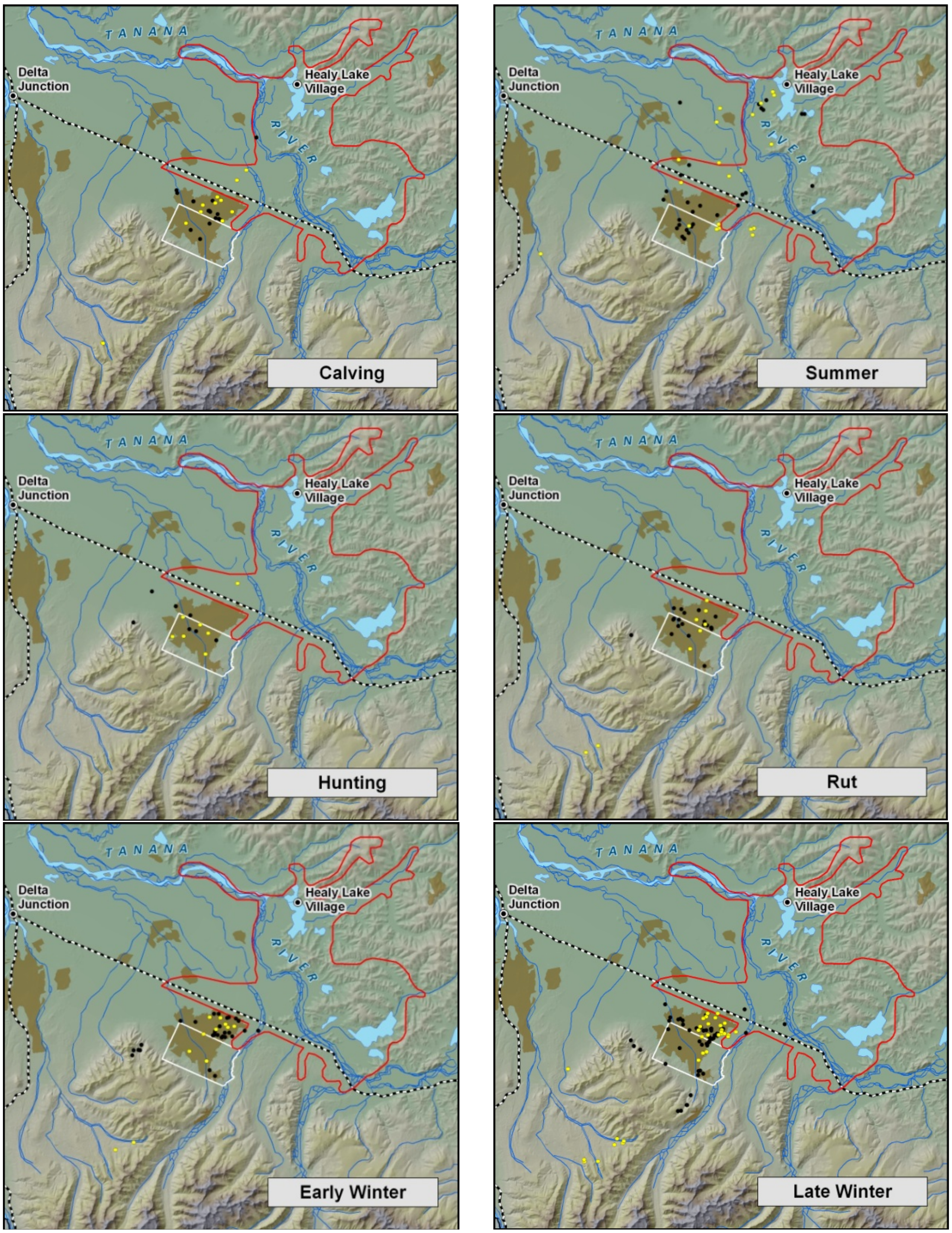

Figure 4. Seasonal distribution of **bull** moose captured in Southwest 20D (●) and 20D North (●). The boundaries of Southwest 20D (yellow), the Gerstle River Training Area (white) and Healy Lake Village traditional hunting area (red) are also illustrated. Seasons are described as calving (May); Summer (June – August); Hunting (September); Rut (October); Early Winter (November – December) and Late Winter (January – March).