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Analysis of VHF Moose Telemetry Data within the Upper Koyukuk River Drainage, 2008-2013

Natural Resource Report NPS/GAAR/NRR—2015/970

ON THE COVER
Sukakpak Mountain during VHF telemetry surveys, April 2009.
Photograph by: Kyle Joly

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May 2015

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Cameron, M. D., Joly, K., Sorum, M. S. 2015. Analysis of VHF moose telemetry data within the upper Koyukuk River drainage, 2008-2013. Natural Resource Report NPS/GAAR/NRR—2015/970. National Park Service, Fort Collins, Colorado.

NPS 185/128681, May 2015

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Abstract/Executive Summary

From 2008 – 2013, 119 moose (*Alces alces*) – 27 males and 92 females – were radio collared and tracked via VHF relocation in the upper Koyukuk Valley of Alaska. We determined 2119 total locations, ranging from 1 – 53 per moose. Home ranges were delineated using 100% Minimum Convex Polygons (MCPs) for those moose with 30 or more locations. Habitat characteristics such as vegetation type, fire history, aspect, elevation, and terrain ruggedness were analyzed for each location. While we calculated the area of MCPs for individuals with 30 or more locations, we were not confident enough in the limited data to draw any conclusions on moose home ranges. Moose were detected most often in coniferous and mixed forests, exhibited a preference for unburned areas but avoided flat terrain. We compared moose habitat use based on visual observations during aerial radio telemetry flights with the habitat type as determined by GIS and satellite land cover imagery for that same location. Habitats classified by visual observation (which assessed the area around the moose) did not correspond well with remotely-sensed classifications (which were based on the exact coordinates for the moose). This could be due to a wide array of factors including differing methodologies. Burn classification showed a stronger agreement between the 2 data sources. While informative for some habitat use characteristics, this VHF data illustrates the point that larger data sets, such as those obtained from GPS collars, are necessary for robust home range and habitat analyses.

Acknowledgments

This project was promoted by public subsistence and wildlife advisory groups. Funding was provided by the National Park Service, US Fish and Wildlife Service, Alaska Department of Fish and Game, and the Bureau of Land Management. We thank pilots Troy Cambier, Mike Spindler, Marty Webb, Paul Zaczkowski, Curtis Cebulski, Les Dillard, Pete Christian, Andy Greenblatt, Heather Bartlett, Nikki Guldager, Dave Sowards, and Sandy Hamilton for making this project possible and safe. Stacia Backensto, John Burch, Jason Caikoski, Roy Churchwell, Tim Craig, Kristin DeGroot, Jen Dillard, Mel Flamme, Alyssa Morris, Christopher Harwood, Tony Hollis, Erin Julianus, Heidi Kristenson, Jim Lawler, Nate Pamperin, Tom Paragi, Kumi Rattenbury, Carl Roberts, Lisa Saperstein, Glenn Stout and many others provided critical assistance with project implementation. Christopher Harwood provided database expertise. We also thank John Burch for his review of this report.

Introduction

Public concern that the Dalton Highway Management Corridor might be acting as a population sink for moose moving from Kanuti National Wildlife Refuge and Gates of the Arctic National Park and Preserve helped prompt a study investigating the movements of moose in the upper Koyukuk River valley.

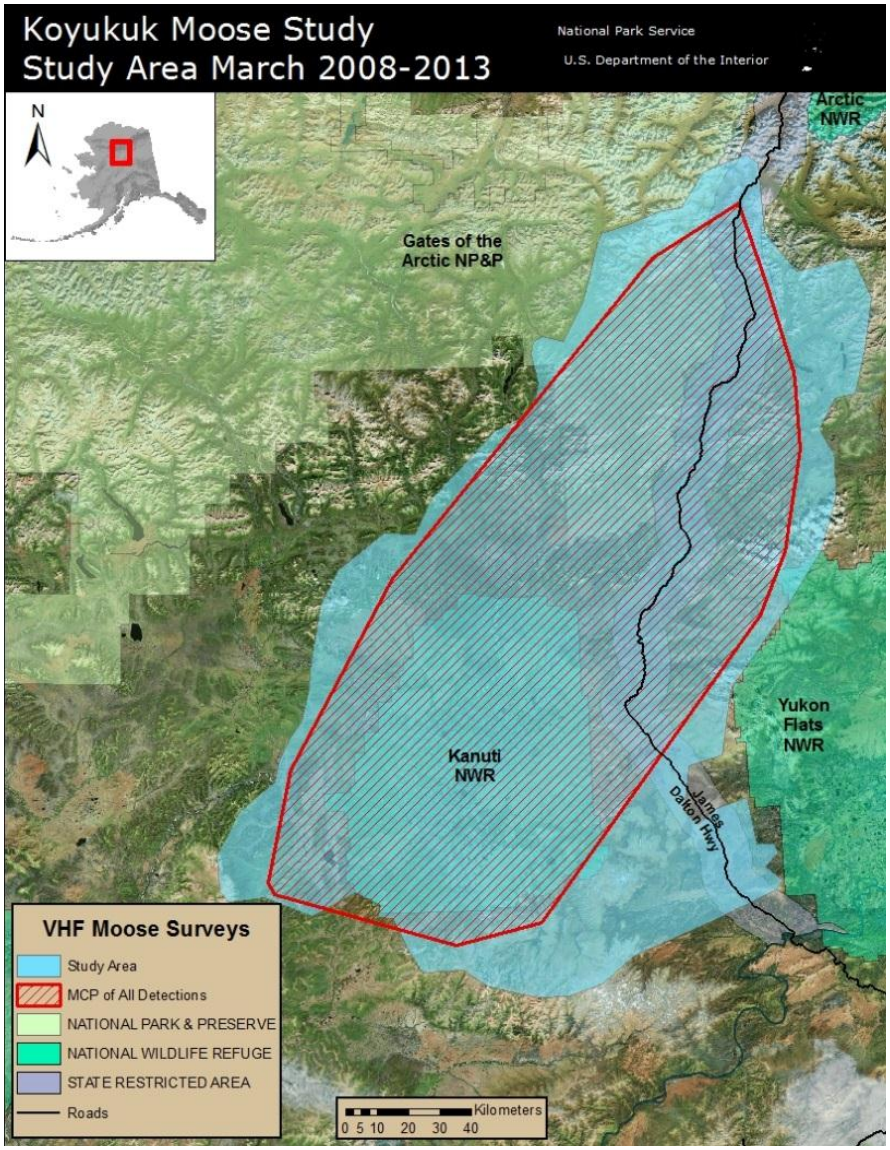

Figure 1. The Koyukuk moose study area with a Minimum Convex Polygon (MCP) encompassing all VHF moose detections from 2008 to 2013.

Methods

Study Area

The study area lies within the upper Koyukuk River region, including all of Kanuti National Wildlife Refuge, the southeast portion of Gates of the Arctic National Park and Preserve, sections of the Dalton Highway Management Corridor, and parcels of State and native owned lands (Figure 1). Habitats range from alpine tundra, shrub lands, taiga and extensive wetlands. The climate is strongly continental.

Moose Capture and VHF Data

Moose were captured using standard aerial darting techniques and equipped with VHF telemetry collars. Thirty-seven individuals were instrumented with GPS collars but the analysis of those data is presented elsewhere (see Joly et al. *in press a, b*). All moose captures adhered to State of Alaska Animal Care and Use Committee (ACUC) guidelines (#07-11). Radio tracking flights were conducted from March 13, 2008 until March 1, 2013. For each location, GPS coordinates and habitat characteristics of the surrounding area were recorded. Survey effort per month ranged from 0 – 7 flights (Table 1) and was contingent on observer and plane availability, weather, logistics and funding.

High-quality (visual observation) moose locations were mapped, attributed and analyzed using ArcMap 10.3 (Environmental Systems Research Institute, Redlands, CA). We used VHF locations of moose to estimate home ranges using 100% Minimum Convex Polygons (MCPs) using the National Park Service's animal movement toolbox in ArcMap 10.3 for all moose with 3 or more locations but focused analyses on moose with 30 or more locations.

We used VHF locations to describe habitat use patterns of moose. We used simple descriptive statistics (e.g., means) to evaluate use between sexes.

Table 1. Number of survey days per month and year for the moose tracking effort within the upper Koyukuk River basin, Alaska, between March 2008 and March 2013.

Month	2008	2009	2010	2011	2012	2013
Jan	-	3	3	0	0	0
Feb	-	2	3	2	2	3
Mar	5	4	4	4	4	1
Apr	3	3	4	4	2	-
May	7	3	6	4	2	-
Jun	1	1	0	2	0	-
Jul	4	3	5	3	0	-
Aug	5	3	2	2	2	-
Sep	4	2	5	4	2	-
Oct	1	3	1	4	3	-
Nov	2	2	7	2	4	-
Dec	2	3	0	0	0	-

Habitat Information

Land-cover and topographical variables used in the habitat use analysis for moose were determined from existing 30-meter resolution raster GIS data (Ducks Unlimited 2002a, 2002b, Homer et al. 2007, Jorgenson et al. 2009). We used a digital elevation model (DEM) to create aspect and terrain ruggedness layers. We categorized aspect into northeast (0-90º), northwest (270-0º), southeast (90-180º), and southwest (180-270). We assigned pixels with no slope as no aspect (flat). We calculated terrain ruggedness using the vector ruggedness measure (VRM; Sappington et al. 2007) at 2 scales: 180 m and 1 km. We reclassified initial land-cover classes into 8 classes (unvegetated, water, conifer forest, deciduous or mixed forest, sedge/herbaceous, tall shrub, dwarf shrub and tussock tundra). We estimated time since last fire (TSLF) using fire inventory data from the region (Alaska Fire Service). All GIS-derived attributes were obtained from the 30-meter grid cell that contained the coordinates (i.e., latitude/longitude) of the visual observation.

Land-cover and Fire Class Error Assessment

We collected both land-cover and fire information at each VHF location during the telemetry flight. We assessed the percentage of locations that had the same classification of land-cover and TSLF using the mirroring GIS layers and visual information collected at VHF locations. For the comparison, an area was considered burned if the digital fire data indicated 99 years or less since last fire and unburned if greater than 100 years.

Results

Moose Locations

We collected 2119 VHF locations via aerial telemetry flights from 119 individual moose (92 female, 27 male) between March 2008 and March 2013 (Figure 2). The number of detections per animal ranged from 1-53.

Home Ranges of Moose

Of the 119 individuals monitored in this study, only 23 moose had ≥30 locations (Table 2). All of these had MCPs which intersected Kanuti National Wildlife Refuge (Figure 3). The number of locations for males (mean = 43.8) was similar to females (mean = 42.3) for these 23 moose.

Table 2. Estimates of moose home range size with 30 or more detections in the Koyukuk study area using 100% Minimum Convex Polygons.

Sex	n	Mean Area (km^2)	SE	Range (km^2)
Male	4	304.4	103.4	130.1 - 603.1
Female	19	510.4	118.9	83.7 - 2092.9

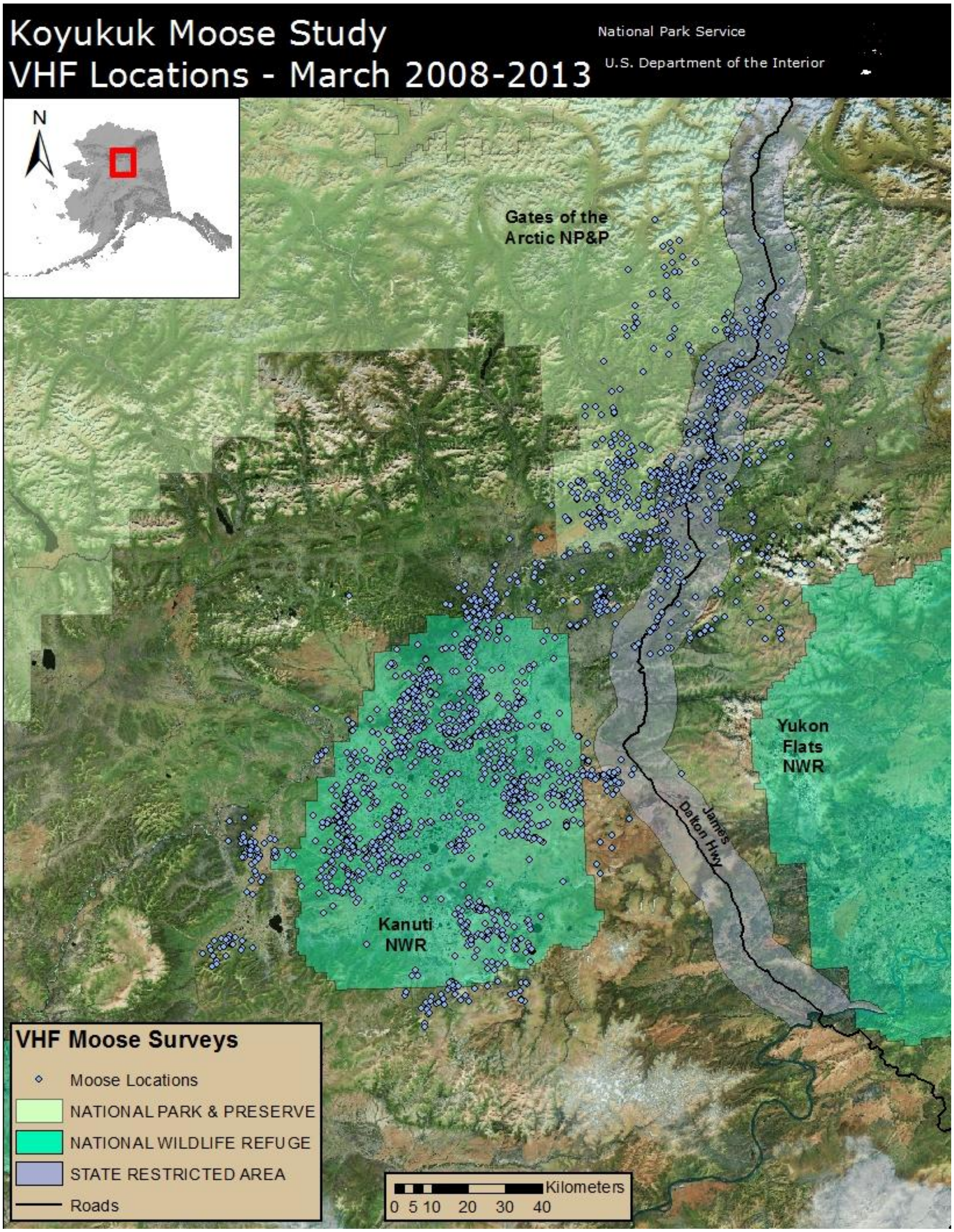

Figure 2. All 2119 high-quality VHF moose locations in the study area from 2008 to 2013.

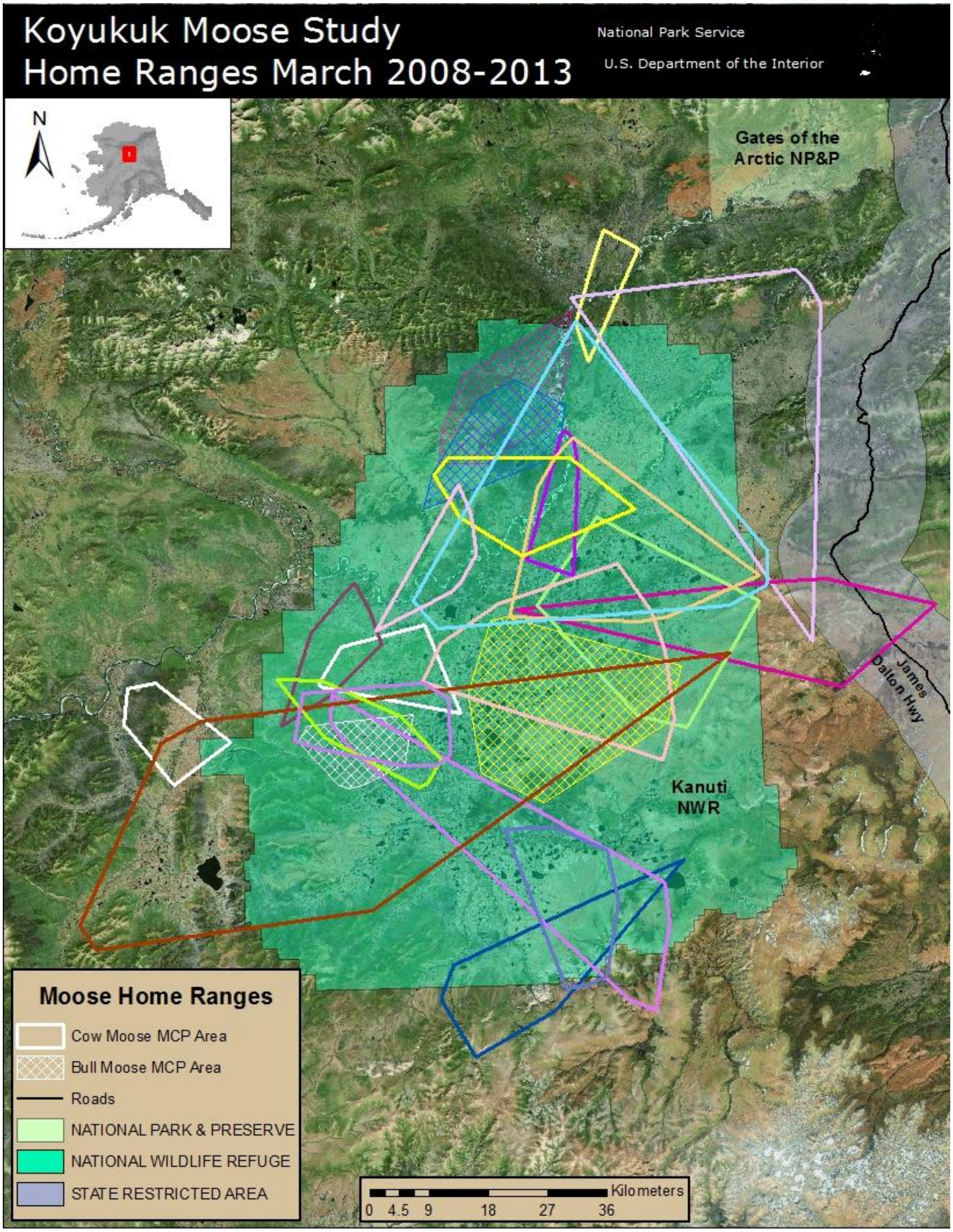

Figure 3. Minimum Convex Polygons for the 4 male and 19 female moose with 30 or more detections with individuals identified by distinct colors.

Habitat Use Patterns of Moose

Use of topographical features varied by sex. Females tended to use lower elevation areas (365 m) than males (444 m). Individual means ranged from 155.8 to 866.2 m, while individual locations ranged from 121.9 m to 1271.9 m. Males were found, on average, in more rugged terrain, at both the fine (180 m) and coarse (1 km) scales that we analyzed (Table 3).

Table 3. Mean terrain ruggedness values for moose detections by sex.

Sex	180 m	1 km
Female	0.003969	0.029493
Male	0.004425	0.038107

Usage of flat areas was low for both sexes (Figure 4). Approximately 31 % of the study area was categorized as flat. Males were detected on southeast aspects more than any other aspect, while females were most commonly found on northwest slopes.

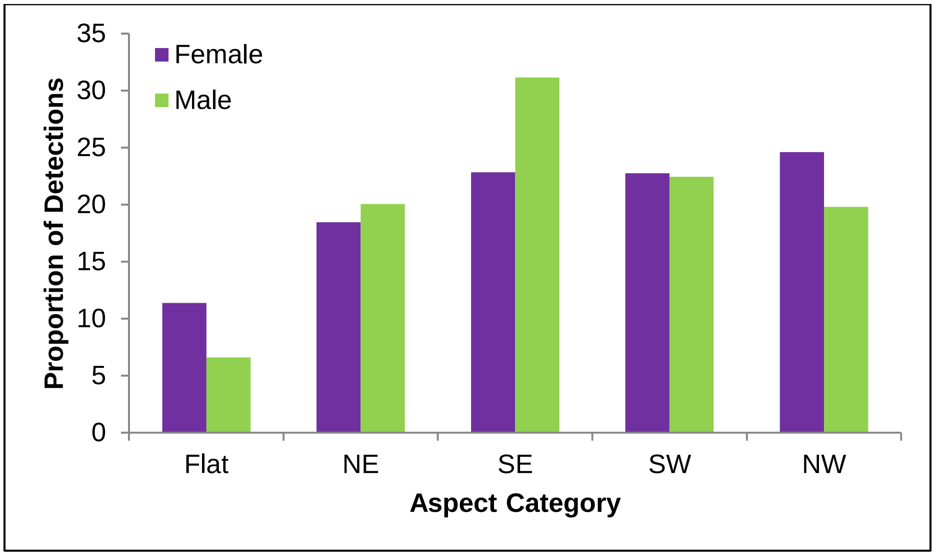

Figure 4. Proportion of moose detections in each aspect category.

Forested habitats were utilized heavily by both male and female moose (Table 4, Figure 5). Specifically, conifer forest was the habitat type most used, though deciduous/mixed forest habitats were often used. Tall and dwarf shrub habitats were the next most commonly used groups, with relatively few locations found in other habitat types.

Table 4. Totals of moose detections in each GIS habitat type.

	Count of Detections	
Vegetation Class	**Female**	**Male**
Unvegetated	109	17
Water	55	8
Conifer Forest	625	174
Deciduous/Mix Forest	393	54
Sedge/Herbaceous	29	10
Tall Shrub	212	43
Dwarf Shrub	293	71
Tussock	15	2
No Data	9	0
Total	**1731**	**371**

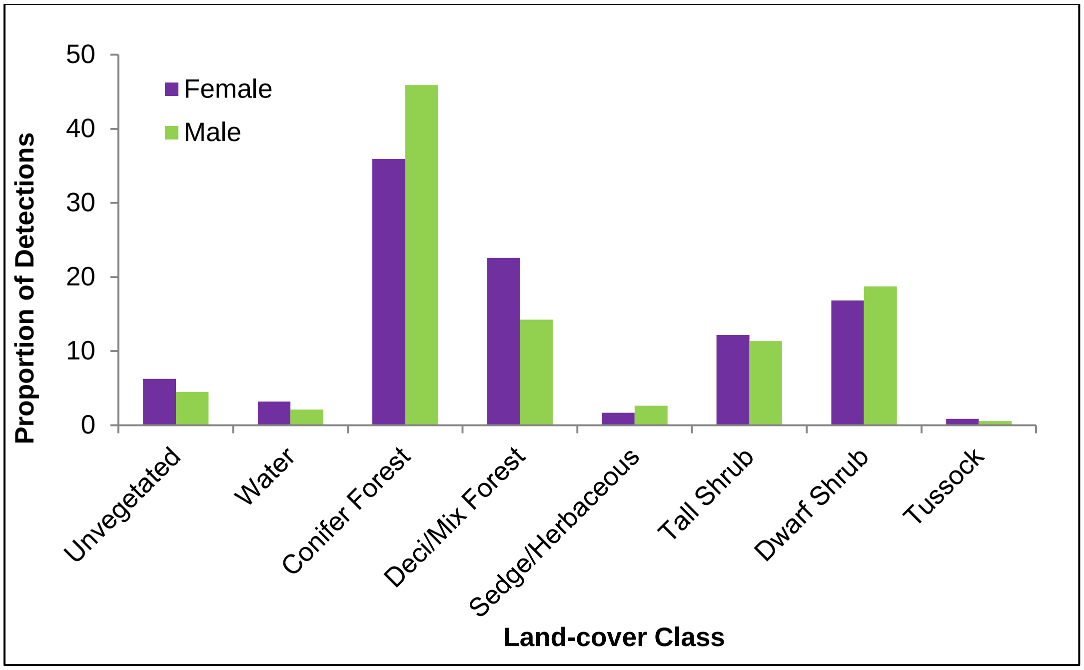

Figure 5. Proportion of moose detections in each GIS habitat type.

Both sexes utilized unburned areas most heavily (Figure 6), although males used unburned areas to a greater degree. Areas burned 10 - 30 years ago were the second most utilized by both sexes, and females used recently burned and 30 – 60 year old areas more than males. Neither sex appeared to utilize areas burned 60 - 99 years ago.

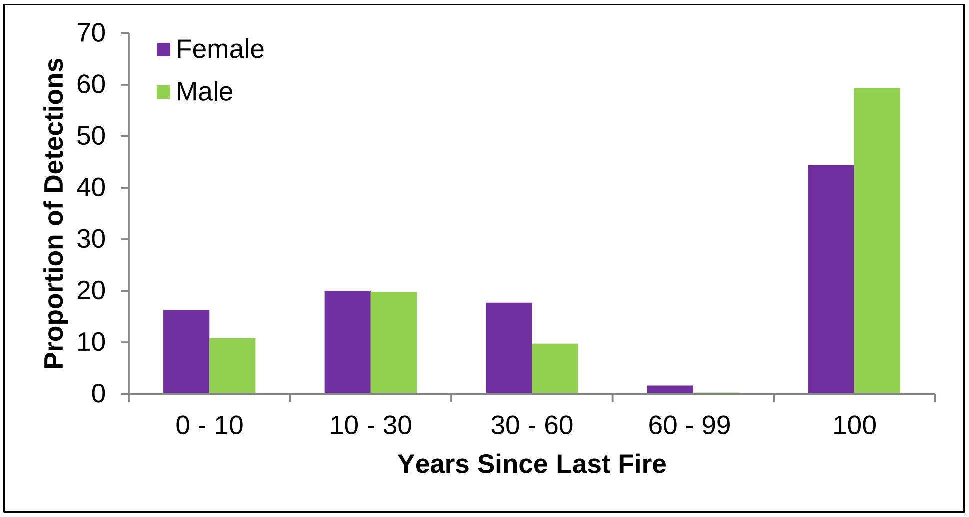

Figure 6. Proportion of moose detections in each fire history type.

Land-cover and Fire Class Error Assessment

We used land-cover and fire information collected at 1899 VHF locations to assess classification comparability of the digital land-cover and fire maps to visual observations obtained from radio tracking flights. This differs from the 2119 total locations due to incomplete data recording or incomparable vegetation characteristics.

Habitat types identified by observers from fixed-wing aircraft while tracking moose generally did not match up well with habitat types attributed to those locations using the GIS layers (Table 5). The most commonly used habitat types (conifer forest, deciduous/mixed forest and tall shrub) showed the greatest levels of agreement between the 2 systems, whereas infrequently used habitat types showed very poor levels of agreement.

Burn classification between the aerial observer and the digital fire perimeter data matched for 64.9% of all locations. Areas categorized as burned by the observer comprised 28.7% of all moose locations.

Table 5. Comparison between visual and GIS habitat type classifications.

Vegetation Type	Total Visual Locations	% Match
Unvegetated	106	0
Water	58	10.3
Conifer Forest	716	45.8
Deciduous/Mix Forest	421	36.8
Sedge/Herbaceous	35	0
Tall Shrub	229	49.3
Dwarf Shrub	319	10.3
Tussock	15	0

Discussion

On initial consideration, 2119 total moose locations collected throughout this 5 year study may seem substantial. However, when considered at the individual level, locations ranged from 1 to 53. We considered home ranges of the 23 moose with 30 or more detections, but 50 detections is the widely accepted minimum for MCP analysis. We only had 3 moose with more than 50 detections. Further, we are not confident about making comparisons between male and female home ranges due to their differences in sample size, 4 and 19, respectively. These factors become evident when considering the wide range of female MCP areas: 83.7 - 2092.9 km^2. For all of these reasons, we are not confident enough in our home range data to make any VHF-based extrapolations for moose home ranges in the study area.

While these data are limited in scope for home range analysis, characteristics of each individual moose location can be informative. Moose were detected predominantly in conifer and deciduous/mixed forest types, which are the dominant vegetation type in the study area. Both sexes were detected most often in unburned areas, which may be surprising given the frequent fire history of the area and reported selection of habitats burned 10-30 years ago. We also found that moose used slopes more than flat areas. We did not provide available habitat information in this report because we feel the VHF data is not robust enough to analyze moose habitat use.

Comparisons of vegetation classification between aerial observations and remote sensing data exhibited less agreement than we expected. The most common habitat types exhibited the most agreement, although less than half matched up. Many explanations may account for this, such as micro-scale habitat differences within a larger habitat resolution scale, differences between observed habitat and the location marked by a GPS in an airplane, and differences between habitat types missed by remote sensing software. Visual assessment of habitat type from aircraft looked at the area nearby (i.e., ~ ¼ mile circle around the moose), whereas the GIS assessment determined the habitat type for the exact, recorded position of the moose that fell within a 30m cell of the remotely-sensed land cover map. These methodological differences also likely were a factor in the poor agreement between techniques. In contrast, our fire history data exhibited greater concurrence. Aerial observations classified nearly 30% of locations as burned while roughly 35% of all locations were classified based on GIS layers as burned within the last 30 years (visually, the time frame most easily recognized as burned).

Management Implications

Many wildlife projects in Alaska have to make difficult decisions about the number and type of radio collars they utilize. VHF collars are much less expensive than GPS collars but require substantial aviation costs and risks in order to collect data. Dedicated efforts to aerial track VHF collared moose monthly only resulted in a maximum of 30-50 relocations per individual over a 5-year study period. Using these data, male moose had smaller home ranges than females. This finding runs contrary to the results utilizing GPS radio collars in this study (Joly et al., *in press a,b*) and elsewhere (Hundertmark 1997) and is likely erroneous due to poor sample sizes of both individuals and number of relocations. While visual observations of habitat utilized by moose are likely superior to habitat classifications assigned by remotely-sensed imagery, the paucity of VHF relocations simply did not allow for a robust analysis of habitat selection using the VHF data. The premiere use of VHF collars comes from data that is not related to relocations but rather visual observations. In our study, that information is presence or absence of a calf, which will be utilized to analyze productivity of moose in the region in another resource report. For future moose projects involving tracking collars, we recommend the use of GPS-equipped collars for studies not solely focused on productivity. GPS collars collect more data at more regular and shorter intervals than VHF-only collars but also allow biologists to track individual animals and visually observe them, their environment, and how they interact with the environment, as needed, if the GPS collars are equipped with VHF beacons. The combination of copious data and biologists intimately connected to the data streams, via captures and visual observations from aircraft, will likely provide the greatest opportunities for data analysis and reasoned interpretation.

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NPS 185/128681, May 2015

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