



Aerial Moose Survey within and around Gates of the Arctic National Park and Preserve, March 2015

Natural Resource Report NPS/GAAR/NRR—2015/967



ON THE COVER

Supercub on wheel-skis taking a break during moose surveys, March 2015.

Photograph by: Alina Pontynen

Aerial Moose Survey within and around Gates of the Arctic National Park and Preserve, March 2015

Natural Resource Report NPS/GAAR/NRR—2015/967

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Abstract/Executive Summary

Moose (*Alces alces*) are an integral component of the boreal ecosystem in Gates of the Arctic National Park and Preserve (GAAR) and are considered good indicators of long-term habitat change within the Park ecosystem. The National Park Service (NPS) surveyed moose in a 6,118mi² (15,846 km²) area in and around GAAR, which included the Alatna, John, and North and Middle Fork of the Koyukuk rivers, during 19 – 24 March 2015. We used the Geo-Spatial Population Estimator (GSPE; Ver Hoef 2002) technique to estimate moose abundance. The population estimate for GAAR was 833 moose (90% confidence interval = 710-957) which yielded a density of 0.16 moose/mi² (0.06 moose/km²). The calf ratio estimate was 10 calves:100 adults. Our results suggest that there has been no significant change in moose abundance within GAAR since the previous population estimate in 2004.

Acknowledgments

We thank all of the pilots (Curtis Cebulski, Dan Shelden, Seth McMillian, Jim Cummings, and Andy Greenblat) and observers (Alina Pontynen, Katie Orndahl, Marci Johnson, Rick Osburn, and David Rosser) that made this project productive and enjoyable. We thank Curtis Cebulski for providing valuable aviation management and safety skills. We thank Mike Spindler for allowing us to use FWS facilities in Bettles and conversations about study design and logistics. We thank the BLM for personnel and financial support.

Data Summary

Entire Survey Area

Survey Dates: 21 – 24 March, 2015

Total area covered by survey: 6,118mi² (15,846 km²)

Total moose observed: 207 moose (188 adults and 19 calves)

March population estimate: 929 (90% confidence interval = 791 – 1,067 or +/- 15 %) moose

Estimated total density: 0.15 moose/mi² (0.06 moose km²)

Estimated ratios: 9.8 calves:100 adults

Gates of the Arctic National Park and Preserve (GAAR) Subset

Survey Dates: 21 – 24 March, 2015

Total area covered by survey: 5,106 mi² (13,225 km²)

Total moose observed: 191 moose (172 adults and 19 calves)

March population estimate: 833 (90% confidence interval = 710 – 957 or +/- 15 %) moose

Estimated total density: 0.16 moose/mi² (0.06 moose km²)

Estimated ratios: 10 calves:100 adults

Middle and North Fork Koyukuk River Drainage (KRD) Subset of GAAR

Survey Dates: 21 – 24 March, 2015

Total area covered by survey: 2,147 mi² (5,561 km²)

Total moose observed: 106 (98 adults and 8 calves)

March population estimate: 430 (90% confidence interval = 354 – 505 or +/- 18 %) moose

Estimated total density: 0.20 moose/mi² (0.08 moose/km²)

Estimated ratios: 8.6 calves:100 adults

Ambler Road Area (ARA) Subset

Survey Dates: 23 – 24 March, 2015

Total area covered by survey: 1,011 mi² (2,618 km²)

Total moose observed: 16 moose (16 adults and 0 calves)

March population estimate: 96 (90% confidence interval = 54 – 137 or +/- 43 %) moose

Estimated total density: 0.09 moose/mi² (0.04 moose km²)

Estimated ratios: 8.4 calves:100 adults

Introduction

Moose (*Alces alces*) are an integral component of the boreal ecosystem in Gates of the Arctic National Park and Preserve (GAAR). Moose are considered good indicators of long-term habitat change within the Park ecosystems because they require large quantities of resources from their habitat year-round, and populations have the potential to respond dramatically to long-term changes in resource conditions. In addition, moose are an important subsistence resource for the residents of Bettles, Evansville, Wiseman, Alatna, and Allakaket.

The National Park Service (NPS) surveyed moose in a 6,118mi² (15,846 km²) area in and around GAAR, which included the Alatna, John, and North and Middle Fork of the Koyukuk rivers, during 19 – 24 March 2015. Moose surveys within this area had only been previously conducted once, during the fall of 2004. Results from the 2004 survey indicated that GAAR had a relatively low moose density (0.19 moose/mi² [0.07 moose/km²]) with an age composition of 25 calves:100 cows (14 calves:100 adults; Lawler et al. 2006). For both the previous and current surveys, the GeoSpatial Population Estimator (GSPE; Ver Hoef 2002) technique was used to estimate moose abundance.

The objectives of the 2015 moose survey were to: 1) continue monitoring the moose population in and around GAAR, using the GSPE method, for management decision purposes, 2) improve the precision of the population estimate by conducting an aerial stratification and re-allocating sampling effort, and 3) estimate moose abundance on lands that are adjacent to GAAR that have been proposed for industrial road development.

Study Area

The survey area is bounded by the Brooks Range to the north (67° 58'N), the Alatna River (155° 26'W) to the west, the Dalton Highway (150° 20'W) to the east, and by the Alatna Hills or northern boundary of the Kanuti NWR to the south (67° 00' N). Principal land managers in this area are the State of Alaska, BLM, NPS, and Native corporations and villages. Vegetation types include spruce and deciduous forest and woodland, tall shrub, low shrub, prostrate shrub, mesic herbaceous, sparsely vegetated areas, and aquatic habitat. Survey units that were entirely alpine or water were intentionally excluded from the survey because those habitats are not typically utilized by moose.

The survey area was analyzed in its entirety as well as 2 subunits, which were: GAAR (5,106 mi² [13,225 km²]), and the proposed Ambler Road Area (ARA) (1,011 mi² [2,618 km²]) (Figure 1). The GAAR subunit was created so that comparisons to the 2004 survey could be conducted. The ARA subunit was created to assess moose populations in an area that has been proposed for the development of an industrial mining road. Further, we differentiated a subunit of GAAR as the Koyukuk River Drainage (KRD) (2,147 mi² [5,561 km²]) at the request of Bureau of Land Management (BLM). The terrain in GAAR and KRD varies from rugged, mountainous areas, 6560 feet (2000 m) in elevation, with a mix of alpine, shrub, and boreal forest habitat types. The landscape in the ARA is comparatively flat and largely composed of boreal forest and small lakes.

Gates of the Arctic NPP Moose Survey
Survey Area March 2015

National Park Service
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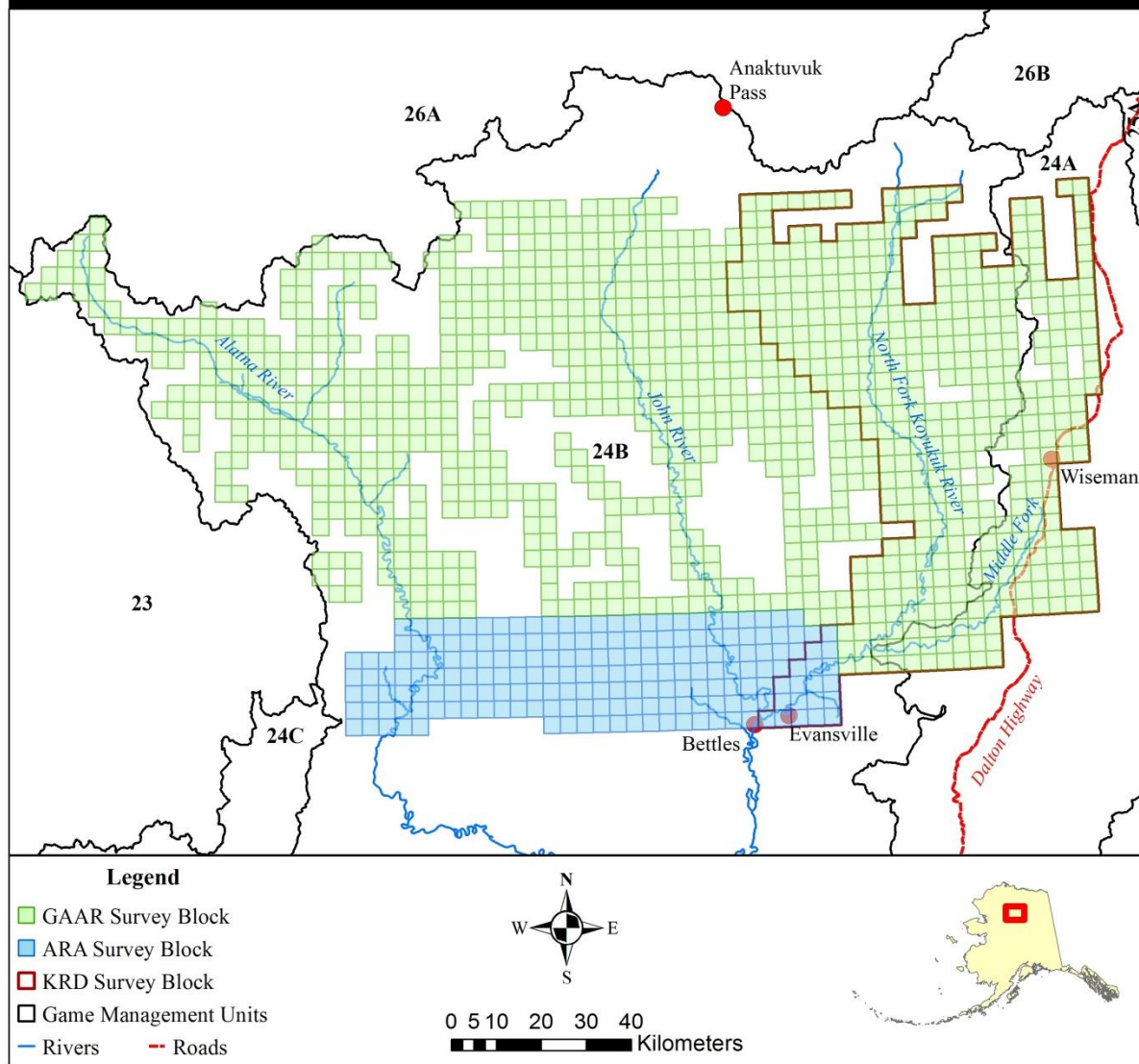


Figure 1. Gates of the Arctic National Park and Preserve moose survey unit boundaries. White areas within the survey boundary were excluded as high alpine and non-moose habitat.

Methods

We conducted a moose population survey using the GeoSpatial Population Estimator (GSPE) method, a modification of a technique initially developed by Gasaway et al. (1986). The GSPE method is widely used in Alaska, which allows comparison between survey areas. The GSPE method is discussed in detail in Kellie and DeLong (2006) but is summarized in this report.

The survey area was delineated using a Geographical Information System (GIS) layer developed by the Alaska Department of Fish and Game (ADFG) that divides the state into a grid of sample units that measure 2 minutes latitude by 5 minutes longitude on a side. Sample units in our survey area averaged about 5.1 mi² (13.2 km²) in size. The area includes 999 sample units that were surveyed in and around GAAR during 2004 (Lawler et al. 2006). We added an additional 195 sample units in 2015 to encompass State and private lands south of GAAR, in the Alatna hills and lower Alatna River drainage that had not been included in previous surveys. The impetus for the inclusion of these additional lands was to identify moose densities within the area slated for road development. In all, the total survey area consisted of 1194 sample units. We used a subset of the GAAR survey area, 420 survey units, to estimate population abundance within the Middle and North Forks of the Koyukuk rivers. This information was requested by BLM for management efforts.

Moose GSPE surveys have 2 components: stratification and intensive surveys. Stratification flights were conducted within the GAAR survey area before survey flights to assign sample units to “high” or “low” moose density stratum. We defined high stratum as 1 or more moose and low stratum as no moose. A stratification survey improves the precision of population estimates by reducing the variance of the estimate.

Stratification flights were conducted using a Cessna 206 sequentially flying over the center of each unit within the lowland areas and along contours within mountainous areas. The stratification crew consisted of 2 back-seat observers, a front-seat navigator/observer, and the pilot. Each unit was evaluated and then classified as “high” or “low” based on habitat characteristics, the number of moose observed, and/or the number of moose tracks. Only the pilot had previous experience stratifying moose survey areas. No stratification had been previously conducted in this area.

Sample units for the intensive surveys were randomly selected from each density strata (Kellie and DeLong 2006). Approximately 10 – 20% of the units were withheld from the random selection and subjectively used to fill in between blocks of units because the GSPE has a spatial component whose results are improved if there are no gaps (<50 km) among surveyed units.

Sampling density affects the precision of the population estimate. Observations are more variable in the high stratum than the low stratum, therefore, it was recommended to sample a greater proportion of the highs to reduce variance (Taras 2014). Therefore, our target was to sample 30% and 15% of the high and low stratum, respectively.

The survey utilized 4 planes, each with a pilot and 1 observer. Planes included 2 Piper Supercubs (Shadow Aviation and Golden Eagle Aviation) and 2 Piper Topcubs (National Park Service). All pilots, but only 1 observer, had previous experience in aerial moose surveys.

Survey aircraft used Global Positioning System (GPS) receivers to identify the boundaries of sample units. Search intensity varied with habitat. Greater effort was spent in areas with higher canopy cover (e.g., forests versus muskeg) or where fresh moose tracks were observed. Moose observed were assigned a group number and the coordinates of the group were recorded using the aircraft GPS receivers. Survey methodology assumes 100% sightability of moose (although this assumption is likely never met; Boertje, ADFG, unpublished data). Numbers of moose in each group were recorded. Moose were categorized as either adult or calf. Moose population estimates within the survey area were made using a web-based GSPE analysis program (Ver Hoef 2002; winfonet.alaska.gov).

Within GAAR, the population had only once been estimated. The previous survey was conducted during the fall of 2004 (Lawler et al. 2006). The 2015 survey was not conducted in the fall because of lack of snow, but also because other moose surveys in northwest Alaska are typically conducted in spring (e.g., Lawler and Dau 2006). Because surveys were not conducted during the same season, estimates are not directly comparable.

Results

Stratification and Survey conditions

The stratification was conducted 19 – 23 March 2015. The survey was conducted 21 - 24 March 2015. No new snow had accumulated in > 2 weeks; however, snow conditions during the survey period were good with complete snow cover of ground vegetation. Temperatures were generally well above 15° F (-9° C). Weather conditions during the survey period were consistently clear and calm with sunny conditions that produced relatively good light conditions (bright light and medium to high intensity light). To improve survey conditions by avoiding long shadows, survey times were restricted between 9:30 am and 6:30 pm. Few delays and changes in survey strategy occurred due to favorable weather conditions.

Stratification Results

Of the 999 sample units within GAAR, 421 (42%) and 578 (58%) were determined to be high and low density survey units (SUs), respectively. Of the 194 sample units within ARA, 50 (26%) and 144 (74%) were determined to be high and low density SUs, respectively. Of the 420 sample units within KRD, 215 (51%) and 205 (49%) were determined to be high and low density SUs, respectively (Table 1, Figure 2). The mean number of moose observed in high density SUs during the surveys was nearly 3, 6, and 6 times the number of moose detected in low density strata within the GAAR, ARA, and KRD areas, respectively. These data indicate that using the stratification classifications was useful for identifying areas of different moose abundance, and subsequently minimizing the variability in moose abundance among survey units. Flight pattern tracks from the stratification are presented in Appendix I.

Table 1. Number of survey units within each survey area and strata, and proportion of SUs intensively surveyed during the Gates of the Arctic National Park and Preserve moose survey, Alaska, March 2015.

Study Area	<u># of Survey Units</u>			<u>Units Surveyed (%)</u>		
	Total	High	Low	Total	High	Low
GAAR	999	421	578	197 (20)	117 (28)	80 (14)
KRD*	420	215	205	82 (20)	59 (27)	23 (11)
ARA	194	50	144	36 (18)	12 (24)	24 (17)

* Subset of GAAR

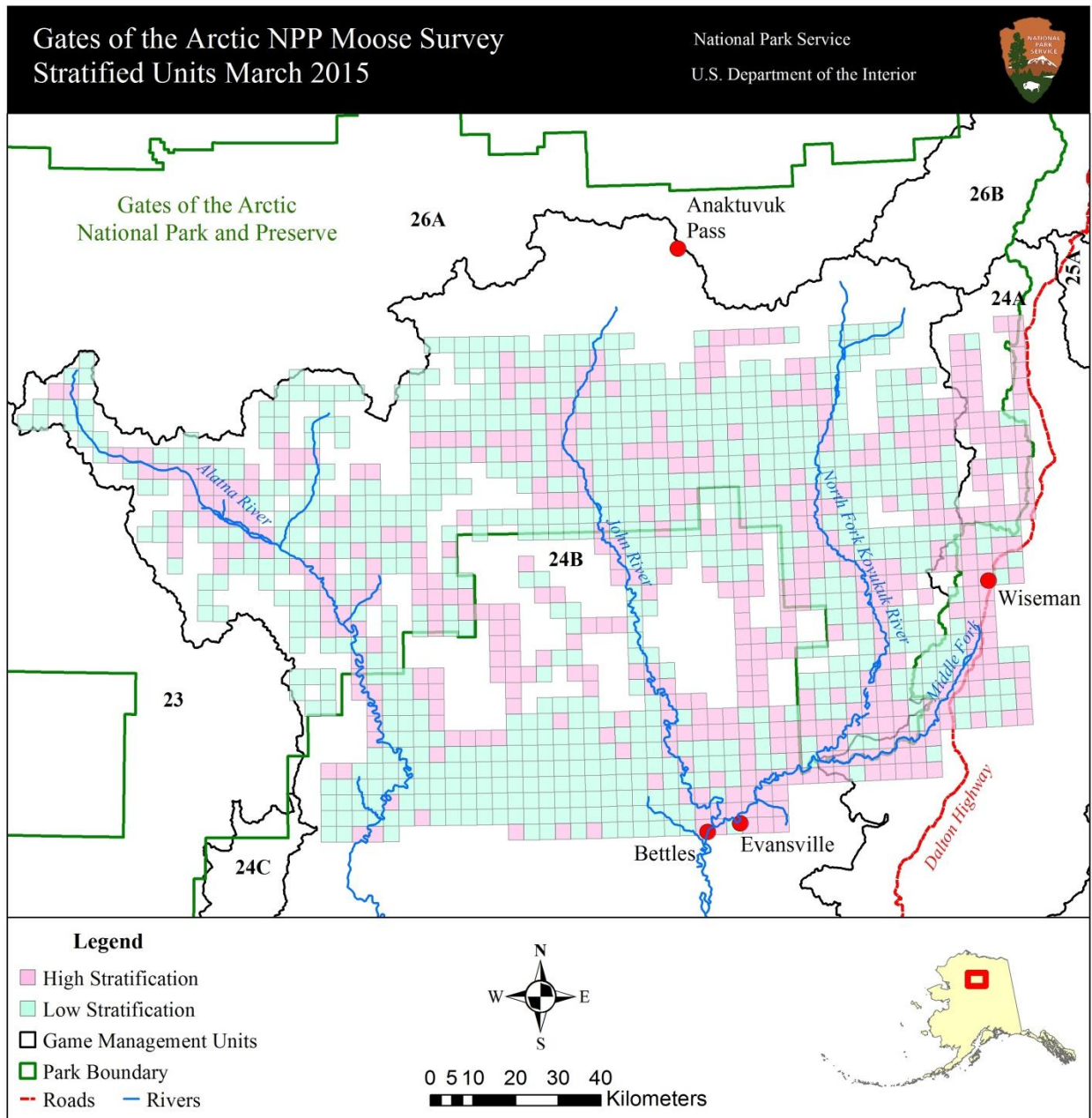


Figure 2. High and low density moose stratum determined from an aerial stratification in and around Gates of the Arctic National Park and Preserve, 19-23 March, 2015.

Population survey results

Of the 999 sample units within GAAR, 197 (20%) were surveyed. 117 (28%) of the high density units and 80 (14%) of the low density units were surveyed (Table 1). Of the 195 sample units within ARA, 36 (18%) were surveyed for moose. 12 (24%) of the high density units and 24 (17%) of the low density units were surveyed (Table 1). Of the 420 sample units within KRD, 82 (20%) were surveyed for moose. 59 (27%) of the high density units and 23 (11%) of the low density units were surveyed (Table 1). Survey time per unit ranged from 3 – 60 minutes with a mean of 19.2 (SD = 8.7 minutes spent in survey units). The number of survey planes used ranged from 3 – 4 airplanes per

day. The maximum number of units surveyed by any 1 plane during a single full day's attempt was 25 (mean = 15.5; range = 10 – 25). Variation in the number of units surveyed depended on habitat cover type (i.e., units with closed tree canopy required more time to survey); however, additional factors such as distance from Bettles, light conditions, fuel needs, number of moose in a unit, and local weather also increased variation. Flight pattern tracks from the intensive survey are presented in Appendix I.

Observers classified 191 observable moose within the 197 units surveyed in GAAR and counted a range of 0 – 8 moose in single units (Figure 3). This yielded an average count of about 1.0 moose per surveyed unit. Of these moose, 172 adults and 19 calves were classified. Observers classified 16 observable moose within the 36 units surveyed in ARA and counted a range of 0 – 4 moose in single units. This yielded an average count of about 0.4 moose per surveyed unit. All 16 moose were classified as adults. Observers classified 106 observable moose within the 82 units surveyed in KRD and counted a range of 0 – 8 moose in single units. This yielded an average count of about 1.3 moose per surveyed unit. Of these moose, 98 adults and 8 calves were classified.

The GSPE population estimate for GAAR was 833 moose (90% confidence interval = 710-957 [14.8% error of estimate]) which yielded a density of 0.16 moose/mi² (0.06 moose/km²; Table 2). The ARA population estimate was 96 moose (90% confidence interval = 54 – 137 [43.4% error of estimate]) for a density of 0.09 moose/mi² (0.04 moose/km²; Table 2). The KRD population estimate was 430 moose (90% confidence interval = 354 – 505 [17.6% error of estimate]) for a density of 0.20 moose/mi² (0.08 moose/km²; Table 2).

Aviation and project costs for the 2015 Gates of the Arctic NPP spring moose survey are found in Appendix II. Complete survey results for the entire 2015 survey are archived in, and can be retrieved from, the ADFG WINFONET database under the survey name “2015, GAARALL” (<http://winfonet.alaska.gov/>; accessed 1 April 2015).

Table 2. Estimated number, density and composition of moose in Gates in the Arctic National Park and Preserve including the Alatna, John and North and Middle Fork Koyukuk rivers, Alaska.

Study Area	Year	Total Moose		90% CI ^a		Density (moose/mi ²)	Composition Calves: 100 Adults
		#	(±SE)	Range	(% of est.) ^b		
GAAR	2004	968	(140.5)	737 – 1199	(24)	0.18	14.0
GAAR	2015	833	(75.0)	710 – 957	(15)	0.16	10.0
KRD	2015	430	(46.0)	354 – 505	(18)	0.20	9.8
ARA	2015	96	(25.2)	54 – 137	(43)	0.09	8.4

^a Upper and lower bounds of confidence intervals (CI).

^b The confidence interval expressed as a percentage (±) of the total estimate.

Gates of the Arctic NPP Moose Survey Surveyed Units and Moose Detections March 2015

National Park Service
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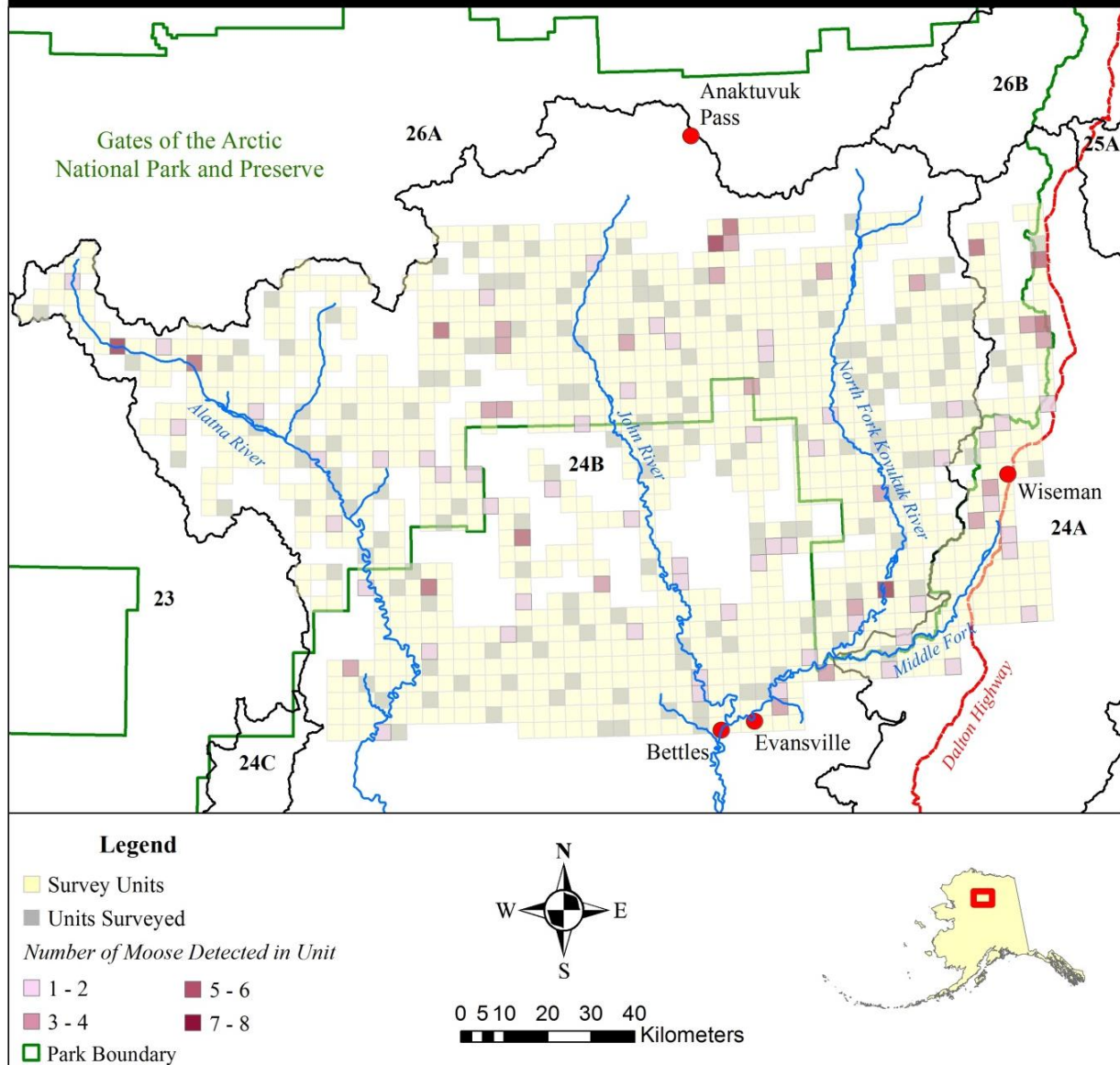


Figure 3. Survey units delineated for a moose survey within and around Gates of the Arctic National Park and Preserve. Randomly selected units that were surveyed are indicated on the map, including those units that were found to contain moose.

Discussion

Our results suggest that there has been no significant change in moose abundance within GAAR since the previous population estimate in 2004. Although there has been a 14% decline in moose abundance based on the point estimates, the confidence intervals of these point estimates largely overlap - suggesting no change. Furthermore, inference to the population is confounded because the surveys occurred during different seasons. One would expect that fewer individuals should exist in a moose population at the end of winter than at the beginning. Thus, the decline in the point estimate may, in part, represent a seasonal population change rather than an inter-annual change.

The age structure of the moose population within GAAR does not appear to have changed significantly since the previous survey in 2004. However, as noted above, direct comparison is not possible due to timing of the 2 surveys. Nonetheless, during the fall of 2004, calf ratios were 14 calves:100 adults (25 calves:100 cows; Lawler 2006) and during the spring of 2015, we estimated the calf ratio to be 10 calves:100 adults. These data suggest calf ratios have remained rather static as compared to the previous survey.

Although current moose densities in GAAR (0.16 moose/mi^2) are low, they are comparable to those in the upper Kobuk (0.18 moose/mi^2), the survey area immediately to the west, and Kanuti National Wildlife Refuge (range since 1999: $0.20\text{--}0.39 \text{ moose/mi}^2$), the survey area immediately to the south (Lawler and Dau 2006, Craig and Stout 2014). Both GAAR and the upper Kobuk share many similarities in that they are dominated in the north by the Brooks Range and a substantial amount of suitable moose habitat occurs in the relatively high elevation drainages (Lawler and Dau 2006, Lawler et al. 2006).

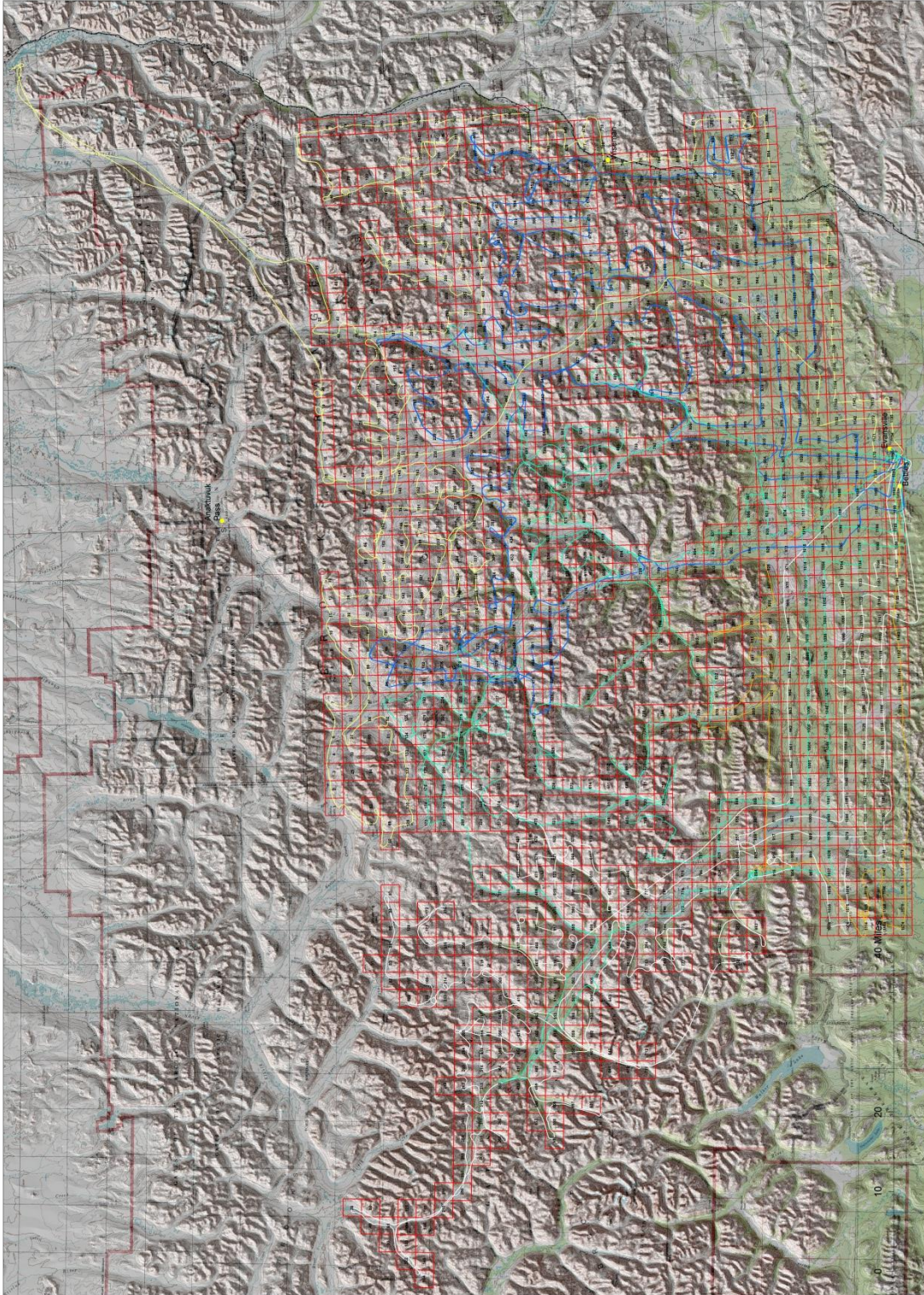
In comparison to the 2004 GAAR moose survey, the precision of the 2015 population estimate was greatly improved (as indicated by the smaller 90% confidence interval) even though nearly the same proportion of SUs (18% in 2004 versus 20% in 2015) were sampled. Improvements in precision of the estimate were likely accomplished by 2 factors: aerial stratification and re-allocation of sampling effort. The aerial stratification improved precision of the population estimate by reducing the differences among SUs within each of the stratum. Because high strata inherently have greater variability, we re-allocated sampling effort from low stratum to the high stratum to reduce the variability in the overall population estimate. Even though we proportionally sampled twice as many highs (28%) as lows (14%), previous studies suggest that allocating a greater proportion of sampling effort to the high stratum (75:25 ratio) may further increase precision (Taras 2014). Future efforts may consider identifying the optimal allocation (Gasaway et al. 1986) based on previous surveys within a study area.

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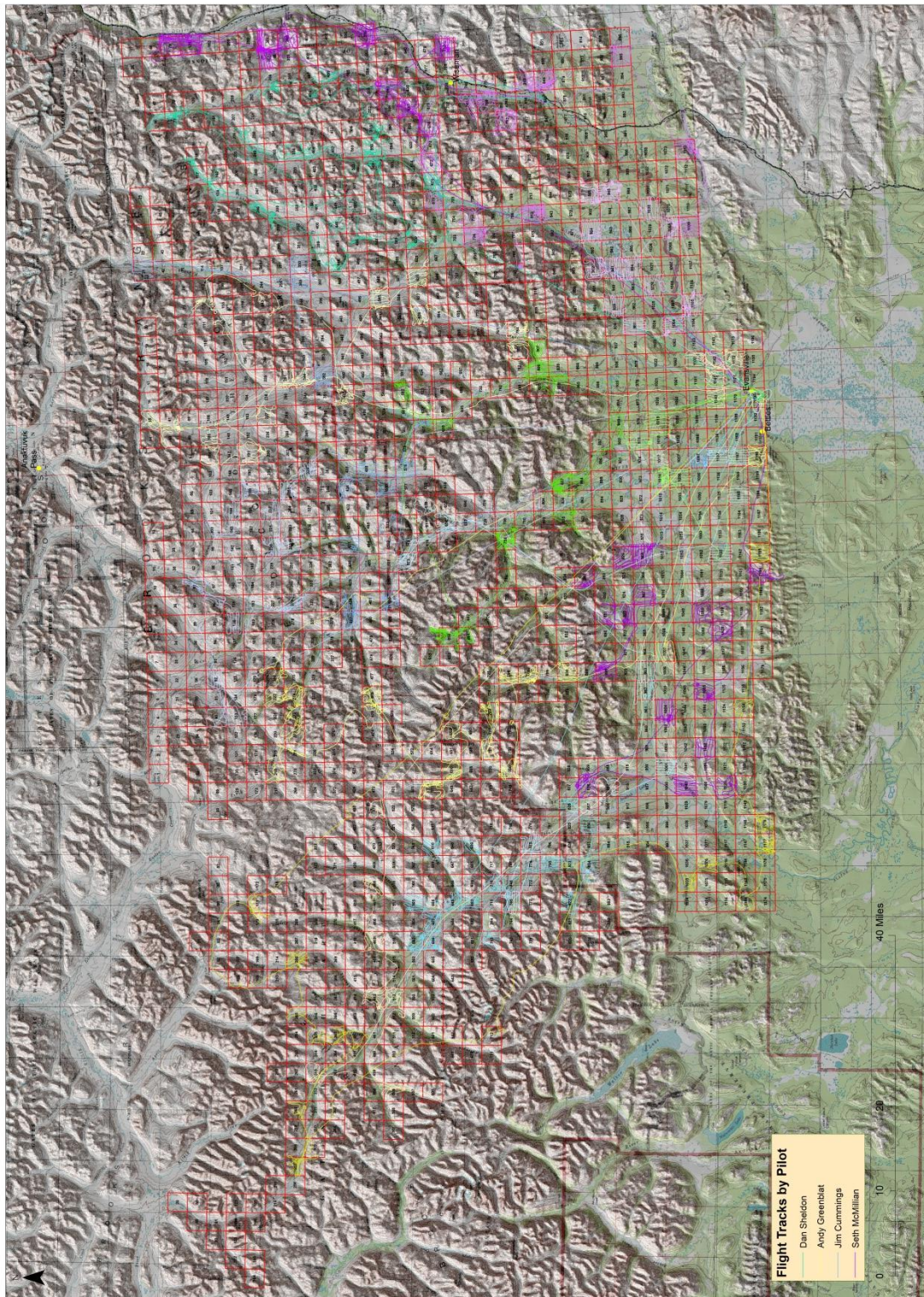
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Appendix I. Flight patterns

A. Stratification flights.



B. Intensive Surveys



Appendix II. Survey Logistics

A. Aviation usage and cost during the 2015 spring moose survey.

Vendor	Plane	Pilot	Description	Hrs	Cost/Hr	Total
Fleet	C-206	Curtis Cebulski	Shuttle	8.0	\$180	\$1,440
Fleet	C-206	Curtis Cebulski	Stratification	31.3	\$180	\$5,634
Fleet	TopCub	Dan Shelden	Survey	25.8	\$125	\$3,225
Fleet	TopCub	Seth McMillian	Survey	36.7	\$125	\$4,587
Golden Eagle	SuperCub	Jim Cummings	Survey	36.8	\$235	\$8,648
Shadow Aviation	SuperCub	Andy Greenblat	Survey	33.4	\$240	\$8,016
Total						\$26,963

B. Overall project cost during 2015 spring moose survey

Category	Description	Quantity	Cost/Unit	Total
Food				\$1,744
Fuel	Bettles 100LL*	1170.5 gal	\$8.80	\$10,300
	Coldfoot 100LL	118.8 gal	\$4.94	\$587
	Fairbank100LL	162.0 gal	\$6.21	\$1,005
Housing	NPS housing	16 rooms	\$12.34	\$197
Aviation	Detailed in Table A			\$26,963
Total Project Cost				\$40,796

* BLM contributed 300 gallons of fuel.

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