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Natural Resource Stewardship and Science

Moose (*Alces alces*) population survey in Yukon-Charley Rivers National Preserve, November 2015

Natural Resource Report NPS/YUCH/NRR—2016/1150

ON THE COVER
Grizzly bear on bull moose kill, November 2015.
Photograph by: Matthew Cameron

Aerial Moose Survey in Yukon-Charley Rivers National Preserve, November 2015

Natural Resource Report NPS/YUCH/NRR—2016/1150

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Contents

Page

Contents iii

Figures ..... **Error! Bookmark not defined.**

Tables ..... **Error! Bookmark not defined.**

Abstract v

Acknowledgments v

Executive Summary vi

Introduction 1

Study Area 2

Methods 3

Results 5

- Weather and Snow conditions 5
- General Survey Results 5
- Population Estimate 7
- Sex and Age Composition 8

Discussion 10

Shortcomings and Future Improvements 12

Literature Cited 13

Appendix I. Survey Logistics 15

Figures

Page

Figure 1. Location of moose survey units within and around Yukon-Charley Rivers National Preserve (YUCH), Alaska. 1

Figure 2. Typical topography and vegetation of the survey area 2

Figure 3. Stratification (indicated by color of survey unit) and numbers of moose counted in each unit in Yukon-Charley Rivers National Preserve, November 2015. 5

Figure 4. Estimated observable fall moose total (with 90% confidence interval) for Yukon-Charley Rivers National Preserve. 8

Figure 5. Observed moose distribution (# represents total number of moose observed in unit) and recent burn activity (1999-2005) within Yukon-Charley Rivers National Preserve. 11

Tables

Page

Table 1. Summary of stratification and sampled units from moose population estimation surveys in Yukon-Charley Rivers National Preserve, 1987 to 2015 6

Table 2. Summary of survey statistics and density estimates for moose population surveys in Yukon-Charley Rivers National Preserve, 1987 to 2015. 7

Table 3. Summary of observed moose during the surveys in Yukon-Charley Rivers National Preserve, 1987 to 2015. 9

Table 4. Number of sets of twins seen during past moose surveys 9

Abstract

Moose (Alces alces) are an integral component of the boreal ecosystem in Yukon-Charley Rivers National Preserve (YUCH) and are considered good indicators of long-term habitat change within the Park ecosystem. The National Park Service (NPS) surveyed moose in a 3,096 mi2 (8,019 km2) area in and around YUCH during 10 – 15 November 2015. We used the Geo-Spatial Population Estimator (GSPE; Ver Hoef 2002) technique to estimate moose abundance. The population estimate for YUCH was 1,138 moose (90% confidence interval = 932-1343, +/- 18%) which yielded a density of 0.37 moose/mi2 (0.14 moose/km2). The age/sex ratios were 27 calves:100 cows, 4 yearling bulls:100 cows, and 64 bulls:100 cows. The estimate of total observable moose has increased since the mid-2000. Major changes to the Park's landscape, such as wildfires during 1999 and 2004 and the 2009 flood, may be affecting bottom-up resources that have contributed to increases in moose abundance.

Acknowledgments

This survey was funded by U.S. National Park Service, Central Alaska Network Vital Signs Monitoring Program, and Yukon-Charley Rivers National Preserve, Alaska. Many safe flight hours and aircraft support were provided during the survey by pilots Dan Sheldon, Jesse Cummings, Seth McMillian, Mike Hinks, and Curtis Cebulski; their help was greatly appreciated. We thank Dave Rosser for organizing aircrafts and pilots, and assistance with communication. Matt Cameron, Kyle Joly, and Mat Sorum served as observers in aircraft. Jillian Richie provided communications and logistical support in Coal Creek Camp. We thank John Burch for edits and helpful comments; in addition, we thank John for conducting moose surveys consistently within YUCH over the last 20 years. Long-term datasets of wildlife populations are invaluable for species management.

Executive Summary

- Survey dates: November 10-15, 2015 (6 days of survey, 1/3 weather days)
- Total survey area: 3,096 mi^2 (8,019 km^2), 555 survey units
- Area surveyed: 714 mi^2 (1849 km^2), 128 survey units
- Total moose observed: 318 (166 cows, 45 calves [4 sets of twins], 107 bulls [7 spike-fork bulls])
- Average search effort: 5.00 minutes/mi^2 (1.93 minutes/km^2)
- Population estimate: 1,138 moose +/- 206 (932-1,343) (+/-18.08% at 90% CI)
- Population estimate with SCF (1.2): 1,365 moose +/- 247 (1,118 – 1,612) (+/-18.08% at 90% CI)
- Estimated density: 0.37 moose/mi^2 (0.14 moose/km^2)
- Estimated age/sex ratios: 27 calves:100 cows, 4 yearlings bulls:100 cows, 64 bulls:100 cows

Introduction

Moose (*Alces alces*) are an integral component of the boreal ecosystem in Yukon-Charley Rivers National Preserve. 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.

The National Park Service (NPS) and the Central Alaska Network of National Park Service (CAKN) conducted an aerial moose survey during November 10 - 15, 2015, in Yukon-Charley Rivers National Preserve (YUCH), Alaska (Figure 1). Moose surveys have been conducted within YUCH for nearly 30 years with 7 surveys being conducted within the current survey area over the last 18 years.

The objectives of the 2015 moose survey were to: 1) estimate numbers of total moose in a 3,096 mi^2 survey area, 2) estimate sex and age ratios, and 3) improve the precision of the population estimate by re-allocating sampling effort.

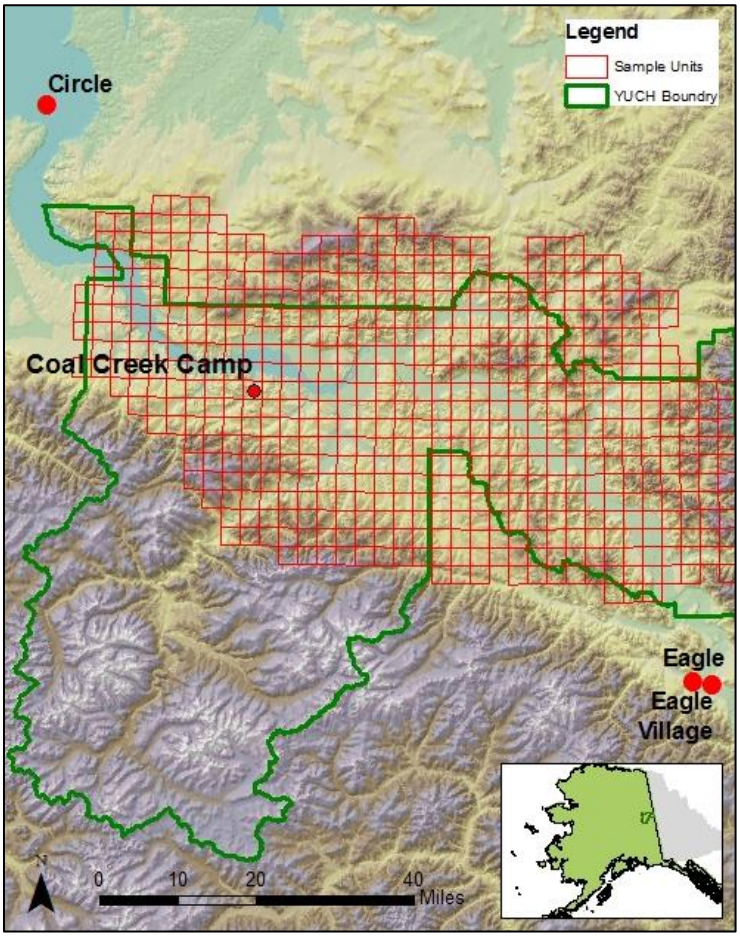

Figure 1. Location of moose survey units within and around Yukon-Charley Rivers National Preserve (YUCH), Alaska.

Study Area

The moose survey was conducted along a 30-40 mile (48-64 km) wide corridor of the Yukon River drainage within YUCH, between Eagle and Circle, Alaska (Figure 1). The topography of the area consists mainly of rolling hills and river bluffs (Figure 2). Isolated rugged terrain occurs on several eroded mountains, with peaks generally under 6000 feet (1200 meters). Vegetation is dominated by black spruce (*Picea mariana*), and several species of deciduous hardwoods including aspen (*Populus tremuloides*) and birch (*Betula papyrifera*). Ponds, sloughs and large areas of tussock tundra are common in the flats along the Yukon River and lower parts of large tributaries such as the Charley and Kandik rivers. Wildfire burns of varying sizes and ages are present throughout the study area including the more recent large fires from summer 1999 and 2004 along the Yukon, Nation and Kandik rivers.

Figure 2. Typical topography and vegetation of the survey area. Mouth of the Kandik River on Yukon River.

Methods

Moose population surveys were conducted 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 publications, "GeoSpatial Population Estimator Software User's Guide" (DeLong 2006), and "GeoSpatial Survey Operations Manual" (Kellie and DeLong 2006) provide guidelines for sample unit design and selection, navigation, and data analysis.

Sample units were stratified into high (3 or more moose) or low (0 - 2 moose) moose densities based on moose locations from previous surveys, locations of wolf-killed moose, and knowledge of the local area (Burch 2003, 2006, 2009, 2012). Nine units (unit numbers: 50, 51, 77, 106, 107, 138, 139, 290, and 492) that were classified as low density during the previous surveys were reclassified as high moose density during the 2015 survey.

Three tandem seat fixed-winged aircraft (Piper PA-18, Top Cub CC-18, and Aviat Husky) were used to survey 5.6 mi^2 units that were delineated by 2 minutes of latitude by 5 minutes of longitude. Aircrafts used Global Positioning System (GPS) to navigate to and within assigned units. Search intensity varied with habitat. The survey protocol required high search intensity in forested habitats (8-10 minutes per square mile) and lower intensity in open habitats or areas with significant water. Survey patterns varied according to terrain. Within lowland area, survey aircrafts generally flew transects about 200 to 400 feet AGL at 70 knots. Within mountainous terrain, survey aircrafts followed the contour of the mountains.

Observed moose were assigned group numbers and mapped by recording coordinates of each group utilizing the aircraft's GPS receivers. Numbers of moose in each group were recorded and the sex and age classification of each moose was determined. Moose were classified as: cow, calf, yearling bull (spike or forked antlers), medium bull (antler spread > spike/fork, but < 50 inches [127 cm]), and large bull (antler spread ≥ 50 inches [127 cm]). Total moose, moose density and sex/age ratios were calculated using the GeoSpatial Population Estimator software (DeLong 2006, Kellie and Delong 2006).

Surveyed sample units 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 high density units to reduce overall variance (Taras 2014, Sorum et al. 2015). Therefore, our target was to sample 50% and 13% of the units in the high and low stratum, respectively.

Sightability trials were conducted within YUCH during the 1997 and 1999 surveys and produced sightability correction factors (SCF) of 1.22 and 1.18, respectively. In addition, the Alaska

Department of Fish and Game (ADFG) uses a sightability correction factor (SCF) of about 1.2 for GMU 20A (unpublished data, Don Young, pers. comm. 2007, 5/22/2007 ADFG Memo). A SCF of 1.2 has been applied to the results of past Geo-spatial surveys (2003 – 2012, Burch 2012) and to selected results here where noted. However, the bulk of the results do not utilize the SCF.

Results

Weather and Snow conditions

The majority of the weather conditions for flying the survey were good to excellent. The week prior to the survey, 8 inches of snow fell with 3 inches accumulating the day before the survey began. Snow cover was complete in the survey area at the onset of the survey. Snow conditions and sightability were good to excellent throughout the survey.

General Survey Results

Between 10-15 November, 128 of 555 survey units were surveyed, covering 23% of the survey area (Figure 3, Table 1). 82 (48%) of the high density units and 46 (12%) of the low density units were surveyed (Table 1). A total of 59.5 hours (3569 minutes) of flight time was spent searching for moose for an average of 28.3 minutes per survey unit. Search intensity averaged 5.0 minutes per mi^2 (1.93 minutes/km^2, Table 1). Five survey units were not surveyed due to low clouds.

Aviation and project costs for the 2015 Yukon-Charley Rivers NP fall moose survey are found in Appendix I. Complete survey results for the entire 2015 survey are archived in, and can be retrieved from, the ADFG WINFONET database under the survey name "Yukon Charley NP, Fall, 2015" (http://winfonet.alaska.gov/; accessed 1 December 2015).

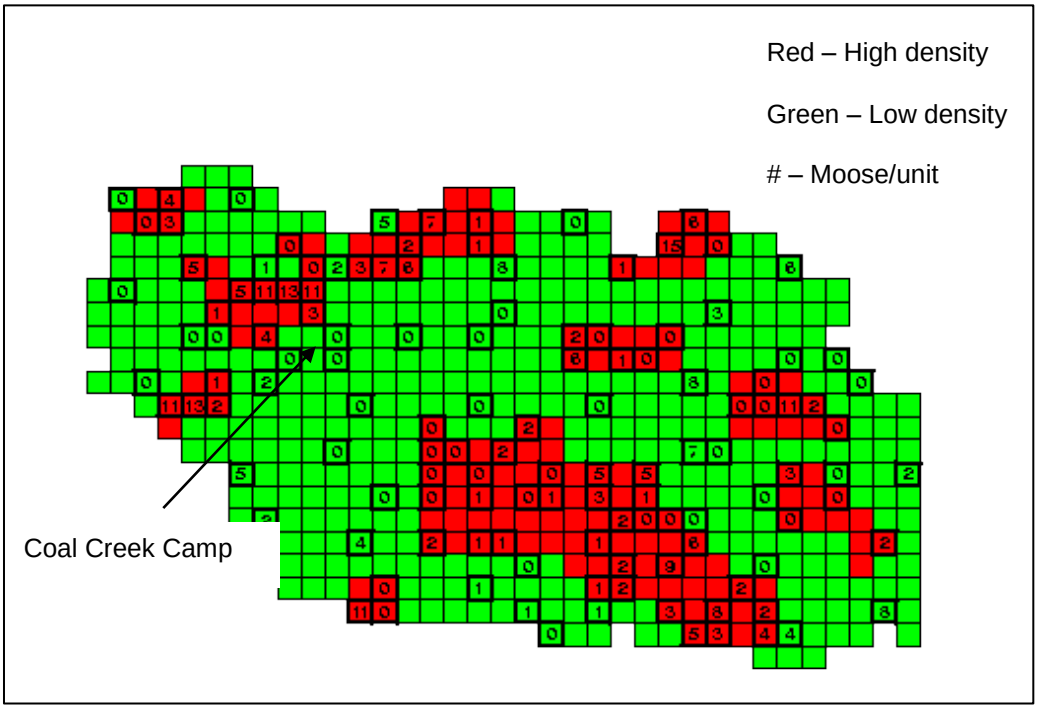

Figure 3. Stratification (indicated by color of survey unit) and numbers of moose counted in each unit in Yukon-Charley Rivers National Preserve, November 2015.

Table 1. Summary of stratification and sampled units from moose population estimation surveys in Yukon-Charley Rivers National Preserve, 1987 to 2015. Square miles (and number of units) of survey and sample areas.

Survey Year	Survey Area	Sample Area	% Sampled	90% CI	Stratified Sampled					
					High	Med	Low	High	Med	Low
1987[a]	3556	240	6.7	-	-	-	-	-	-	-
1994[a]	2790	1844	66.1	0.23	-	-	-	-	-	-
1997	2758 (201)	1358 (98)	49.2	0.20	303 (22)	788 (57)	1667 (122)	238 (21)	537 (38)	537 (39)
1999	2745 (200)	1389 (100)	50.6	0.19	333 (24)	622 (45)	1790 (131)	333 (24)	576 (42)	480 (34)
2003	3157 (566)	591 (106)	18.7	0.24	1049 (188)	-	2108 (378)	340 (61)	-	251 (45)
2006	3096 (555)	841 (151)	27.2	0.19	899 (161)	-	2197 (394)	540 (97)	-	301 (54)
2009	3096 (555)	618 (111)	20.0	0.19	899 (161)	-	2197 (394)	329 (59)	-	289 (52)
2012	3096 (555)	664 (119)	21.4	0.21	899 (161)	-	2197 (394)	362 (65)	-	301 (54)
2015	3096 (555)	714 (128)	23.0	0.18	949 (170)	-	2147 (385)	458 (82)	-	256 (46)

[a] – not directly comparable with later surveys

Population Estimate

The GSPE population estimate for observable moose in YUCH was 1,138 moose (90% confidence interval = 932-1343 [18.1% error of population]) which yielded a density of 0.37 moose/mi^2 (0.14 moose/km^2; Table 2, Figure 4). When total observable moose is corrected for sightability (20%), the corrected moose population estimate is 1,365 (90% confidence interval = 1,118 – 1,612) which yielded a density of 0.44 moose/mi^2 (0.17 moose/km^2).

Table 2. Summary of survey statistics and density estimates for moose population surveys in Yukon-Charley Rivers National Preserve, 1987 to 2015.

Year	Method	Survey Area mi^2 (# units)	Sampled Area mi^2 (# units)	Search Intensity (min/mi^2)	# Moose	90% CI	Density (moose/mi^2)	Sightability Correction Factor
1987[a]	Gasaway	3556	240	4.4	1116	-	0.31	-
1994[a]	Gasaway	2790 (245)	1844 (162)	1.0	551	0.23	0.20	1.34
1997	Stratified Random	2758 (201)	1358 (98)	3.9	602	0.20	0.22	1.22
1999	Stratified Random	2745 (200)	1389 (100)	4.0	830	0.19	0.30	1.18
2003	GSPE	3157 (566)	591 (106)	6.6	696	0.24	0.22	-
2006	GSPE	3096 (555)	841 (151)	5.4	605	0.19	0.20	-
2009	GSPE	3096 (555)	618 (111)	6.7	1109	0.19	0.36	-
2012	GSPE	3096 (555)	664 (119)	6.0	780	0.21	0.25	-
2015	GSPE	3096 (555)	714 (128)	5.0	1138	0.18	0.37	-

[a]– not directly comparable with later surveys

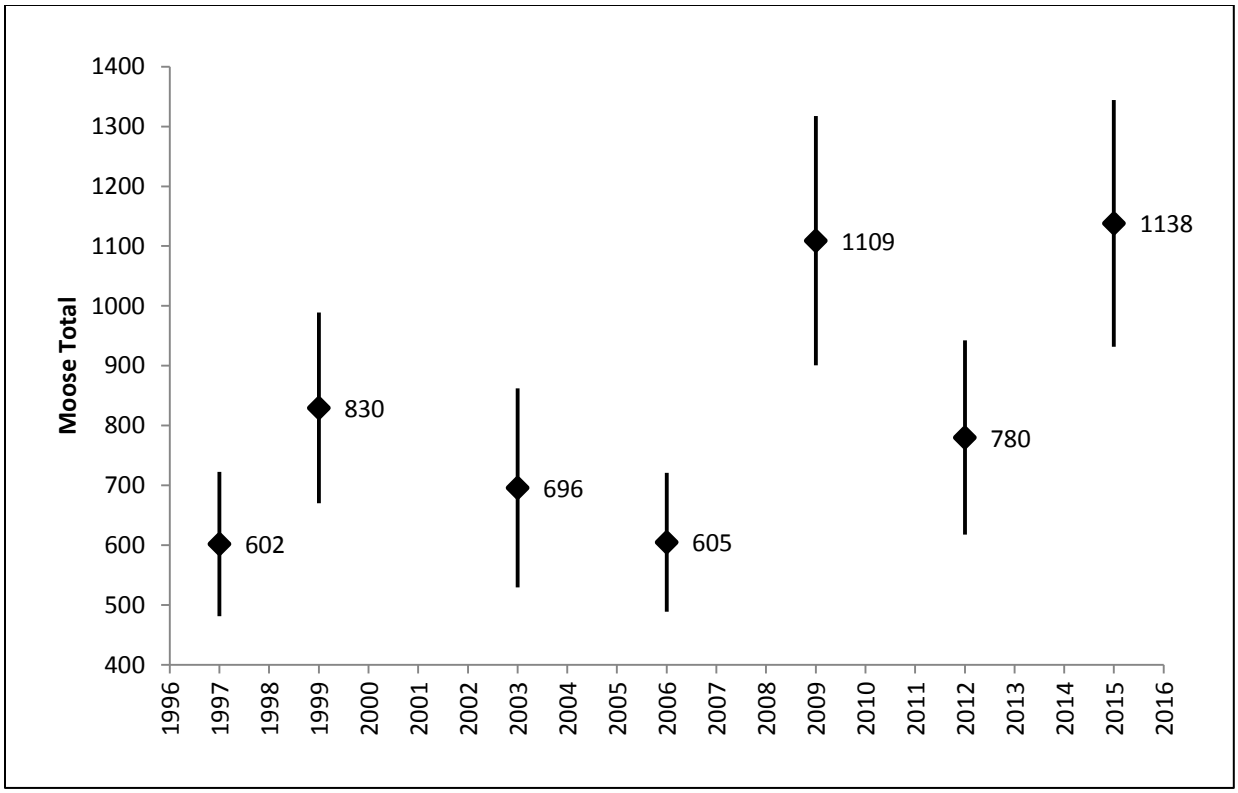

Figure 4. Estimated observable fall moose total (with 90% confidence interval) for Yukon-Charley Rivers National Preserve.

Sex and Age Composition

The sex and age composition of the 314 observed moose were as follows: 165 cows, 105 bulls, and 44 calves (Table 3). Composition of the observed bulls included 7 yearling bulls (spiked or forked antlers), 34 medium bulls, and 64 large bulls (Table 3). Two single-antlered bulls were observed, however antler shed did not appear to be a problem. The estimated sex and age ratios of the population were 27 calves:100 cows, 4 spike/fork (yearling bulls):100 cows, and 64 bulls:100 cows (Table 3). The twinning ratio was 2.4 twins:100 cows. Four sets of twins were observed, which was above long-term average (Table 4).

Table 3. Summary of observed moose during the surveys in Yukon-Charley Rivers National Preserve, 1987 to 2015.

Survey Year	Area (mi^2)	Total Bulls	Total Cows	Total Calves	Total Moose	Bulls/ 100 Cows	YrlBulls/ 100 Cows	Calves/ 100 Cows	% Bulls	% Cows	% Calves	Density ($moose/mi^2$)
1987[a]	3556	86	73	7	169	121	14	10	51	43	4	0.68
1994[a]	2790	147	176	37	364	84	7	21	40	48	10	0.20
1997	1358	136	197	51	384	60	8	28	35	51	13	**0.28**
1999	1389	169	266	77	513	51	5	36	33	52	15	**0.37**
2003	591	55	87	17	159	61	6	25	35	55	11	**0.27**
2006	841	63	89	28	180	73	7	33	35	49	16	**0.21**
2009	618	102	164	42	308	59	12	26	33	53	14	**0.50**
2012	664	80	118	25	223	68	13	24	36	53	11	**0.18**
2015	718	105	165	44	314	64	4	27	33	53	14	**0.44**

[a]– not directly comparable with later surveys

Table 4. Number of sets of twins seen during past moose surveys

Survey Year	Sets of twins seen
1994	1
1997	3
1999	6
2003	1
2006	5
2009	4
2012	0
2015	4
Average	3

Discussion

Moose in Yukon-Charley National Preserve (Alaska GMU 20E, 25B, 25C, and 25D) continue to occur at low densities. The fall count of 1,138 observable moose resulted in a moose density of 0.37 moose /mi^2, or 0.14 moose/km^2. The sightability corrected moose population estimate of 1,365 resulted in a moose density of 0.44 moose/mi^2, or 0.17 moose/km^2. Continued conservative management of harvest is recommended. Moose continue to occur at relatively low densities across YUCH, which has been documented for nearly 30 years (Burch 2003, 2006, 2009, 2012).

The population estimate of observable moose during the 2015 survey was the highest on record for all surveys that are comparable (1997-2015). Moose abundance was 38% greater than the long-term average (since 1997), and total observable moose increased annually 13.4% since the previous survey in 2012. The increase was within the range of previous fluctuations in density estimated under the GSPE survey method. Improved yearling survival in recent years likely contributed to the increase. During the 2009 and 2012 surveys, on average, yearling bull abundance was 56% greater than the long-term average, implying stronger recruitment of yearlings into the population.

Major changes to the Parks' landscape over the last decade could be affecting bottom-up resources (i.e., food) that influence growth and reproduction of moose. Large areas of YUCH burned during the summers of 1999 and 2004. Moose select habitats that burned 11-30 years prior because these areas tend to revegetate with deciduous shrubs (Weixelman et al. 1998, Maier et al. 2005, Joly et al. *in prep*). These recently burned areas are likely associated with high quality moose forage, and have potentially improved the quality of moose habitat within YUCH (Figure 5). Another factor that may have contributed to increases in moose abundance could be improved forage quality along the Yukon River. During breakup and record flood along the Yukon river in 2009, riparian areas were greatly altered which created new sandbars. Subsequently, these disturbed areas created opportunity for new growth of high quality moose forage (e.g., *Salix* sp.) .

It is unlikely that predator (wolf) control efforts by ADF&G within the Upper Yukon Tanana Predator Control Area contributed to the increase in moose density. Few to no wolves killed within the Predator Control Area inhabited the YUCH moose survey area (John Burch, pers. comm. 2016, NPS). Additional, in a nearby study in the Fortymile drainage south of YUCH found that only 15% of newborn moose calf mortality was attributed to wolves (Gasaway et al. 1992). In the same study, they found that survival rates of adult moose were relativity high, and ranged from 78% to 93%. In 1998 and 1999 in Yukon Flats National Wildlife Refuge, data from a moose calf mortality study found that 32 of 80 (40%) collared calves were killed by bears, and only a single calf was known to have been killed by a wolf (Bertram and Vivion 2002).

Similar increases in moose densities observed in YUCH have been reported in the Yukon Flats National Wildlife Refuge, down river from YUCH, where there has been relatively light predator harvest (Lake 2015). Within the Yukon Flats, moose densities increased from approximately 0.20 moose/mi^2 to 0.35 moose/mi^2 over the past decade, while harvest rates of wolves has been light and not approached levels know to impact wolf numbers (Lake et al. 2015).

The ratio of bulls to cows (64 bulls to 100 cows) was high for a hunted system with bull only harvest, and indicated light harvest intensity. The bull cow ratio was slightly above the long-term average (62), which has ranged between 51 and 73 bulls per 100 cows since 1997. Moose hunting in the preserve occurs primarily along the main rivers such as the Yukon, Kandik, Nation, and Charley rivers (Burch 2012).

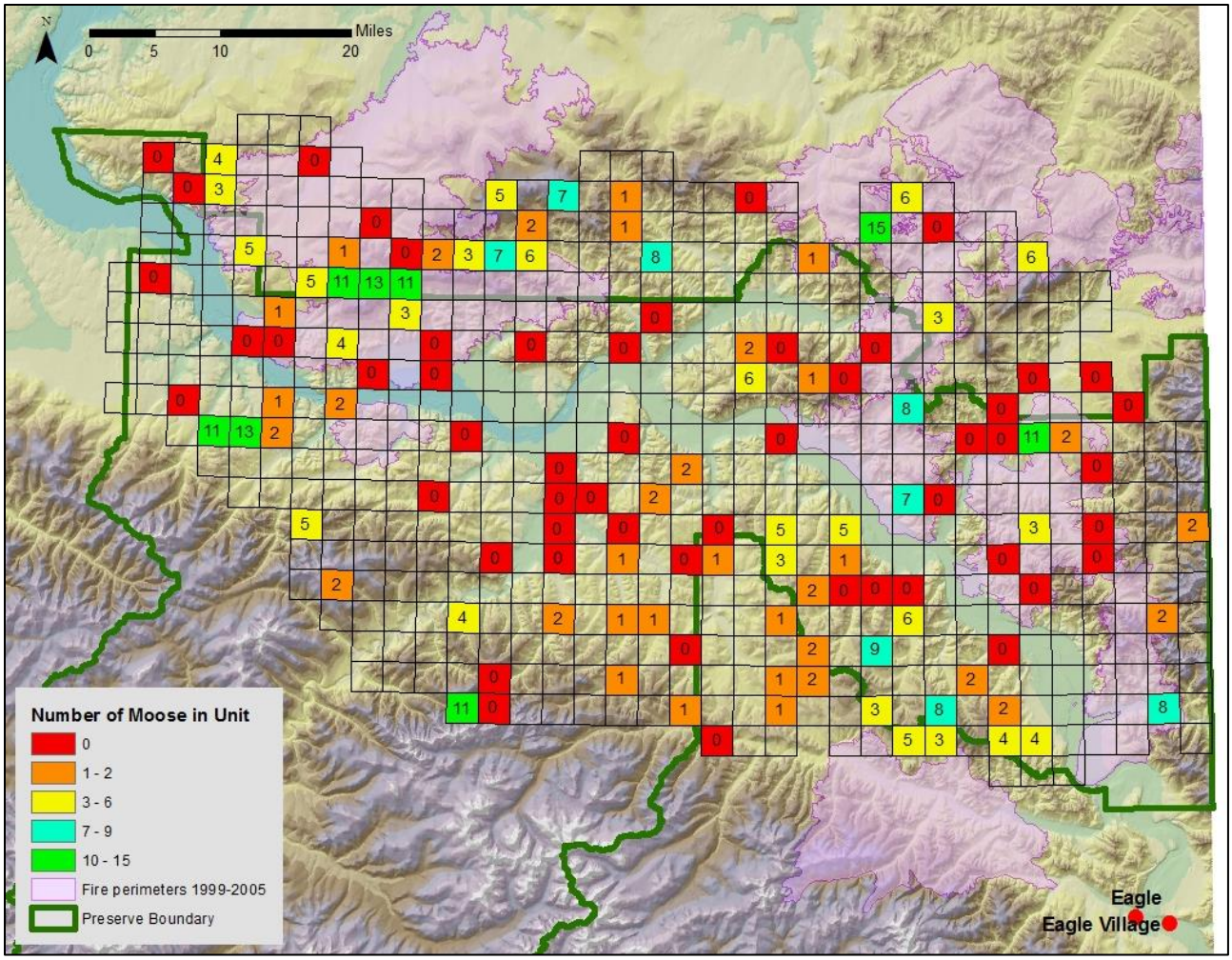

Figure 5. Observed moose distribution (# represents total number of moose observed in unit) and recent burn activity (1999-2005) within Yukon-Charley Rivers National Preserve.

Shortcomings and Future Improvements

Moose surveys conducted in areas with low densities of moose similar to YUCH have been able to improve the precision of the population estimate by reallocating sampling effort to higher density strata (Tarus 2014, Sorum et al. 2015). We applied this strategy by surveying 48% of the high strata units and only 12% of the low strata units (Table 1). Through this strategy we were only able to improve the precision of the estimate by < 2% over the previous best estimate. To further improve the precision of the estimate we suggest either adjusting the desktop stratification or conducting an aerial stratification. If a desktop stratification is used in future surveys we suggest using previous survey data to identify units with high and low moose densities. We suggest averaging number of moose observed in each unit across all GSPE surveys (2003-2015), and those that average 0-2 moose be considered low and units averaging > 2 be considered high. Units that have never been surveyed (186) should not be adjusted unless additional information (e.g., fire history) is used.

Future surveys may want to consider conducting sightability trials within YUCH to identify an area specific sightability correction factor (SCF). Sightability trials have been conducted within YUCH in 1994, 1997, and 1999, and in nearby areas (GMU 20A and Yukon Flats NWR) and results suggest the SCF are variable among areas (Burch 2012, Lake 2015).

Literature Cited

Bertram, M. and M. Vivion. 2002. Moose mortality in Eastern Interior Alaska. Journal of Wildlife Management 66(3):747-756.

Burch, J. W. 2003. 2003 aerial moose survey along the Yukon River corridor, Yukon-Charley Rivers National Preserve, Alaska. NPS Technical Report NPS/AR/NRNT-2004/44. 27pp

Burch, J. W. 2006. 2006 aerial moose survey along the Yukon River corridor, Yukon-Charley Rivers National Preserve, Alaska. Natural Resource Technical Report NPS/CAKN/NRTR—2006. National Park Service, Fort Collins, Colorado. 36pp

Burch, J. W. 2010. 2009 aerial moose survey along the Yukon River corridor, Yukon-Charley Rivers National Preserve, Alaska. Natural Resource Technical Report NPS/CAKN/NRTR -2010/331. National Park Service, Fort Collins, Colorado. 28pp

Burch, J. 2012. Annual report on vital signs monitoring of moose (*Alces alces*) distribution and abundance in Yukon-Charley Rivers National Preserve, Central Alaska Network: November 2012 survey report. Natural Resource Technical Report. NPS/CAKN/NRTR—2012/772 National Park Service, Fort Collins, Colorado.

DeLong R. A. 2006. GeoSpatial population estimator software user's guide. Alaska Department of Fish and Game, Fairbanks, Alaska, USA. 72pp.

Gasaway, W. C., R. D. Boertje, D. V. Grangaard, D. G. Kelleyhouse, R. O. Stephenson, and D.

G Larson. 1992. The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. Wildlife Monograph 120. 59pp.

Joly, K., M.S. Sorum, T. Criag, and E.L. Julianus. *in prep.* The effects of sex, terrain, wildfire, maternal status and winter severity on habitat selection and use patterns of sympatic mountain and lowland moose in north-central Alaska.

Kellie, K. A. and R. A. DeLong. 2006. Geospatial survey operations manual. Alaska Department of Fish and Game. Fairbanks, Alaska, USA. 55pp.

Lake, B.C. 2015. Moose population survey of the western Yukon Flats – November 2015. U.S. Fish and Wildlife Service. 25pp.

Lake, B.C., M.R. Bertram, N. Guldager, J.R. Caikoski, and R.O. Stephenson. 2013. Wolf kill rates across winter in a low density moose system in Alaska. Journal of Wildlife Management 77:1512-1522.

Maier, J. A. K. et al. 2005. Distribution and density of moose in relation tolandscape characteristics: effects of scale. – Can. J. For. Res. 35: 2233–2243.

Sorum, M. S., Joly, K., Cameron, M. D. 2015. Aerial moose survey within and around Gates of the Arctic National Park and Preserve, March 2015. Natural Resource Report NPS/GAAR/NRR—2015/967. National Park Service, Fort Collins, Colorado.

Taras, B. 2014. 2014 Unit 22D and 22E moose population survey summary. Alaska Department of Fish and Game. Fairbanks, Alaska. 10 pp.

Weixelman, D. A. et al. 1998. Diet selection by Alaskan mooseduring winter: effects of fire and forest succession. – Alces 34: 213–238.

Appendix I. Survey Logistics

Appendix A-1. Aviation usage and cost during the 2015 spring moose survey.

Vendor	Plane	Pilot	Description	Hrs	Cost/Hr	Total
Fleet	C-185		Shuttle	7.0	$185	$1,295
Fleet	TopCub	Dan Shelden	Survey	34.5	$125	$4,313
Fleet	Husky	Curtis Cebulski	Survey	26.0	$125	$3,250
Golden Eagle	SuperCub	Jesse Cummings	Survey	33.3	$235	$7,826
					Total	**$16,684**

Appendix A-2. Overall project cost during 2015 spring moose survey

Category	Description	Quantity	Cost/Unit	Total
Food	N/A	N/A	N/A	$1,400
Fuel	CCC 100LL	583.2 gal	$6.15	$3,587
	Eagle 100LL	216.0 gal	$6.15	$1,328
	Fairbank100LL	177.0 gal	$5.00	$885
Housing	NPS housing	42 nights	$7.81	$328
Aviation	Detailed in Table A	N/A	N/A	$16,684
			Total Project Cost	**$24,212**

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior

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