



# 2013 Voyageurs National Park Moose Population Survey Report

Natural Resource Data Series NPS/VOYA/NRDS—2014/644



**ON THE COVER**

A bull moose, with snow in his antlers, is spotted during an aerial survey in Voyageurs National Park, Minnesota.  
Photograph by: Bryce Olson, Voyageurs National Park

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## Introduction

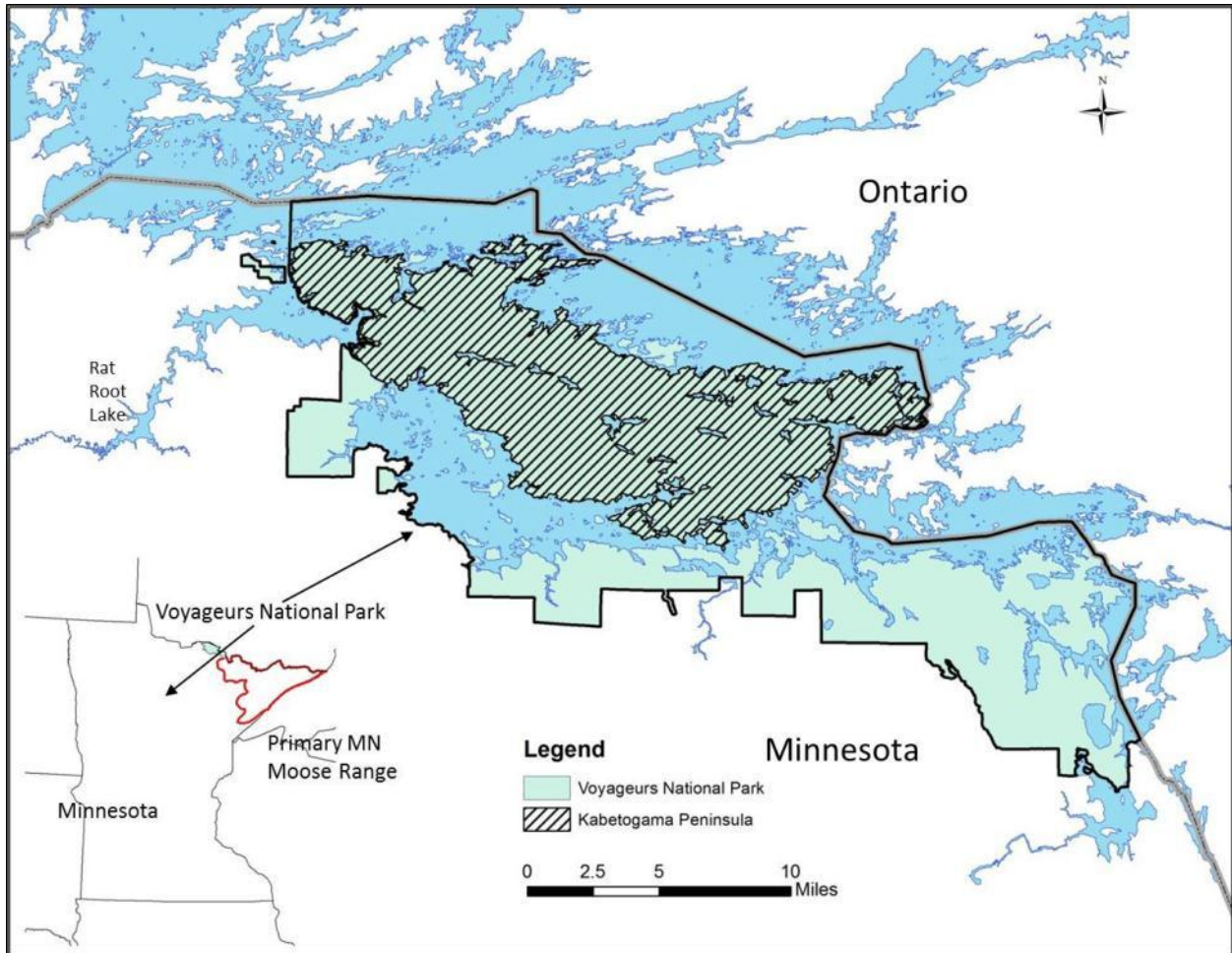
Voyageurs National Park, Minnesota was established in 1975 in part to fulfill the National Park Service's (NPS) mission to preserve and protect wildlife populations and provide opportunities for the public to enjoy them. Moose are native to Voyageurs National Park (VOYA), but recent declines in moose populations elsewhere in the region have raised concerns about the long-term viability of moose in the park. Moose populations in northwestern Minnesota declined precipitously during the period 1984–2000 (Murray et al. 2006). Moose populations in northeastern Minnesota have been experiencing similar declines in recent years, with the 2013 estimate more than 68% lower than estimates in 2006 (DelGuidice 2013). Voyageurs National Park is not surveyed as part of the state's systematic annual survey because it lies just outside of primary moose range in northeastern Minnesota (Figure 1; DelGuidice 2013). Voyageurs National Park, in collaboration with the University of Minnesota–Duluth and the U.S. Geological Survey, began more intensive monitoring and research of moose in and adjacent to the park in 2009 to better understand local moose population dynamics. Information will help NPS managers to determine how to ensure the survival of moose for future generations.

## Methods

The moose population within the boundaries of Voyageurs National Park was surveyed 20–28 February 2013. The survey area was limited to the Kabetogama Peninsula, a 305 km<sup>2</sup> roadless area in the center of the park where >95% of the park's moose population occurs (Figure 1). Surveys were conducted using a two-seat Aviat Husky during which the pilot and observer searched for moose while flying overlapping circles at an intensity of at least 3.5 min/km<sup>2</sup>. The peninsula was broken down into 23 separate survey units to facilitate the completion of the survey, but all units were surveyed. Data recorded for each observed moose were location, group size, sex/age class (calf, yearling, adult cow, adult bull), and whether the animal was standing or bedded. All observations of white-tailed deer and gray wolves were also recorded.

Twenty-three test plots were conducted to estimate visibility (detection probability) of moose using this survey method. Test plots were searched for moose wearing GPS telemetry collars, using the same flight pattern and intensity as the survey plots. Locations of moose not observed during the test plots were confirmed by GPS locations or using VHF telemetry. Test plots were completed between 1 February and 26 March 2013.

The number of moose observed during the aerial survey was adjusted with the estimated detection probability, giving a population estimate for the Kabetogama Peninsula ( $\pm$  90% confidence intervals). Other measures of population status were also estimated, including calf:cow ratio, twinning rates, and bull:cow ratio. Pregnancy rates (percent of adult females that were pregnant) were estimated via progesterone levels in blood collected in mid-winter from animals that were caught for GPS collaring.



**Figure 1.** Moose survey area in Voyageurs National Park, Minnesota, USA, 2013. The Kabetogama Peninsula (305 km<sup>2</sup>) contains >95% of the park's moose population. A small pocket of moose (approx. 10–15 individuals) also exists west of the park in the Rat Root Lake area, and evidence from GPS collars suggests that some moose seasonally move between this area and the Kabetogama Peninsula.

## Results

Survey conditions were considered “good” to “excellent” during the 2013 survey (including visibility trials), with snow depths exceeding 60–90 cm (24–36 in) throughout the Kabetogama Peninsula and little snow in the canopies of trees. Most collared moose 78% ( $\pm 6\%$ ; 25 out of 32) were detected during visibility trials.

Thirty-six moose were counted during the survey (9 bulls, 16 cows, 2 yearlings, and 9 calves). After correcting for visibility, the 2013 population estimate for the Kabetogama Peninsula was 46 moose (90% Confidence Interval = 43-50), or 0.15 moose/km<sup>2</sup>. Five moose (2 cows, 1 yearling, and 2 calves) that were not observed during the survey but were known to occur on the Kabetogama Peninsula during the survey period were accounted for using GPS collar data and incidental observations. Therefore, the minimum number of moose observed or known to be on the Kabetogama Peninsula during the 2013 survey was 41, very close to the lower end of the 90% Confidence Interval for the survey estimate. The 2013 population estimate is similar to those from the period 2009–2011 (Table 1). Indices of calf production in 2013 were relatively high. The estimated calf:cow ratio was 0.61, and calves were 25% of the population. The bull:cow ratio was relatively low (0.56), similar to estimates from 2010–2011. Pregnancy rate (N=8 cows) was also relatively low (63%).

**Table 1.** Population estimates and demographic characteristics for moose in the Kabetogama Peninsula, Voyageurs National Park, USA, derived from aerial surveys and other sources, 1991–2013. Note the break in years between 1992 and 1997 and between 1998 and 2009.

Year	Population Estimate	90% Confidence Interval for Estimate	Calf: Cow	% Calves	% Twins <sup>a</sup>	Bull: Cow	% Pregnant <sup>b</sup>
1991	31	23-57	-	9	-	-	-
1992	47	35-72	-	9	-	-	-
1997	53	32-88	-	25	~10 <sup>c</sup>	-	-
1998	38	23-63	-	9	0	-	-
2009	51	44-58	-	7	0	-	-
2010	41	36-47	0.54	23	0	0.82	60
2011	45	39-51	0.60	28	8	0.53	69
2012	-----Not Surveyed-----						33
2013	46	43-50	0.61	25	6	0.56	63

<sup>a</sup> Percentage of twins observed among all cows.

<sup>b</sup> Estimated from blood samples collected during winter capture for GPS collaring.

<sup>c</sup> One set of twins recorded; % Twins for 1997 based on assumption of 1:1 adult sex ratio.



## Discussion

Survey results from 2013, when combined with earlier survey results from 2009–2011 and other available data, suggest Voyageurs National Park currently maintains a stable, low density moose population. The northeastern Minnesota moose population declined 65% from 2009 to 2013 (DelGuidice 2013). Assuming a similar decline was occurring in VOYA, the expected 2013 population estimate in VOYA should have been 18 moose. To the contrary, a minimum of 41 moose were documented currently living in the Kabetogama Peninsula. The observed stability in the VOYA population during the present study is further corroborated by estimates of adult survival obtained from telemetry/GPS collars and estimates of calf recruitment obtained from aerial surveys. Since 2010, the survival of >25–40% of the estimated adult population has been monitored with GPS telemetry collars. Six of 22 adult moose collared since 2010 in VOYA have died, resulting in a mean annual mortality rate of approximately 10%. Two of the moose in the VOYA study died from health-related issues, three from unknown causes (either health-related or predation), and one was assumed to be capture-related. Albeit from a small sample size, our estimate of annual adult mortality is similar to those reported for non-hunting mortality rates from other moose populations in North America, but noticeably less than those reported for the northwestern Minnesota population in 1995–2000 (21%; Murray et al. 2006) and for the northeastern Minnesota population in 2002–2008 (19%; Lenarz et al. 2009).

Two indices of productivity (calf:cow ratio and percent calves) estimated from 2010–2013 surveys were relatively high for moose in the region. When considered in relation to the low pregnancy rates in this study, recent calf:cow ratios suggest that calves produced by those cows that do give birth have a relatively high chance of surviving to mid-winter. Though data are lacking about actual recruitment of calves into the adult population at VOYA, the recent survey data do suggest that it may be enough to offset the observed adult mortality, and therefore maintain a stable population. However, gray wolves and black bears, both of which are abundant in Voyageurs, readily prey on young calves, and annual survival of calves in most moose populations is low. Densities of white-tailed deer are relatively high in the VOYA area (ca. 4 deer/km<sup>2</sup>), and it's possible that wolves and other potential predators more readily prey on deer rather than moose. More study is needed to better understand calf survival and recruitment in the VOYA area in relation to other populations in the region.

Pregnancy rates in most North American moose populations typically exceed 80–90% (Van Ballenberghe and Ballard 2007). The low pregnancy rates observed in VOYA since 2010 could be indicative of poor condition or health-related issues in the population. They also may be reflective of the low bull:cow ratio—i.e., there may not be enough bulls available to breed all cows in the population. Though there is an incomplete understanding of what factors may be contributing to the low bull:cow ratios observed, since this result runs counter to expectations for an un hunted population. (Moose hunting is not allowed in VOYA, and the area west of the park has also been closed to hunting since 1923.)

It is not clear why the moose population in VOYA appears relatively stable when nearby populations are declining. Spatial variability in population trends and demographic patterns likely exist in most populations if examined at a large enough scale. In other words, the stable population apparent in VOYA may not be unique in the region. Current estimates are similar to those reported in 1997–1998 (Voyageurs National Park, unpublished data) and 1991–1992 (Gogan et al. 1997). Though survey methods have changed slightly since 1991, it is likely that VOYA has maintained a low density population throughout this period. However, in spite of the apparent current population stability, the potential effects of large-scale impacts such as climate warming or disease outbreaks threaten the long-term persistence of the small, isolated moose population in VOYA.

The method employed at VOYA in 2013—flying overlapping circles at a high search intensity—appears to be effective for surveying moose at the low density that occurs in VOYA. The method will continue to be refined for future surveys, particularly in estimating visibility in different years under variable conditions. In addition to population monitoring, Voyageurs National Park is currently investigating other aspects of moose ecology in collaboration with the University of Minnesota–Duluth, Lakehead University, and the U.S. Geological Survey. Other studies include understanding how moose behave in response to high temperatures and other weather events, how and why moose use wetlands for foraging and temperature regulation, and the interactions of moose, deer, beavers, and wolves.

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