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Natural Resource Stewardship and Science

Moose Population Survey at Voyageurs National Park

2016

Natural Resource Data Series NPS/VOYA/NRDS—2016/1031

ON THIS PAGE
A few functioning GPS/satellite collars remain on moose in Voyageurs National, such as this one on a cow moose observed during the 2016 survey (the collar is the white band on the neck). Collars were last deployed in February 2013; most collars put out at that time have dropped off or the moose has died.
Photograph by Bryce Olson, Voyageurs National Park.

ON THE COVER
A cow and yearling moose observed during the 2016 survey.
Photograph by Bryce Olson, Voyageurs National Park.

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

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Introduction

Voyageurs National Park (Minnesota) was established in 1975 in part to fulfill the National Park Service's mission to preserve and protect wildlife populations and provide opportunities for the public to enjoy them. Moose (*Alces alces*) are native to Voyageurs National Park (VOYA), but recent declines in other moose populations in the region 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 recent estimates nearly 55% lower than the 2006 estimate (DelGiudice 2016). 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; DelGiudice 2016). Voyageurs National Park, in collaboration with the University of Minnesota–Duluth, began more intensive monitoring and research of moose in and adjacent to the park in 2009 to better understand local moose population dynamics. The moose population within VOYA has remained stable since 2009 but, due to the small size and relative isolation of the park's moose herd, annual monitoring is needed to assist park staff in maintaining a viable population.

Methods

We surveyed the moose population within the boundaries of Voyageurs National Park during 12–27 February 2016. The survey area was limited to the Kabetogama Peninsula, a 305 km^2 (117 mi^2) roadless area in the center of the park where >90% of the park's moose population occurs (Figure 1). Surveys were conducted using a 2-seat Top Cub aircraft during which the pilot and observer searched for moose while the plane flew in overlapping circles at an intensity of at least 3.5 min/km^2. The peninsula was broken down into 23 separate survey units to facilitate the completion of the survey, and all units were surveyed. For each observed moose we recorded location, group size, sex/age class (calf, yearling, adult cow, adult bull, unknown), and whether the animal was standing or bedded. We also recorded all observations of white-tailed deer (*Odocoileus virginianus*) and gray wolves (*Canis lupus*).

We conducted 23 test plots to estimate visibility (detection probability) of moose for our survey method. We searched test plots, using the same flight pattern and intensity as the survey plots, for moose wearing GPS telemetry collars. Locations of moose not observed during the test plots were confirmed by GPS locations or using VHF telemetry. Test plots were completed between 4 February and 3 March 2016 during conditions similar to those that occurred during the survey.

The number of moose observed during the aerial survey was adjusted with the estimated detection probability, giving a population estimate for the Kabetogama Peninsula (± 90% confidence intervals) during the survey period. We also estimated other measures of population status, including calf:cow ratio, twinning rates, and bull:cow ratio. No moose were captured in 2016 and therefore we did not estimate pregnancy rates (percent of adult females that were pregnant, as indicated by blood progesterone levels), as was done from 2010 to 2013.

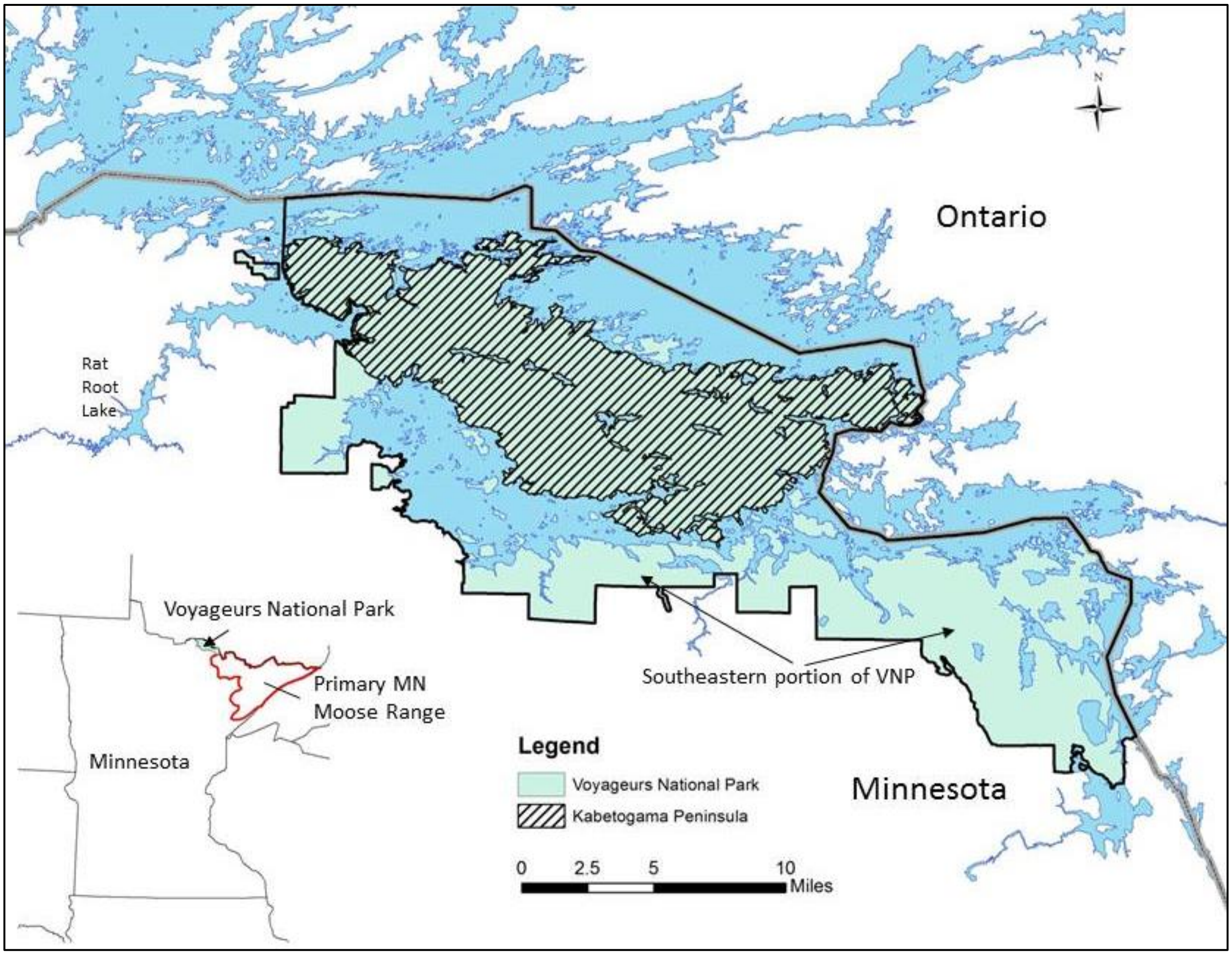

Figure 1. 2016 moose survey area in Voyageurs National Park, Minnesota, USA. The Kabetogama Peninsula (305 km^2) contains >90% of the park's moose population. A small pocket of moose (approx. 10–15 individuals) also exists west of the park in the Rat Root Lake area, and evidence from GPS collars suggests that some moose seasonally move between this area and the Kabetogama Peninsula. Some moose also reside in the southeastern portion of the park but we did not survey this part of the park in 2016.

Results

Survey conditions were considered "good" to "excellent" during the 2016 survey (including visibility trials), with snow depths exceeding 20 cm (8 in) throughout the Kabetogama Peninsula and little snow in the canopies of trees. We detected 78% (±9%; 18 out of 23 trials) of collared moose during visibility trials.

We counted 32 moose during the survey (11 bulls, 11 cows, 2 unknown adults, 3 yearling, and 5 calves). After correcting for visibility, the 2016 population estimate for the Kabetogama Peninsula was 41 moose (90% confidence interval [CI] = 40–46), or 0.13 moose/km^2 (0.34 moose/mi^2). We accounted for eight additional moose (2 bulls, 3 cows, 3 calves) not observed during the survey but observed during visibility surveys or confirmed from known GPS collared animals. The minimum number of moose on the Kabetogama Peninsula during the 2016 survey based on known individuals was 40, above the lower end of the calculated 90% CI for the survey estimate of 37. Thus we truncated the lower end of the 90% CI to 40. The 2016 population estimate is similar to those from the period 2009–2015 (Table 1).

Table 1. Population estimates and demographic characteristics for moose in the Kabetogama Peninsula, Voyageurs National Park, USA, derived from aerial surveys from 1991–2015. Note two breaks in the continuity of survey years.

Year	Population Estimate	90% Confidence Interval for Estimate	Calves:Cow	% Calves	%Twins[a]	Bulls:Cow	%Pregnant[b]
1991	31	23-57	-	9	-	-	-
1992	47	35-72	-	9	-	-	-
1997	53	32-88	-	25	ca. 10[c]	-	-
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	-[e]	-[e]	-[e]	-[e]	-[e]	-[e]	33
2013	46	43-50	0.61	25	6	0.56	63
2014	40	34-48	0.23	11	0	0.46	-
2015	46	41-52	0.38	14	0	1.00	-
2016	41	40-46[d]	0.46	16	0	1.00	-

[a] Percentage of twins observed among all cows.

[b] Estimated from serum progesterone levels from blood samples collected during winter capture for GPS collaring during 2010–2013.

[c] One set of twins recorded; % Twins for 1997 based on assumption of 1:1 adult sex ratio.

[d] Lower end of 90% CI truncated to minimum number of known individuals.

[e] Not surveyed.

Indices of calf production in 2016 were relatively low, similar to 2014–2015. No twins were observed in 2016, as has been the case in most survey years. The estimated calf:cow ratio was 0.46, and calves were 16% of the population. The bull:cow ratio observed during the 2016 survey (1.0) was the same as 2015; both were higher than in previous years. If we assume that the minimum number of known individuals (i.e., those seen during the survey + other observations) is an unbiased representative sample of the population, then calf:cow ratio would be 0.57 and calves would be 20% of the population.

Discussion

Voyageurs National Park staff have been monitoring the park's moose population since 2009, including conducting aerial surveys to estimate population size and demographics, and monitoring adult moose with GPS collars to understand survival, habitat use, and other behaviors. Aerial survey data continue to support the contention that VOYA maintains a stable, low density moose population in the Kabetogama Peninsula.

Since February 2010, we have monitored adult survival with GPS/VHF telemetry collars on ≤50% of the adult population. Of nine adult moose with functioning collars on 1 March 2015, five survived the survey year until 29 February 2016. One bull died of unknown causes in June. One cow was legally killed in Ontario during moose hunting season in October. This cow, VOYA02, was originally captured in the park in 2010. Most years, she spent the summer/fall in Ontario and winter in the park. Two additional collared moose survived at least 4–6 months until we lost contact with their collars. Overall, we have confirmed the deaths of 9 of 22 adult moose collared since 2010. Discounting 1 capture-related mortality, the mean annual mortality rate has been approximately 9% during the period 1 February 2010 to 31 January 2016 (range = 0%–16% per year; Voyageurs National Park, unpublished data). Causes of death for collared moose have been health-related (37%), legal hunting (13%), or unknown (50%), though predation could be responsible for some of the unknown cases where scavengers had consumed too much of the carcass to determine the original cause of death.

Our estimate of annual adult mortality is similar to those reported for non-hunting mortality rates from other moose populations in North America (Van Ballenberghe and Ballard 2007), 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) and 2013–2015 (ca. 15%, M. Carstensen, personal communication). Survey data from 2009–2015 suggest that reproduction and recruitment may be enough to offset observed adult mortality, and therefore maintain a stable population (Windels and Olson 2015).

A recent study suggested that increased wolf abundance and hence increased predation may be partially responsible for the dramatic decline in the northeastern moose population since 2006 (Mech and Fieberg 2014). There is little evidence to support that wolves are having a similar negative impact on the moose population in VOYA at present, despite a relatively high wolf:moose ratio on the Kabetogama Peninsula in 2015–2016 (17 wolves : 41 moose; VOYA, unpublished data).

Data from studies of wolf diet composition in the VOYA ecosystem confirm that wolves consume primarily deer and beaver and very little moose (Chenaux-Ibrahim 2015; T. Gable, unpublished data). Densities of deer (ca. 3.8 deer/km^2; 10 deer/mi^2) and beavers (ca. 5.0 beavers/km^2; 13 beavers/mi^2) are relatively high in the VOYA area (VOYA, unpublished data), and wolves and other potential predators typically prefer to prey on deer and beavers rather than moose. However, if abundances of alternative prey such as deer and beavers dramatically drop, we might expect that predation on adult or calf moose may increase.

In addition to population monitoring, Voyageurs National Park is currently investigating other aspects of moose ecology in collaboration with the University of Minnesota–Duluth, Minnesota Zoo, Bemidji State University, Lakehead University, University of Minnesota–Twin Cities, and other partners. Recently completed projects that include data from VOYA projects include an examination of moose habitat selection in response to temperature (Street et al. 2016); a study to understand factors that affect temperature in different types of moose habitat (Olson et al. 2014); a study of spatial patterns in deer infected with brainworm, a parasite fatal to moose (VanderWaal et al. 2015); and a study of abundance of terrestrial gastropods, the main vector of brainworm for deer and moose, in different forest habitats (Cyr et al. 2014). Ongoing studies include understanding how moose behave in response to high temperatures and other weather events; identifying potential thermal refugia for moose in the face of a changing climate; interactions of moose, deer, beavers, and wolves; and how and why moose use wetlands for foraging and temperature regulation.

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