

## Age Structure of Moose (*Alces alces*) Killed by Gray Wolves (*Canis lupus*) in Northeastern Minnesota, 1967–2011

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The ages of 77 adult Moose (*Alces alces*) killed by Gray Wolves (*Canis lupus*) during the period 1967–2011 in northeastern Minnesota were significantly older than those of a sample of 17 585 Moose killed by hunters in nearby Ontario. Our findings support those of earlier studies of protected Moose populations in national parks that found that Gray Wolves tend to kill disproportionately more older Moose.

**Key Words:** *Canis lupus*, Gray Wolf, *Alces alces*, Moose, predation, hunting, Minnesota, Ontario.

The age structure of Moose (*Alces alces*) killed by Gray Wolves (*Canis lupus*) is available from only two national parks in the United States where hunting by people is not allowed and from three areas in Alaska where Moose are hunted (Mech 1966; Peterson et al. 1984; Ballard et al. 1987; Mech et al. 1998). The samples of Moose killed by Gray Wolves from each hunted area are relatively small (47–117), given that Moose live to 20 or more years (Passmore et al. 1955). This article adds age data from another 77 Moose killed by Gray Wolves from a fourth (lightly) human-hunted area and assesses the age structure of all the samples.

This study was conducted as part of a radio-tracking study of Gray Wolves in the Superior National Forest in northeastern Minnesota (48°N, 92°W) (Mech 2009). There, Gray Wolves prey on both White-tailed Deer (*Odocoileus virginianus*) and Moose. The point estimates of the Moose population in the region varied from 2140 to 8840 between 1971 and 2011 (J. Giudice, Minnesota Department of Natural Resources, personal communication and M. Lenarz, Minnesota Department of Natural Resources, personal communication). Since 1971, Moose hunting on a lottery basis has been allowed, and about 200 Moose per year have been harvested (Edwards et al. 2004).

Of 107 Moose killed by Gray Wolves that we located by aerially radio-tracking Gray Wolves from 1967 through 2011, we examined 85 that we could sex; 45 were females and 40 were males. We collected teeth from 37 cows and 26 bulls from among the 85 and from 14 Moose from among the 22 of unknown sex (total 77 Moose). Mattson's Laboratory (Milltown, Montana) aged the teeth by cementum analysis (calves were probably underrepresented because there are fewer of their remains to find). The age structures of the two sexes were not significantly different (Kolmogorov-Smirnov test;  $P > 0.40$ ). We therefore pooled them and added the unknowns that we could age. The ages of our sam-

ple varied from calves >6 months old to bulls 13 years old and a cow 19 years old (Figure 1).

The best, and about the only, age-structure data available for a hunted Moose population are those for 17 585 Moose killed by hunters in north-central Ontario, presumably a representative estimate of the Moose population at large (Timmermann and Rempel 1998). The age structure of our sample killed by Gray Wolves was significantly different from that of the Ontario population (Kolmogorov-Smirnov;  $P < 0.0001$ ).

Peterson et al. (1984) plotted ages of Moose killed by Gray Wolves from various areas in Alaska in 6-year age classes (1–6, 7–12, and 13+). Of our sample of adult Moose killed by Gray Wolves, only 34% were 1–6 years old, similar to the 27% in the sample in Alaska in Peterson et al. (1984) (no significant difference), whereas 76% of the Ontario population was of this age class ( $\chi^2 = 68.55$ ;  $P < 0.0001$ ). Assuming that the

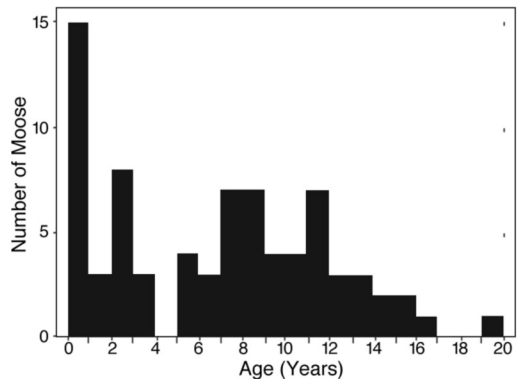


FIGURE 1. Age distribution of 77 Moose (*Alces alces*) killed by Gray Wolves (*Canis lupus*) in northeastern Minnesota between 1967–2011. (Calves are probably underrepresented.)

age structure of the Ontario Moose population at large reasonably approximates that of the study population in Superior National Forest, this is strong evidence that Moose 1–6 years of age are the least vulnerable to Gray Wolves in this area.

We have long known that Gray Wolves tend to kill a disproportionate number of older Moose and calves and that a disproportionate number of younger Moose > 1-year of age survive Gray Wolf predation (Mech 1966; Peterson 1977; Haber 1977; Peterson et al. 1984; Ballard et al. 1987; Mech et al. 1998). However, the actual age when disproportionate vulnerability begins may vary. Peterson et al. (1998) showed that Moose  $\geq 9$  years of age were more vulnerable on Isle Royale and those >12 years of age on the Kenai Peninsula were more vulnerable (Peterson et al. 1984).

In our sample, Moose  $\geq 9$  years old comprised 39% of the Moose >1 year of age killed by Gray Wolves, whereas Moose  $\geq 9$  years old comprised only 10% of the Ontario sample of Moose >1 year of age killed by hunters ( $P < 0.0001$ ;  $\chi^2 = 68.29$ ; 1 d.f.). Thus our study tends to confirm the findings on Isle Royale (Peterson et al. 1998) and adds to the general conclusion that Gray Wolves tend to kill older Moose, whether in populations hunted by people or not.

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