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EFFECTS OF EAR-TAGGING WITH RADIOTRANSMITTERS ON SURVIVAL OF MOOSE CALVES

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Abstract: A critical assumption of radiotelemetry studies is that the radiotransmitters themselves do not influence mortality. Here we report the effects of marking techniques on survival of moose (*Alces alces*) calves from birth to the beginning of the autumn hunting season. We marked and followed 181 moose calves with ear tags and 71 with ear transmitters, and we also followed 175 unmarked control calves, all with marked mothers, in 5 study areas in Sweden; 2 areas had resident brown bears (*Ursus arctos*), and 3 did not. Survival was lower for calves with ear transmitters than for those with ear tags ($P < 0.001$) and for control calves ($P < 0.001$). There was no difference in survival between control calves and calves with ear tags ($P = 0.09$). Survival was lower in areas with bears, but bears apparently did not prey differentially on calves marked with ear transmitters. Marking newborn moose calves with plastic ear tags did not have measurable effects, but we do not recommend marking calves with ear transmitters, because of the high mortality rates calves experienced.

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Radiotelemetry has been of great importance in documenting rates and causes of mortality in studies of wildlife. Of course, a crucial assumption is that the radiotransmitters themselves neither affect mortality rates nor predispose the marked animal to certain types of mortality (Pollock et al. 1989). Some types of radiotransmitter mountings have been found to increase mortality rates in birds (Small and Rusch 1985, Marks and Marks 1987, Marcström et al. 1989, Ward and

Flint 1995). Understandably, large animals appear to be less affected by radiotransmitters. In fact, a review of 59 papers and reports on mortality rates of radiomarked neonatal ungulates and 8 of ear-tagged neonatal ungulates revealed none had reported negative effects due to the transmitters, although known losses to abandonment were disregarded in this review (Linnell et al. 1995). Byers (1997) even reported a significantly higher survival among pronghorn (*Antilocapra americana*) fawns that were captured and ear-tagged than those that were not. These results may give researchers a false sense of security when planning studies of the rates and causes of mortality in ungulate neonates.

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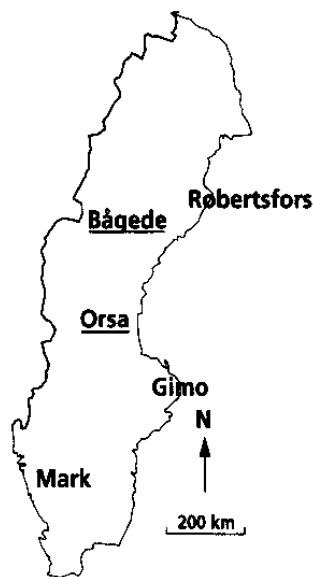


Fig. 1. Map of Sweden showing the locations of the 5 study areas (under the capital letter). The areas where bears occur are underlined.

Livezey (1990) emphasized the importance of analyzing the effects of marking newborn ungulates by comparing mortality rates of unmarked and undisturbed neonates with those that have been marked. Here we report the effects of marking newborn moose calves with plastic ear tags and radiotransmitters mounted into ear tags by comparing their mortality with unmarked calves following marked mothers. We marked these calves with transmitters mounted into ear tags because some moose calves were choked when neck collars failed to expand as planned in a study in Norway (B.-E. Sæther and R. Andersen, Norwegian University of Science and Technology, personal communication). This episode received much public attention, so we attempted to use a more benign marking technique.

STUDY AREAS

We marked moose calves in 5 forested areas in Sweden: Robertsfors in Västerbotten County (64°15'N, 20°50'E) during 1990–95, Bågede in Jämtland County (64°20'N, 14°20'E) during 1994–95, Orsa in Dalarna County (61°40'N, 14°50'E) during 1994–95, Gimo in Uppland County (60°05'N, 18°10'E) during 1994, and Mark in Älvsborg County (57°25'N, 12°40'E) during 1994–95 (Fig. 1). The study areas occurred within the boreal biogeographic region, except Mark, which occurred in the boreone-moral biogeographic region (Abrahamsen et al. 1977). Scotch pine (*Pinus sylvestris*), Norway

spruce (*Picea abies*), or both dominated in all areas, except Mark, where pine was rare. Amount of deciduous trees, dominated by birches (*Betula pendula*, *B. pubescens*) varied but generally decreased from south to north.

In Sweden, the occurrence of brown bears is concentrated in 4 areas. There are some bears (mostly males) in surrounding areas, but they occur at low densities (Swenson et al. 1998). Bågede and Orsa are within 2 of these bear concentration areas, and bears are continually present. Robertsfors is at the edge of a peripheral area, and bears are rarely recorded there; there is no continuous presence. Gimo and Mark are located outside the range of bears in Sweden. No other natural predators of moose calves are present in any of the study areas, except lynx (*Lynx lynx*).

METHODS

Cow moose were equipped with radiotransmitters mounted in neck collars after being immobilized from a helicopter in winter. The cows were checked by carefully approaching them every third day during the calving season in mid-May to early June. When newborn calves were found, they were counted from a distance. Calves to be marked were chased down, captured, weighed, and marked with either a radiotransmitter, with a mortality function, mounted on an ear tag (Televilt model TXP-2M; Televilt International AB, Lindesberg, Sweden; the entire assembly weighed 29 g; Fig. 2) or a colored, plastic ear tag weighing 3.5 g. The transmitters had been stored in juniper and pine needles to remove human scent, and the field assistants rubbed their hands with leaves to reduce their scent prior to chasing calves. The entire marking procedure took about 5 min. The cow's behavior varied from defense to running far away, but the most common behavior was to remain within a few hundred meters during the marking procedure and to return to the calf within 1 hr. About 40% of the calves were used as a control group, and they and their radiomarked mothers were left undisturbed.

Radiomarked calves were located daily from the ground to determine causes of mortality, but they were not approached or observed. Outside the bear area, control and ear-tagged calves were checked when they were 20–30 days old and just before the beginning of the autumn hunting season by locating the cow and carefully approaching her to observe if the calves were still with her. If a calf was not seen,

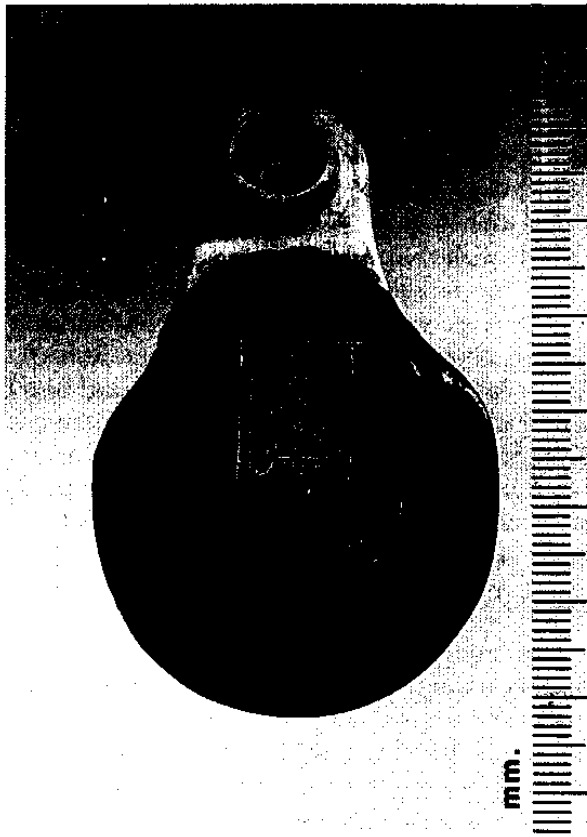


Fig. 2. Photograph of the ear tag radiotransmitter used in the study. A millimeter scale is on the right.

cows were rechecked 2–3 days later. To determine the timing of disappearance in the bear areas, the control calves there were checked weekly during the first 5–6 weeks of life by carefully approaching and observing them. If a calf was not seen, cows were rechecked 2–3 days later. Efforts were made not to disturb them, but this was not always successful.

We have compared survival from birth to just before the beginning of the hunting season

(early September, except in the Gimo and Mark areas, where it began in early October). Survival was calculated as n/N , where N was the total number of calves at birth, and n was the number alive just prior to the hunting season. We have not attempted to compare causes of death, including calves that were abandoned, because cause of death was not known for any calves not carrying a transmitter.

RESULTS

In the 5 areas, 175 calves were included in the control groups, 181 were marked with ear tags, and 71 were marked with ear transmitters (Table 1). Thus, we were able to evaluate the effects of capture and the effects of 2 different ear-marking methods.

The combined data showed a highly significant difference in mortality rates related to marking group ($\chi^2_2 = 103.5$, $P < 0.001$; Table 1). Mortality among those with ear transmitters was higher than those in the unmarked control group ($\chi^2_1 = 58.8$, $P < 0.001$) and the ear tag group ($\chi^2_1 = 84.8$, $P < 0.001$). However, there was no difference in mortality among calves marked with just an ear tag and the control calves ($\chi^2_1 = 2.9$, $P = 0.09$). In the 2 areas where ear transmitters were used and sample sizes were adequate for testing, mortality was higher than in the control and ear tag groups, but nowhere did we find an increased mortality associated with just capture and marking with an ear tag (Table 1).

A logistic regression model analysis of calf mortality that included marking with an ear transmitter and presence of brown bears showed that mortality was significantly related to both presence of the ear transmitter and

Table 1. Mortality of neonatal moose calves from birth to the beginning of the autumn hunting season in Sweden in relation to type of marking and presence of brown bears.

Area	Bears?	Mortality by group					
		Control		Ear tag		Ear-tag transmitter	
		% ^a	n	% ^a	n	% ^a	n
Robertsfors	No	12A	116	11A	128	56B	27
Gimo	No	0A	2	11A	8		
Mark	No	4A	23	5A	43		
Bågede	Yes	38A	8	50A	2	69A	13
Orsa	Yes	42A	26			77B	31
Combined	No	11A	141	9A	179	56B	27
Combined	Yes	41A	34	50A,B	2	75B	44
Combined	Yes + No	17A	175	10A	181	68B	71

^a Mortality rates with the same letter in common are not different within an area (2-tailed χ^2 or Fisher's exact test, as appropriate; $P > 0.05$).

Table 2. Linear regression analysis of the effect of ear-tag transmitters and presence of brown bears on survival of neonatal moose calves in 5 areas of Sweden.

Source	df	Parameter estimate	Wald χ^2	P
Intercept	1	6.13	60.9	<0.001
Ear-tag transmitter or not	1	-1.57	22.7	<0.001
Bear presence or not	1	-2.60	16.7	<0.001
Bear \times marking	1	0.26	1.5	0.225
Entire model	3		106.3	<0.001

brown bears. However, there was no interaction between these factors (Table 2).

DISCUSSION

Capturing newborn moose calves and marking them with an ear tag did not increase their mortality in our study areas, at least in the areas without bears; we marked only 2 calves with ear tags in the bear areas. This finding has also been reported from North America for moose calves marked with neck-collar transmitters (Ballard 1992) and is consistent with the literature as reported by Linnell et al. (1995). However, in another survey of the literature, Livezey (1990) found that 9% of 661 captured newborn moose calves in North America were reported to have been abandoned following marking. The mortality we report is a combination of abandonment and other mortality factors. These results suggest the abandonment rate of captured calves was not greater than for undisturbed calves, and that marking per se did not induce a higher mortality.

Calves marked with ear transmitters experienced a significantly higher mortality rate than control calves or those marked with just ear tags, which indicates that something associated with the transmitter was responsible for the elevated mortality. This effect was not relatively greater where bears were present, because there was no significant interaction between presence of bears and presence of ear-tag transmitters on calf survival. This result suggests that the smell from potential draining from the sore in the ear or changes in the calves' behavior that would make them more vulnerable to predation were not important factors in increasing their mortality rates. The actual mechanism of the problem is unknown, but it may have been related to the calves' ability to deal with the transmitter, changes in the calves' behavior that resulted in higher abandonment rates, or other disruptions of the calf-mother relationship (Livezey 1990). Noises from the transmitter may

have contributed to the problem. Because of strict regulations in Sweden that prohibited the use of mercury switches in the mortality transmitters, an iron switch was used (P. A. Lemnell, Televilt International AB, personal communication). This switch made a "clicking" sound when the transmitter moved, which may have affected the calf's or cow's behavior. We also have observed that the calves' ears drooped during the first 2-3 weeks after marking.

Until the mechanism causing the problem can be identified and mitigated, we do not recommend marking newborn moose calves with ear transmitters. Our experiences illustrate that using a new marking method can cause unexpectedly high mortality to neonate ungulates, even though other studies have found few problems when using related methods.

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