REPRODUCTION AND MORTALITY OF MOOSE TRANSLOCATED FROM ONTARIO TO MICHIGAN

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ABSTRACT: Twenty-five bull moose (*Alces alces*) and 36 cow moose were translocated from Algonquin Provincial Park, Ontario to Marquette County, Michigan in 1985 and 1987. Mortality-sensing radio-collars enabled biologists to census calves and perform necropsies on dead animals. Total calf production was 122 animals during 1985-89. Average percentage of adult cows with calves was 78%. Average birth rate was 107 calves per 100 adult cows (range 71-124). Average twinning rate for adult cows was 37% (range 24%-69%). Average survival of calves through their first winter was 82%. The postpartum population during 1985-89 was 47, 49, 103, 124, and 128 moose, respectively. Fifty percent of the translocated cows and 32% of the translocated bulls died by 30 September 1989. Brainworm (*Parelaphostrongylus tenuis*) was the leading cause of death, accounting for 13 (38%) of 34 deaths. A study of winter bedding sites is also reviewed.

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Michigan's native moose population approached extirpation in the 19th century as logging, fire,and various land developments drastically degraded moose habitat and increased numbers of whitetailed deer (*Odocoileus virginianus*) and therefore probable moose deaths from brainworm (see Hickie n.d., Anderson 1964, Baker 1983). Unrestricted hunting by an increasing human population took large numbers of moose until the state legislature granted complete protection in 1889. Reproduction by scattered individuals appeared negligible. A translocation of 69 moose from Isle Royale to the Upper Peninsula of Michigan during 1935-37 (Hickie n.d.) failed to establish a viable population, probably because of the moose's poor physical condition, high deer numbers, and poaching. In January and February 1985 and February 1987, the Ontario Ministry of Natural Resources and the Michigan Department of Natural Resources cooperatively translocated 25 bulls and 36 cows from Algonquin Provincial Park, Ontario, to Marquette County, Michigan in a second attempt to reestablish a viable population (Burgoyne 1985, Schmitt and Aho 1988). This paper reports on reproduction and mortality of these animals and reviews an ancillary study of winter bedding habitat characteristics.

METHODS

Each translocated moose was fitted with a mortality-sensing radio-collar (Schmitt and Aho1988). During 28 February-14 March 1989, 2 female calves, 2 male calves, and a yearling cow in Michigan were stalked on snowshoes, immobilized with carfentanil and xylazine, fitted with a mortality-sensing radio-collar (Telonics, Mesa, Ariz.) (expandable for calves, non-expandable for the yearling), reversed with naltrexone, and released (Schmitt and Dalton 1987).

Radio-collar signals were monitored usually once each week from a Beechcraft T34 or Cessna 172 aircraft to detect mortality. Signals were monitored 2-3 times per week during August-November 1985 (Schmitt and Aho 1988). Necropsies were performed on carcasses of radio-collared moose and others serendipitously discovered. Specialists at the Wildlife Disease Laboratory, East Lansing, Michigan examined skulls for brainworm and examined organ samples from field necropsies to determine cause of death.

Newborn calves were censused during May-July 1985-89 by radio-tracking adult cows on foot and searching for calves and calf sign. During December-January 1985-89 and April 1985-88 calves were aerially censused by radio-tracking adult cows and looking for their calves.

RESULTS

Reproduction

During 1985-89, 122 moose calves were identified (Table 1). Average percentage of adult cows with calves was 78%, average birth rate was 107 calves per 100 adult cows, and average twinning rate was 37% (Table 2). These data are based on sightings of calves or of fresh calf beds, tracks, and feces. The magnitude of predation on neonates or other postnatal losses occurring before these sightings is unknown (Verme 1974). Therefore, the productivity data given here must be considered as minimum values and actual productivity is likely higher.

Table 1. Production and survival of moose calves born in Michigan, 1985-89 cohorts.

Cohort Year	Calves Born	Surviving first winter *n*	Surviving first winter %
1985	21	17	81
1986	10	9	90
1987	30	24	80
1988	34	28	82
1989	27		
All	122	78	82

Blood tests of 2 translocated yearling cows showed that they were not pregnant (Schmitt and Aho 1988). Biologists who stalked the yearling cow radio-collared in February 1989 on 7 June and 6 July1989 saw no evidence of a calf, and we assume that she was not pregnant.

The 1988 cohort consisted of 27 calves from translocated cows and 7 calves from other cows believed to be part of the 1985 cohort. The 1989 cohort consisted of 17 calves from translocated cows and 10 calves from cows believed to be from the 1985 or 1986 cohort.

Table 2. Productivity of translocated adult cow moose in Michigan and twinning rate of yearling and adult cow moose in Algonquin Provincial park, Ontario[a], 1985-89.

Year	*n*	% Cows with calves	Birth Rate (Calves per 100 cows)	Twinning Rate (%)[b] Michigan	Twinning Rate (%)[b] Algonquin	*n*
1985	17	100	124	24	29	34
1986	14	50	71	43	40	45
1987	27	89[c]	111	25[d]	18	39
1988	23	70[e]	117	69	14***	29
1989	16	75[f]	100	33	9*	43
All	97	78	107	37	23**	190

[a]M.L. Wilton, Ont. Minist. Nat. Resour., pers. commun.

[b]% of cow-calf groups containing 2 calves.

[c]86% for cows translocated in 1985 (n=14) and 92% for cows translocated in 1987 (n=13).

[d]Same for cows translocated in 1985 (n=12) and 1987 (n=12).

[e]83% for cows translocated in 1985 (n=12) and 54% for cows translocated in 1987 (n=11).

[f]78% for cows translocated in 1985 (n=9) and 71% for cows translocated in 1987 (n=7).

***$P<0.005$.

*$P<0.050$.

**$P<0.025$.

Average calf survival through the first winter was 82% for the 1985-88 cohorts (Table 1). These data exclude any calves that died before the neonatal calf censuses, and thus are biased upward. The April 1988 aerial calf census was rendered ineffective by patchy snow cover and cold temperatures that drove moose into coniferous cover. This drastically reduced the observability of cows and calves. Only 2 cows, each with its calf, were sighted out of 24 cows that were radio-tracked. Similar conditions existed in April 1989, and the aerial calf census was therefore cancelled. Survival of the 1987 and 1988 cohorts through their first winter is based on aerial calf censuses in January 1988 and 1989. The assumption that calves seen then survived the entire winter is supported by occasional ground and aerial sightings of calves during February-March 1988 and 1989.

Mortality

Eighteen (50%) of 36 translocated cows and 8 (32%) of 25 translocated bulls died as of 30 September 1989. Eight dead offspring were found. Twelve causes of death were identified (Table 3). Brainworm was the leading cause, killing 13 (38%) of 34 moose examined.

Postpartum Population Estimates

The postpartum population was estimated at 47 in 1985, 49 in 1986, 103 in 1987, 124 in 1988, and 128 in 1989. The sharp increase in 1987 was caused by the addition

Table 3. Causes of death of translocated and filial moose in Michigan, February 1985 - September 1989.

	No. translocated		No. filial			
Cause	Bulls	Cows	Bulls	Cows	Unknown Sex	Total
Brainworm		10	1[a]	2[b]		13
Unknown	4			1[a]		5
Awkward fetal position at birth		1			2[c]	3
Hepatitis and peritonitis		2				2
Narcotic recycling		2				2
Liver flukes & tapeworms[d]	2					2
Drowning	1					1
Infected gored foreleg	1					1
Mired in mud, exhaustion		1				1
Fall off cliff		1				1
Abscessed liver, septicemia		1				1
Poaching			1[a]			1
Congenitally defective lungs				1[c]		1
Total	8	18	2	4	2	34

[a]Yearling.

[b]1 2-year-old and 1 calf.

[c]Perinatal.

[d]*Fascioloides magna* and *Echinococcus granulosus*, respectively.

of 15 adult bulls and 13 surviving adult cows from the translocation that year, 15 calves born to these newly translocated cows, and 15 calves born to cows translocated in 1985. Postpartum population estimates reflect known losses of radio-collared animals, an assumption that calves not seen during post-neonatal censuses are dead, and an assumption that mortality rates for 1, 2, and 3-year-old moose born in Michigan are equal to the mortality rates for translocated moose.

DISCUSSION

Reproduction

The percentage of adult cows with calves was similar to North American and Swedish pregnancy rates reviewed by Franzmann (1981) and by Boer (1987) and reported by Larson *et al.* (1989), with the exception of a reduced percentage associated with the first rut experienced by translocated cows in Michigan. Perhaps a residual stress of translocation, unfamiliarity with locations of moose of the opposite sex, a low bull density in 1985, lactation stress, and, in some cases, cows' peripheral locations in the moose range combined to reduce calf production. Whatever the cause(s), the percentage of adult cows with calves recovered during the second rut experienced in Michigan.

The average birth rate of adult cows was about in the middle of those reviewed by Franzmann (1981) and by Boer (1987) and reported by Larson *et al.* (1989). The average twinning rate of adult cows was in the upper range of those reported by these authors. The highest twinning rate (69% in1988) was about the same as the 70% combined twinning rate for yearlings and adults in good habitat in Alaska in 1982-83 (Franzmann and Schwartz 1985). A comparison of twinning rates with those in Algonquin Provincial Park, Ontario, the source of these Michigan moose, is particularly relevant (Table 2). Twinning rates of translocated adult cows were not significantly different from those ofAlgonquin cows (yearlings and adults combined) in 1985 ($x^2 = 0.20$, df = 1, $P > 0.100$), 1986 ($x^2 = 2.15$, df = 1, $P > 0.100$) and 1987 ($x^2 = 0.29$, df = 1, $P > 0.500$). However, twinning rates differed significantly in 1988 ($x^2 = 14.01$, df = 1, $P < 0.005$) and 1989 ($x^2 = 4.36$, df = 1, $P < 0.050$). During1986-89, the overall twinning rate of adult cows conceiving in Michigan (45%, $n = 47$) was significantly greater than the twinning rate of Algonquin cows (21%, $n = 156$) ($x^2 = 10.24$, df = 1, $P < 0.005$). We recommend a more rigorous study of the twinning rates of these genetically similar populations and contributing factors to help clarify relationships among range quality, weather, nutritional fitness of cows, and twinning rate.

Brainworm

Schmitt *et al.* (1983, 1987, 1988, 1989) assessed the prevalence of brainworm larvae in white-tailed deer fecal pellet groups in Michigan's Upper Peninsula. They found a 76% prevalence in 1982 (n = 157 pellet groups), 65% in 1987 (n= 179), 65% in 1988 (n = 212), and 59% in 1989 (n= 150). Saunders (1973) showed that prevalence of brainworm in white-tailed deer was inversely proportional to moose densities in northwestern Ontario. The high prevalences found in Michigan suggest that only a low moose density (≤0.08 moose/km^2) is possible. Gilbert (1974) found that prevalence of brainworm in moose was directly related to deer density in Maine. Deer density in Michigan's translocated moose range increased from less than 1.9 deer/km^2 in the early 1980's to 5.2 deer/km^2 in 1987 (H.R.Hill, Mich. Dep. Nat. Resour., unpubl. data). The latter density is higher than Karns' (1967) suggested management objective of ≤4.6 deer/km^2 in areas managed primarily for moose. However, Saunders (1973) and Karns (1967) data are not necessarily directly applicable to Michigan because of possible differences in contributing factors such as weather, soils, vegetation, densities and/or species of gastropod intermediate hosts, and foraging patterns of moose and deer.

Precipitation appears to be positively correlated with observed losses of moose to brainworm (Schmitt *et al.* 1987). However, more years of data are needed to understand the relationship between annual or seasonal precipitation and brainworm transmission.

Veterinarians injected translocated moose with ivermectin to kill brainworm larvae (Schmitt andAho 1988), but this drug's effectiveness disappears after 30 days. Monthly stalks to administer more ivermectin via projectile syringe are not feasible. S. M. Schmitt (Mich. Dep. Nat. Resour., pers.commun.) is conducting trials with penned deer to determine the ability of fenbendazole to kill adult brainworms. If so, it may be possible to orally administer the drug to deer concentrated in winter deer yards via specially formulated feed blocks or salt blocks, and thus reduce the prevalence of brainworm among deer and transmission to moose.

Winter Bedding Sites

Casual observations suggested that moose made greater use of conifers for bedding sites as the winter progressed, often bedding in small clumps of hemlocks (*Tsuga canadensis*) scattered through northern hardwood stands. Minzey (1989) subsequently studied vegetational and physical characteristics of winter bedding sites of 4 adult bulls and 3 adult cows with calves, December 1987-March 1988. He found that after snow depths exceeded 50 cm, cows with calves preferred mature hemlock stands with canopy closures near 90%. Cows bedded near the edges of the hemlock stands,while their calves bedded deeper inside the stands. Bulls preferred balsam fir (*Abies balsamea*) stands that had more open canopies and southern exposures. These data point out the desirability of retaining clumps of 2-10 hemlocks within stands of uneven aged hardwoods at a time when markets favor removal of hemlocks to convert to higher valued northern hardwoods.

Conclusions

The density of moose resulting from the moose translocations appears sufficient to maintain good reproduction. Birth, twinning, and calf survival rates imply that quantity and quality of food and cover are more than adequate. Public acceptance of the translocation project remains high; poaching has been a negligible mortality factor. The future of this moose population appears to hinge on losses to brainworm, which may increase from anticipated higher deer numbers caused by brisk logging activity and some mild winters in the mid 1980's.

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REFERENCES

ANDERSON, R. C. 1964. Neurologic disease in moose infected experimentally with *Pneumostrongylus tenuis* from white-tailed deer. Pathol. Vet. 1:289-322.

BAKER, R. 1983. Mammals of Michigan. Michigan State Univ. Press, East Lansing, Mich. 642pp.

BOER, A. H. 1987. Reproductive productivity of moose in New Brunswick. Alces 23:49-60.

BURGOYNE, G. E., Jr. 1985. Moose lift. Mich. Nat. Resour. 54:26-43.

FRANZMANN, A. W. 1981. *Alces alces*. Am. Soc. Mammal. Mamm. Species No. 154. 7pp.

______, and C.C. SCHWARTZ. 1985. Moose twinning rates: A possible population condition assessment. J. Wildl. Manage. 49:394-396.

GILBERT, F.F. 1974. *Parelaphostrongylus tenuis* in Maine: II-Prevalence in moose. J. Wildl. Manage. 31:42-46.

HICKIE, P. F. n.d., ca. 1943. Michigan moose. Mich. Conserv. Dep., Game Div. 57pp.

KARNS, P. D. 1967. *Pneumostrongylus tenuis* in deer in Minnesota and implications for moose. J. Wildl. Manage. 31:299-303.

LARSON, D. G., D. A. GAUTHIER, and R. L. MARKEL. 1989. Causes and rate of moose mortality in the southwest Yukon. J. Wildl. Manage. 53:548-557.

MINZEY, T. R. 1989. Winter bedding habitat characteristics of moose (*Alces alces*) in Michigan. M.S. Thesis, Northern Michigan Univ., Marquette. 113pp.

SAUNDERS, B. P. 1973. Meningeal worm in white-tailed deer in northwestern Ontario and moose population densities. J. Wildl. Manage. 37:327-330.

SCHMITT, S. M., and R. W. AHO. 1988. Reintroduction of moose from Ontario to Michigan. Pages 258-274 *In* L. Nielsen and R. D. Brown, eds. Translocation of wild animals. Wisconsin Humane Soc., Milwaukee, and Caesar Kleberg Wildl. Res. Inst., Kingsville, Texas.

______, and W. J. DALTON. 1987. Immobilization of moose by carfentanil and xylazine and reversal by naltrexone, a long acting antagonist. Alces 23:195-219.

______, H. R. HILL, and T. M. COOLEY. 1983. Upper Peninsula brainworm incidence survey - 1982. Mich. Dep. Nat. Resour. Wildl. Div. Rep. No. 2944. 6pp.

______, ______, and ______. 1987. Upper Peninsula brainworm incidence survey - 1987. Mich. Dep. Nat. Resour. Wildl. Div. Rep. No. 3059. 7pp.

______, ______, and ______. 1988. Upper Peninsula brainworm incidence survey - 1988. Mich. Dep. Nat. Resour. Wildl. Div. Rep. No. 3084. 9pp.

______, ______, and ______. 1989. Upper Peninsula brainworm incidence survey - 1989. Mich. Dep. Nat. Resour. Wildl. Div. Rep. No. 3108. 8pp.

VERME, L. J. 1974. Problems in appraising reproduction in Cervidae. Proc. N. Am. Moose Conf. Workshop 10:22-36.