MODELING OF MOOSE HUNTING: PROTECTION OF COWS WITH TWINS

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ABSTRACT: I developed a simulation model to evaluate moose hunting strategies. The model incorporated age and sex-specific schedules for natural (nonhunting) mortality and fecundity. I evaluated 2 strategies for harvesting cow moose. In the first, cow moose were harvested irrespective of whether they were accompanied by calves. In the second, hunters were not allowed to kill cows accompanied by twin calves. Simulation results indicated that 500 calves/1000 cows could be saved under the second harvest strategy.

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Moose are one of the most important game species in the USSR. In the European portion of the USSR, the goal of most game managers is to increase moose numbers. Traditional hunters in these regions do not understand or accept the concept of a selective harvest. For this reason, simulation modeling was used to evaluate the effect of different harvest strategies. In the first strategy, cow moose were harvested regardless of whether they were accompanied by calves. In the second, hunters were not allowed to kill cows accompanied by twin calves. Based on a comparison of the number of calves and embryos in cow moose harvested in the Kostroma region (Baskin, unpublished data), I assumed that individual cows consistently produce either single calves or twins.

In contrast, moose density is too high in all parts of the Lithuanian Republic. The model was used to help determine the best strategy to reduce moose density while retaining the sex and age structure of the population. In particular, a strategy was needed that would preserve bulls in the 5.5 – 8.5 year age classes for trophy hunting, maximize meat production, and shooting opportunities. These needs can be addressed using an optimizing model (Lopatin and Rosolovsky 1990).

METHODS

Simulations were run on a DVK-3 microcomputer with OS RT11SJ and the model code was written in PASCAL. The model tallied moose numbers after each of a sequence of discrete events: natural mortality, hunting mortality, and calving. The post-calving population was then subjected to that sequence in the next iteration of the model. Through tabulations, we tracked the sex and age structure of the population, proportions of cows with 0, 1, and 2 calves, and carcass weights in each sex and age category. In modeling the harvest in Lithuania, a harvest quota was set, then the antlerless portion (including calves) was set, and finally, the age distribution in each category was identified. Simulations ignored the potential effects of weather and nutrition. Output from the simulations was displayed on the screen, printed out, or saved as a separate file.

For evaluating the twin protection strategies discussed above, I modeled only the female portion of the population. I assumed that natural mortality, pregnancy rates, and fecundity rates remained constant throughout the simulations. Furthermore, I assumed that hunting maintains a stable population of mature cows and only the proportion of cows with single or twin calves varies. The probability for a cow to have a single calf was set as P1 (the probability of twins for the same cow was P2 = 1-P1), and the probability that that cow would have a single calf again next year was P3 (thus, the probability that a cow would twin in consecutive years was P4 = 1-P3). As indicated earlier, if P2 is increased, P4 should increase as well because it is assumed that the ability to bear twins is inherited and individual to each cow.

BIOLOGICAL PARAMETERS OF THE MODEL

No single source of data was available for all 16 age classes used in the model, and the initial set of population parameters used in the model were a composite from several areas and authors. Several sources of data were used: Baleisis (1973, 1977) and the Society of Hunters and Fisherman (Baleisis and Butautas 1987, 1988) [Lithuania]; Filinov (1983) and Kozlo (1983) [various regions of the USSR]; and Sylven et al. (1979) [Sweden]. The starting population contained 1,000 moose divided among 16 age classes (Table 1). Natural mortality was set at 3%, harvest mortality at 20%, and I assumed that equal numbers of cows and bulls were harvested. The sex ratio of newborn calves was 108 male calves/100 female calves.

Table 1. Initial set of parameters for moose population model.

Age Class (years)	Percent females in population	Percent females not pregnant	Percent females with one calf	Percent females with twins	Percent mortality	Carcass mass (kg)	
						max	min
0.5	20.0	100.0	0.0	0.0	25.0	72.0	65.8
1.5	13.0	75.0	25.0	0.0	10.0	128.8	120.6
2.5	10.0	70.0	25.0	5.0	5.0	153.7	143.0
3.5	10.0	40.0	50.0	10.0	3.0	168.7	158.6
4.5	8.0	20.0	50.0	30.0	3.0	187.6	166.3
5.5	7.0	15.0	50.0	35.0	3.0	204.3	167.5
6.5	6.0	20.0	40.0	40.0	3.0	210.6	170.0
7.5	4.0	20.0	45.0	35.0	3.0	211.9	172.0
8.5	3.0	30.0	40.0	30.0	3.0	218.7	177.0
9.5	3.0	35.0	45.0	20.0	3.0	220.0	178.0
10.5	3.5	40.0	40.0	20.0	3.0	220.0	182.0
11.5	3.0	42.0	30.0	28.0	3.0	224.7	185.0
12.5	3.0	45.0	35.0	20.0	3.0	228.0	192.0
13.5	3.0	50.0	35.0	20.0	3.0	230.0	206.0
14.5	2.5	60.0	30.0	10.0	10.0	220.0	200.0
15.5	1.0	85.0	10.0	5.0	100.0	210.0	195.0

The probability P1 was modeled as varying from 0.4 to 0.8 and P3 varied from 0.3 to 0.7. Precise values are unknown. Based on data from the Kostroma region, we can assume the probability of twins recurring is 1.7, so P1 equals 0.3. However, more data must be analyzed to determine a precise probability level of twins recurring. We modeled female harvest ratios of 5%, 10%, 15%, and 20%.

RESULTS AND MANAGEMENT IMPLICATIONS

The value of protecting cows with twins was determined by comparing the number of calves born during 10 years of the first and second harvest strategies. This difference was expressed as a percentage of (A) the number of calves born under the first strategy and (B) as a percentage of the initial number of cows (Table 2).

When the harvest rate ranged from 10 to 15% of the mature cows, the protection of twins resulted in 3-5% more calves, compared to a strategy of no protection. Over a 10-year period, this could result in an increase of 300-500 individuals. With higher harvest rates, even more calves are recruited; however, the population may become saturated with twin-bearing cows. The harvest was limited to yearling cows, the only age class that would produce a single calf.

Simulations with the 1987 harvest data from Lithuania (Table 3) indicate that moose density would remain stable for the first 5 years and that there would be a constant output of meat (Table 4). Overharvest of cows in the 6.5 age-class, however, results in a female-biased harvest in the sixth year. Moose numbers will decrease insignificantly but provide a higher yield of meat. Simulations with the 1988 harvest data indicate that moose numbers will decline 4% in the first 5 years and provide 25 tons of meat annually/1,000 moose. Overharvest of the population will occur later.

The harvest quota can be increased up

Table 2. Results of protecting cows with twins.

		Percent of Cows Harvested							
		5		10		15		20	
P1	P3	A	B	A	B	A	B	A	B
0.8	0.7	0.33	3.6	0.666	7.2	0.98	10.8	1.32	14.4
	0.6	0.65	7.2	1.29	14.4	1.94	21.6	2.58	28.8
	0.5	0.95	10.8	1.91	21.6	2.86	32.4	3.81	43.2
	0.4	1.25	14.4	2.50	28.8	3.75	43.2	5.00	57.6
	0.3	1.54	18.0	3.08	36.0	4.62	54.0	6.15	72.0
0.7	0.6	0.45	5.4	0.90	10.8	1.35	16.2	1.81	21.6
	0.5	0.88	10.8	1.77	21.6	2.65	32.4	3.53	43.2
	0.4	1.30	16.2	2.59	32.4	3.89	48.6	5.18	64.8
	0.3	1.69	21.6	3.38	43.2	5.07	64.8	6.76	86.4
0.6	0.5	0.56	7.2	1.11	14.4	1.67	21.6	2.22	28.8
	0.4	1.08	14.4	2.16	28.8	3.24	43.2	4.32	57.6
	0.3	1.58	21.6	3.16	43.2	4.74	64.8	6.32	86.4
0.5	0.4	0.64	9.0	1.29	18.0	1.94	27.0	2.58	36.0
	0.3	1.25	18.0	2.50	36.0	3.75	54.0	5.00	72.0

Table 3. Moose harvest data from Lithuania (% of quota).

Year	Age Class															
	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5
1987	32.7	11.5	14.4	13.4	6.8	8.7	4.0	2.1	2.4	1.2	1.7	0.5	0.4	0.1	0.1	–
1988	36.7	11.5	10.3	10.4	6.7	7.8	4.5	3.8	2.9	2.2	2.0	0.5	0.6	0.2	0.2	0.1

Table 4. Results of moose population modeling according to the harvest data from Lithuania.

Year	According to 1987 data						According to 1988 data					
	Number Alive		Number Born		Harvest	Meat Yield[1]	Number Alive		Number Born		Harvest	Meat Yield[1]
	max	min	max	min			max	min	max	min		
1	517	506	135	121	192	25.3	513	508	131	120	192	25.7
2	519	506	129	117	195	25.5	513	502	126	114	194	25.8
3	517	503	126	116	195	25.5	509	498	123	114	193	25.8
4	511	492	119	110	194	25.4	502	488	117	109	191	25.6
5	502	477	114	103	191	25.2	485	472	105	100	188	25.2

[1]x 1000 kg.

to 10% or more with an increased harvest of yearlings and a reduced harvest of cows. It should be stressed that for successful moose population management using the numerical simulation models, precise knowledge of the sex and age structure of the population is needed. Gathering these data is a high priority for Lithuanian game managers.

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