A REVIEW OF MOOSE FERTILITY IN RUSSIA

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ABSTRACT: Information on fertility of moose (*Alces alces*) and survival rate of calves in Russia is reviewed. The potential fertility of moose averages 1.3 (1.1-1.6) embryos per pregnant female. The percent of dry cows is variable, but usually does not exceed 35%. Annual calf mortality reaches 60-80%. Potential recruitment rate is near 40%, but is generally close to 30% by autumn, and drops to 10-15% by spring.

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The fertility of moose and the survival rate of calves are the most essential criteria for understanding the dynamics of moose populations. We gathered extensive, unsystematized, and little-known material on the subject across Russia. We attempt to generalize and analyze the available information on fertility of moose and the rate of survival of young animals. Such knowledge is necessary to manage populations of this very important large species whose numbers in recent years have been sharply declining.

FERTILITY

One or two (rarely, 3 - 4) embryos are found in the uteri of female moose in Russia. Data about multiple pregnancies (Devishev 1967) is doubtful since it is taken from the license-hunting reports and quoted by unqualified people. On average, moose fertility is 1.3 (1.1-1.6) embryos per pregnant female (Table 1). Female moose productivity is roughly correlated in different years within a certain region. In the Moscow region, between 1967-1980, the number of embryos per female varied from 1.15 to 1.43 (Filonov 1983); in the southern Urals in 1971-1990 (Table 2) the same indicator was within 1.10-1.41 (Matveyev and Bakunin 1994).

Moose fertility depends on several factors, including population density, sex and age structure, available forage, age and mass, weather conditions, and helminth loads (Yurgenson 1964; Filonov 1977, 1983, 1993; Kozlo 1983; Glushkov 1987).

Nearly all sexually mature moose at the moose farms have calves every year (Knorre 1959), whereas in the natural environment, many cows are not pregnant (Table 1). In most populations dry cows are not in excess of 35%, but in some populations over half the females are allegedly dry. In these studies, many of the authors include 1.5-year-old females which are not sexually mature. In other cases the hunters fail to identify small-sized embryos or misreport killing a pregnant female, thus inflating the proportion of dry cows. In one population the percent of non-pregnant females varied annually (Table 2), typically between 5 and 35% (Yazan 1972, Kozlo 1983, Glushkov 1987).

Yearling moose females usually have 1 calf, middle-aged females 2. Females reach their maximal productivity between age of 4-10 years. They remain productive after age 10 with higher survival of the calves (Table 3). Thus, in Krasnoyarsk Region, the female moose of 3.5-6.5 years of age, while constituting as low as 14.3% of the

Table 1. Potential fertility (%) of moose in Russia, 1950-1994.

Region	Source[1]	Females		Females with Embryos			Embryos/Female	
		Harvest	Pregnant	1	2	3	Pregnant	Harvest
		n	%	%	%	%	n	n
Northwest	9	151	62.3	61.7	38.3	-	1.38	0.86
Leningrad	10	6191	54.3	79.6	20.2	0.2	1.2	0.65
Leningrad	22	111	74.8	92.8	7.2	-	1.07	0.80
Leningrad	23	206	73.8	89.5	10.5	-	1.11	0.81
Murmansk[2]	1	1209	-	81.8	18.1	0.1	1018	-
Arkhangelsk	3	513	75.0	62.0	38.0	-	1.38	1.02
Arkhangelsk	5	1430	47.4	65.2	34.5	0.3	1.35	0.64
Vologda	5	4428	54.6	63.2	36.7	0.1	1.37	0.75
Yaroslavl	5	2835	46.3	63.4	36.4	0.1	1.37	0.63
Yaroslavl	21	1030	80.6	75.8	24.2	-	1.24	1.01
Tver	5	2937	56.0	68.0	32.0	0.06	1.32	0.78
Moscow	5	5729	49.0	72.7	27.2	0.03	1.27	0.63
Tula	17	1275	68.8	61.5	38.5	-	1.38	1.13
Oksky Reserve	18	161	60.9	54.6	45.4	-	1.45	0.88
Tambov	2	177	79.7	53.9	44.7	1.4	1.47	1.17
Tambov	15	556	61.9	-	-	-	1.40	0.78
Voronezh	15	516	36.6	-	-	-	1.58	0.37
Saratov region	15	1423	47.2	-	-	-	1.41	0.67
Central Black Earth Area	13	2547	80.1	72.2	27.7	0.1	1.28	1.03
Pechoro-Ilychsky Reserve	7	291	76.6	70.8	29.2	-	1.27	0.98
Moose farm	15	121	80.2	62.8	37.2	-	1.50	1.37
	8	77	94.8	60.3	39.7	-	1.40	1.32
	8[3]	37	97.3	63.9	36.1	-	1.36	1.32
	16[3]	251	-	45.8	53.8	0.4	1.55	-
Kirov	11	321	78.8	47.8	52.2	-	1.52	1.20
European Russia	6	900	76.1	59.1	40.9	-	1.41	1.07
"	19	472	71.4	56.5	43.5	-	1.43	1.02
"	20	622	76.0	52.6	47.4	-	1.47	1.12
Chelyabinsk	4	4705	77.6	64.9	35.1	-	1.35	1.00
Novosibirsk	12	400	89.5	54.7	45.0	0.3	1.45	1.30

[1] 1=Makarova (1981); 2=Kheruvimov (1969); 3=Yevtikhov *et al.* (1980); 4= Matveyev and Bakunin (1994); 5=Filonov (1983); 6=Yurgenson (1964); 7=Yazan (1964); 8= Knorre (1959); 9=Vereshchagin and Rusakov (1979); 10=Timofeyeva (1974); 11= Glushkov (1982); 12=Zinoviev (1971); 13=Prostakov (1996); 14=Neyfeld (1990); 15=Paponov (1985); 16=Kozhukhov (1990); 17=Devishev (1967); 18=Rosolovsky *et al.* (1988); 19= Priklonsky and Chervonny (1970); 20= Kiseleva *et al.* (1965); 21=Dan-Chin-Yu (1983); 22=Kim (1967); 23= Chervonny (1967).

[2]Pregnant females, total.

[3]New-born calves.

Table 2. Variation in fertility of female moose in the Southern Urals between years and at different population densities, 1971-1990[1].

Years	Average Density Moose/1000ha	Females		Females with Embryos		Embryos/Female	
		Harvest	Pregnant	1	2	Pregnant	Harvest
		n	%	%	%	n	n
1971	0.7	27	37	90	10	1.10	0.40
1972		39	48	84	16	1.16	0.56
1973		61	49	60	40	1.40	0.68
1974		90	47	62	38	1.37	0.65
1975	2.2	96	41	67	33	1.32	0.55
1976	3.0	126	47	62	38	1.38	0.65
1977		195	57	69	31	1.31	0.75
1978		201	50	63	37	1.36	0.80
1979		231	68	65	35	1.34	0.92
1980		213	71	70	30	1.29	0.92
1981	3.9	310	73	70	30	1.30	0.95
1982		304	72	61	39	1.39	1.00
1983		357	71	71	29	1.29	0.92
1984		452	80	67	33	1.32	1.07
1985		355	85	61	39	1.39	1.18
1986	4.2	352	86	63	37	1.37	1.18
1987		304	85	66	34	1.34	1.12
1988		483	79	72	28	1.28	1.02
1989		505	78	61	39	1.38	1.00
1990	4.8	638	82	58	42[1]	1.41	1.16

[1]After Matveyev and Bakunin (1994).

population, contributed as much as 42.6% to the population reproduction (Semyanov 1990). There is a clearly traceable correlation between fertility and body mass of female moose (Shubin and Yazan 1959, Yazan 1964, Vereshchagin and Rusakov 1979, Glushkov 1982, Kozlo 1983).

As population density increases moose fertility also increases to a certain level (Kheruvimov 1969, Matveyev and Bakunin 1994), due to a decrease in nonpregnancies (Table 2). However, when density is very high and forage resources are depleted, fertility declines: the percentage of nonpregnant females increases, yearling females do not breed, the number of twin calves declines, some embryos are resorbed, and progeny are less viable as fewer calves live to 1-year of age (Knorre 1959; Yazan 1964; Kheruvimov 1969; Priklonsky and Chervonny 1970; Filonov 1977, 1993; Kozlo 1983; Filonov and Kaletskaya 1994; Kiryukhin 1990). At the Sosnovsky Forest and Hunting Holding (Leningrad Region) with a population density of 30-41 moose per 1,000 ha, only 7-8% of pregnant females had 2 embryos. However, despite high density, the level of barrenness remained relatively low at between 13-32% (Chervonny 1967, Kim 1967). Whenever the adult population in general, and males in particular, is exposed to heavy hunting pres-

Table 3. Fertility of female moose and survival of offspring relative to age of female, 1967-1985.[1]

Age Years	Females n	Dry %	Females with Embryos 1 %	2 %	3 %	Embryos/ female	Survival to one Year calves/female
1.5	37	78.4	18.9	2.7	-	0.24	-
	39	84.6	12.8	1.5	-	0.18	-
	8	100	-	-	-	0	-
2.5	54	25.9	61.1	11.1	1.9	0.89	0.17
	28	42.8	50.0	7.1	-	0.64	-
	16	68.8	25.0	6.2	-	0.38	-
3.5	70	8.6	52.8	37.2	1.4	1.31	0.44
	42	11.9	76.2	23.8	-	1.00	-
	19	36.8	47.4	15.8	-	0.79	-
4.5-5.5	68	5.9	32.4	61.7	-	1.60	0.57
	59	10.2	69.5	30.5	-	1.10	-
	39	18.0	48.7	33.3	-	1.15	-
6.5-7.5	56	10.7	26.8	62.5	-	1.52	0.79
	58	5.2	39.6	60.4	-	1.50	-
	35	22.9	40.0	37.1	-	1.14	-
8.5-9.5	47	10.6	34.0	53.2	2.2	1.47	0.91
	48	12.5	68.8	31.2	-	1.06	-
	16	31.2	50.0	18.8	-	0.88	-
10.5-15.5	47	12.7	23.4	63.9	-	1.55	0.74
	17	17.6	70.6	29.4	-	0.94	-
	12	41.7	33.3	25.0	-	0.83	-
>15.5	21	14.3	47.6	38.1	-	1.24	0.67

[1]After Yazan (1972), Vereshchagin and Rusakov (1979), Glushkov (1987).

sure, barrenness of females may rise (up to 82%) in spite of a general decrease in the population (Paponov 1985). This happened in the Western Altai, where the percentage of dry cows dramatically rose the year after males were intensively harvested during the rut (Baidavletov 1988). Selectively killing adult females can rejuvenate the population and reduce the reproduction prolificacy because most younger females do not reproduce until 2 or 3 years of age.

Lower fecundity of moose females has also been noted in years with earlier winters (Kudryashova 1980) and thicker snow cover when abortions, embryo resorption, and higher mortality of weak calves occurs at higher rates (Teplov 1948, 1960; Knorre 1959; Zykova 1964; Ling 1973).

SURVIVAL RATE OF CALVES

The proportion of calves in the population decreases monthly due to a high mortality rate, which is especially evident in twins. There are losses to predators, particularly wolves and bears, and some mortality of poorly developed individuals. Mortality increases during bad weather and when females cross rivers (Likhachev 1965; Timofeyeva 1974; Bromley and Kucherenko 1983; Filonov 1983, 1989, 1993; Filonov and Kaletskaya 1994; Baidavletov 1988; Zaguzov 1989; Prostakov 1996). In the

Central Forest Reserve during summer, no females with twin calves were observed (Kochetkov 1990). Twin calves may also get separated and perish because the cow will not search for her lost calf unless she hears a "distress signal" (Minayev 1992). Calves orphaned when their mothers are shot also may perish (5.6% or 1.1% of the total population prior to a shooting). When orphaned calves attempt to join adult animals or a group of animals, they invariably meet aggressive reception (Glushkov 1985, 1988). The higher the population density, the lower the rate of calf survival (Filonov 1988).

Calf mortality is high even in comparatively propitious conditions of the southern regions of European Russia. For example, in the Khoper Natural Reserve 5-7 dead calves are found annually, which is significant for a population of about 100 (Kaznevsky 1977). In June-July the average number of calves per cow is 1.06 (of which 46% are twins) for the forest-steppe zone; the respective figures for the mixed-forest and taiga zones are 0.94 and 42% and 0.76 and 31%. By the end of winter, only 13% remain in the first 2 zones and about 9% in the taiga zone. Calf mortality by the end of the first year of life in forest-steppe, mixed forest and taiga zones is 61%, 58%, and 67%, respectively (Priklonsky and Chervonny 1969, Chervonny 1975). In central regions of European Russia the calf mortality rate in the first half year of their life reaches 40% (Kiseleva *et al.* 1965). In the Darwin Natural Reserve only 35% of calves have lived through to April of the next year (Filonov and Kaletskaya 1994). In northern regions up to 80% of calves perish, half of them failing to survive to a 6-month age (Yazan 1972, Troitsky 1974, Nikulin 1981, Kozlovsky 1996).

DISCUSSION AND MANAGEMENT IMPLICATIONS

Pregnant females constitute about 25-30% of moose populations on the territory of Russia. Each female can have, on average, 1.3 calves, of which only 1.0 (at best) will live through autumn. Hence, the potentially biological recruitment of moose populations is about 40%, but actual recruitment is less than 30% in autumn (season of hunting). Moose fertility in Russia is comparable with that in Sweden (Markgren 1969) and North America (Peterson 1974, Crichton 1988). In contrast to European moose, the percentage of pregnant females remains relatively constant (varying within 6%) in different geographical regions of North America, even at various population densities and under various winter conditions (Boer 1990).

Due to a high mortality (up to 60-80%), the number of moose calves in Russia rapidly declines each month. Consequently, the number of yearlings in the population is much lower. Mortality rate of moose calves in Alaska and Canada is as high as 55-67% (Franzmann *et al.* 1980, Mytton and Keith 1981). Radiotracking studies of moose neonates in Alaska and Canada show mortality rates as high as 55-67% (Franzmann *et al.* 1980, Mytton and Keith 1981). Radiotracking studies of moose neonates in Alaska, shown maximal mortality (up to 94% of those perished) during the first 2 months of life, mostly from predators (up to 86%), and trauma (9%) (Ballard *et al.* 1981).

Recruitment rate can be enhanced by maintaining prime-aged adults in the moose population, and by providing abundant forage and reducing predation.

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