

ANATOLIY VOLOKH, Melitopol/Ukraine

European moose in the forest areas of South Ukraine

Key words: moose, range, population, steppe zone, forest, Ukraine

1. Introduction

Formerly, the moose used to be numerous in the forest and forest-steppe zones of Ukraine. However, the First World War, the Socialist Revolution of 1917 and the following Civil War with a long-term period of anarchy resulted in the boost of illegal moose hunting and deforestation. For 50 years (1873–1923), the forest area in Ukraine shrank by 17.9 %, and the southern limit moved to the south of Moscow (GEPTNER 1961). Few animals and small populations only survived in Byelorussia (FEDJUSHIN 1929) and Northern Ukraine (MIGULIN 1938).

However, after introducing strict measures against poaching in the former USSR, the number of moose and its range started to increase rapidly. In 1947–1960, migrant individuals from forests of Byelorussia and Russia occupied the forest and eastern forest-steppe zones of Ukraine and even penetrated to the Carpathian foothills (GALAKA 1964). In 1957–1962, moose were known to intensively occupy southern regions. The following growth of the steppe population maximized in 1974 ($n = 2776$), with 57.6 % animals inhabiting Luhansk Region, 23.4 % – Donetsk Region, 8.7 % – Dnipropetrovsk Region, and the rest were found in other regions of Ukraine (VOLOKH 2014). It should be noted that the dynamics of the moose population throughout Ukraine was noted for its syn-

chronism. The time period between the initial encounter and when the maximum population was reached in each area of the steppe zone was nearly identical, 15.3 ± 0.57 (13–17) years. This was irrespective of relative distance of southern forests, occupied by moose, to refuges. It was evidence of the strong influence of the migration rate and effective reproduction in an anthropogenic landscape. However, the start of moose hunting in 1962 brought about a 46.5 % reduction in the population by 1974–1977. The decreasing trend continued, and the population numbers in steppe areas dropped from 1088 ind. in 1992 to 83 ind. in 2009. Since 1989, moose have not been recorded in Zaporizhzhja and Nikolaev regions, since 1997 – in Odesa and Kherson regions, although few migrants still occasionally were seen in the area (VOLOKH 2016). Extermination of a bulk of the animals reduced the range: currently, its southern border has retracted northward and fully lies within the forest and forest-steppe zones. Only in lower parts of the Dnieper and Severskyi Donets, a small part of the range cuts into the steppe zone of Ukraine (SMAGOL 2012). In 2020, after positive number dynamics (2002–4377; 2019–6375 ind.), anti-hunters managed to include the species in the Red List of Ukraine.

Given the successful occupation of the forest zone by moose and the continuous increase of its steppe population, our research was focused

upon revealing the adaptations of the forest species to new ecological conditions.

2. Material and methods

The paper is based on the research carried out in 1976–2015. The data were collected from visual records of animals in different areas of the steppe zone: on permanent plots, during expeditions and with observers in helicopter and plane. It allowed wider coverage with analysis of moose habitat distribution ($n = 651$), the structure of herds ($n = 346$) and dynamics. Twenty-two females were dissected to assess their reproductive state, and 36 broods were analyzed to assess fertility. Observations of mortality ($n = 111$) were conducted with clarifying the causes. The materials of the State Statistics Committee of Ukraine were used to analyze the number dynamics.

3. Results and Discussion

3.1. Moose habitats in the steppe zone

During migrations, moose mostly used floodplain forests preserved in large river floodplains (Dnipro, Seversky Donets and Don). It was the intrazonal habitats that connected moose refuges from the forest zone of Byelorussia and

Russia with forest-steppe regions and peripheral southern forests (Fig. 1).

This was an important prerequisite allowing the animals to maintain the genetic structure of populations and avoid rapid exposure to the environment with distinct ecological characteristics. The dominant species in the floodplain forests were various willows (*Salix alba*, *S. fragilis*, *S. pentandra* e. a.), poplar, elm, maple, linden, etc. Along with herbaceous plants, their twigs and bark served as the main forage for migrating animals.

Artificial forests, planted by large landowners and German colonists since the early 19th century, have mitigated the impact of wind erosion on crops in the steppe zone of Ukraine (Fig. 2). The planted forests have a small area (0.2–2.0 thousand hectares), resembling “islands” in the surrounding steppe and are characterised by a rich species diversity with a high number of exotic species. They are currently dominated by plantations of oak (*Quercus robur*), ash (*Fraxinus excelsior*, *F. americana*), elm (*Ulmus carpinifolia*, *U. laevis*, *U. suberosa*), maple (*Acer negundo*, *A. tataricum*, *A. platanoides*, *A. campestre*), poplar (*Populus nigra*, *P. alba*), black locust (*Robinia pseudoacacia*), Russian olive (*Eleagnus argentatus*), pine (*Pinus silvestris*, *P. pallasiana*), and other forest species.

Field protective, anti-erosive and other forest belts planted since the late 19th century be-



Fig. 1 Forest areas in the Dnieper floodplain (Khortytsia Island) near Zaporizhzhia. Photo by A. Volokh

came crucial for the expansion of moose into the steppe zone. By 1965, the area of artificial forests in the steppe zone reached 53.5 thousand hectares, and now they are a characteristic feature of southern landscapes (Fig. 3). In the 20th century, planted forests of the steppe zone

served as the main refuge for wild animals during intensive agricultural activity.

At the end of the 20th century, moose occupied fragmented areas in artificial and natural forests, connected by a network of planted forest belts. In the period of the range explosion



Fig. 2 Distribution of forests in the steppe zone of Ukraine: A –artificial forests and the year when they were planted; B – floodplain natural forests.



Fig. 3 Current landscapes of the steppe zone (2009). Photo by V. Demchenko

in 1955–1971, the distance between these areas and single animals was 106.6 ± 9.12 km (13.1–300.2 km). In 1980–1990, when the steppe moose population reached maximum, this parameter decreased to 24.4 ± 5.67 km (3.1–135.0 km). Unfortunately, initial migrants were often tolerant of people (Fig. 4) and most were hunted, killed or shot by poachers.

Given that the moose has currently disappeared in most areas of the steppe zone of Ukraine, we can only speak about its former distribution per habitats. Thus, the highest number of animals (40.40 %) was found in deciduous, smaller – in swampy floodplains (11.48 %) and coniferous (11.04 %) forests (Fig. 5). Quite often, moose were seen in forest belts (17.88 %), orchards (5.74 %) and agrocenoses (11.70 %) where they lived in the corn and sunflower plantations with good protective qualities.

The wide distribution of tree and shrub plantations in the steppe zone sufficiently provided the moose with their main forage: the animals were especially eager to feed on the twigs and bark of elm, willow, ash, Russian olive and pine. Despite the forest origin of the species, the animals often grazed on the crops of winter wheat and corn, ate watermelons, melons and pumpkins. In the livestock farms, moose ate corn silage, fodder beets and hay. The use of crops for food has become an important adaptation of forest migrants to new environmental conditions.

In the northeast steppe zone in Luhansk and Donetsk regions, a majority of moose lived in pine forests, in the southernmost parts – in

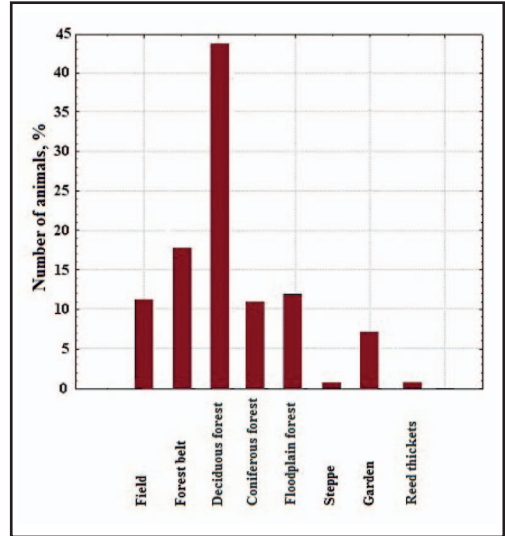


Fig. 5 Distribution of moose per habitats in the steppe zone of Ukraine ($n = 651$)

deciduous forests. A particularly large grouping arose in the Seversky Donets floodplain (in natural Kremenets Woods). Planted forests (Veliko-Anadolsky Forestry in Donetsk, Velykomikhailovsky in Dnipropetrovsk, Staro-Berdiansky in Zaporizhzhia regions) provided valuable habitats for small self-regulating micro populations. In Dnipropetrovsk Region, moose preferred swampy forest areas dominated by alder (*Alnus glutinosa*), birch (*Betula verrucosa*), aspen (*Populus tremula*), and alluvial pine forests. In the warm season, they visited



Fig. 4 A moose and a man (Zaporizhja Reg., Melitopol Distr., Staro-Berdiansky Forest: 06.10.1979). Photo by A. Volokh

the shores of floodplain reservoirs, meadows and sandy steppe, where rested in high-grass spots. Young pine stands, forest lakes with associations of reeds (*Phragmites australis*), cattails (*Thypha latifolia*) and other wetland plants (BULAKHOV, PAKHOMOV OKULTON 2014, ANULTON 2014, ANULTON 2014) were the most preferable as wintering areas. Even in small artificial forests in southern Ukraine, moose chose the wettest spots, located in swampy areas. In general, in the steppe zone of Ukraine, the occurrence of moose in forest habitats reached 62.9 %, or even 80.8 % if taking into account the forest shelter belts. However, it is significantly lower than that (~ 90 %) in the Russian forest-steppe (KHERUVIMOV 1969) or northwestern taiga (TIMOFEEVA 1974; VERESCHAGIN, RUSAKOV 1979). Therefore, in southern Ukraine with predominantly field landscapes, the moose remains a forest animal that uses agrocenoses and other habitats only for feeding and migrations.

3.2. Reproduction

At the beginning of the occupation of the steppe zone, moose reproduction was high. Along with the intensive migration of animals from other regions, this added to a rapid increase in the number and ensured an annual growth of 5.8–6.0 % (VOLOKH 2009), though later these rates decreased. After 2002 in southern Ukraine, females with calves and then moose, in general, became extremely rare.

The study of moose reproduction characteristics showed that during the period of its highest abundance in southern Ukraine (1981–1990), the participation of females in reproductive processes and their fertility were maximal, while during the period of population development

and depression they were significantly lower (Table 1). Perhaps this was related to the dominance of young females in the population that are less fertile than animals of middle age (FILONOV 1983; ROZHKOV 2001).

According to the summarized data, calves were recorded in 40.7 % of herds with adult females, with the mean calving rate equaling to 1.4 ± 0.08 or 0.6 per 1 adult female. On average there were 65.1 % singletons, 32.6 % twins, and 2.3 % triplets. Of the 36 recorded cases, 26 (72.2 %) female moose gave birth in a deciduous, 5 (13.9 %) in a coniferous forest, 3 (8.3 %) in an old garden, and 2 (5, 6 %) – in a forest belt.

The adult female reproductive rate in the Ukrainian steppes was only ~ 34 %. In comparison, this rate was 46.3 % in the north of and 68.8 % south of the forest zone of Russia with 1.20–1.38 embryos/pregnant female (FILONOV 1983). An analysis of 27,300 licenses from harvested females indicated embryo/adult females ratios of 1.2–1.41 in European taiga and 1.29 in the forest-steppe and the steppe zones. In the latter case, the proportion of pregnant females to adults was 0.33–0.84 (ROZHKOV 2001). It is interesting that reproductive rates were 80–100 % along the northern border of moose range in Finland (RAJAKOSKI, KOIVISTO 1970) where fertility ranged from 0.31 for young animals to 1.07 for animals of middle age (NYGREN 1999).

One of the causes of the low reproduction of the steppe moose population in Ukraine was specific features of its spatial and gender composition. Thus, in forests, the sex ratio of animals was 1♀: 1.2♀, whereas in other habitats it was 1.6♂: 1♀. Moreover, in the steppe zone, many adult individuals (n = 205) lived solitary in small forests. During the mating period, 107 (52.2 %) and depression they were significantly lower

Table 1 Some reproduction indices of a Southern Ukrainian moose group

Years	Number of adult females			Quantity of calves per 1 pregnant female		
	total	with alves	%	Mean $\pm$ SE	Range	σ
1971-1980	76	28	36.84	1.25 ± 0.08	1 – 2	0.44
1981-1990	83	37	44.49	1.40 ± 0.10	1 – 3	0.60
1991-2002	47	18	38.30	1.28 ± 0.11	1 – 2	0.46
2003-2015	8	4	50.00	1.33 ± 0.33	1 – 2	0.58
Total:	242	87	35.95	1.37 ± 0.08	1 – 3	0.54

males and 98 (47.7 %) females were isolated in separate forest habitats that negatively affected reproduction. This was also facilitated by the remoteness of other adult moose of different sexes, being part of other herds. Twenty-two (8.4 %) adult males lived in habitats with no adult females, 53 (20.6 %) females lived in habitats without males (Table 2). This prevented their participation in reproduction and explained not very high increase in the population (~ 6 % per year), a low number of calves (17.1 %) and yearlings.

Low reproductive rates were caused by the isolation of forest habitats preventing animal exchange, as well as different reproductive strategies of males and females. At the southern border of their range, adult females are usually long-term occupants of isolated forest habitats, island-like among agrocenoses, and move little during the breeding season. Conversely, males often disperse widely searching for females and forest habitats; many perish from different causes. Unfortunately, this information was not considered when harvest regulations were developed for exploiting the southern moose prosperous population and contributed to its rapid extirpation.

We identified traits of gunshot wounds in 46.8 % of mortalities ($n = 111$) which is shown in Fig. 6. Part of moose was killed by poachers, and the exact volume of uncontrolled hunting is not known. Although, according to inquiries, illegal shooting was much larger than one might imagine. More than 30 % of moose drowned in numerous irrigation canals, the construction of

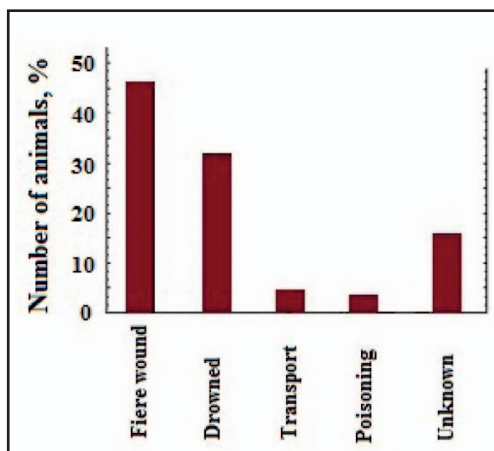


Fig. 6 Moose mortality in the steppe zone of Ukraine and its causes ($n = 111$)

which did not consider movements of wild and domestic ungulates. A few animals died from collisions with cars and 2 – with a train.

3.3. Population dynamics

In 1955, a single moose was encountered in the forests of the steppe zone, in 1958 – 13, in 1962 – 44, and in 1966 – 351 animals were found. In 1967, moose already occupied all the steppe regions, except for the Crimea, although its main population was concentrated in the east – in Luhansk ($n \sim 300$) and Donetsk ($n \sim 130$) regions. The population increase continued steadily until 1974. In some years, the growth rate reached 28 % (13–49 %), similar to the rate

Table 2 Spatial distribution of moose in the steppe zone of Ukraine in the late 20th century.

Habitat	Single adult moose			Composed herds		
	Total, ind.	Males, %	Females, %	Total ind. / adult	Males without females, %	Females without males, %
Deciduous forest	74	36.5	63.5	89/51	5.9	13.7
Coniferous forest	26	53.9	46.1	37/18	27.8	11.1
Forest belt	29	72.4	27.6	36/19	5.3	10.5
Floodplain forest	22	63.6	36.4	31/20	10.0	15.0
Field	21	71.4	28.6	34/14	7.1	7.1
Garden	12	41.7	58.3	15/6	16.7	16.7
Gully	11	45.5	54.5	6/3	-	33.3
Steppe	6	83.3	16.7	3/2	-	-
Reedbeds	4	25.0	75.0	5/3	-	33.3
Total:	205	52.2	47.8	256/136	8.4	20.6

for the whole country, which in the 1960s was estimated at 25–26 % (BOLDENKOV 1975). It should be noted that the high population growth was the result of effective reproduction as well as powerful immigration from the forests of Byelarusia and Russia.

Although moose hunting in Ukraine began as early as 1962, the insignificant harvest rate (4.3–8.1 %) had minimal influence on population density. However, a measurable population decline occurred after the harvest rate increased to 16.1 % in 1973 and 12.5 % in 1974. In 1974, the population reached its maximum ($n=2776$), with 57.6 % of individuals living in Lugansk, 23.4 % in Donetsk, 8.7 % in Dnepropetrovsk, and some animals in other regions. From 1974 to 1977, the moose numbers in the steppe zone decreased by 46.5 %, which was evidence of the overexploitation of its resources.

In 1985–1991 the population stabilized at 1,000–1,200 animals, with small increases observed in 1986, 1988, and 1991. Since 1992 a steady and rather quick population decline (25.3 ± 5.80 % annually) occurred throughout the steppe zone.

It was especially noticeable in 1991/92 (-27.9 %), 1994/95 (-31.9 %), 1995/96 (-28.2 %), 1996/97 (-41.2 %) and 1997/98 (-58.3 %). In sparsely wooded areas, the process of a steady decrease in resources or the elimination of moose began much earlier. To restore the number in Ukraine, since 2000, moose hunting was prohibited except for a few selected individuals (3 in 2001, 8 in 2003, and

12 in 2004. However, further, the appetites of officials and businessmen have increased (since in the early 21st century ordinary hunters had almost no access to moose hunting). As a result, 30 animals were harvested in 2005, 50 in 2006, 91 in 2007, 346 in 2008, 1 in 2009, 0 in 2010, and 7 in 2011 (6 - illegally), in 2012 - 64 (13 - illegally), in 2013 - 112 (2 - illegally). In general, the prohibition of moose hunting in Ukraine from 2000 to 2019 led to a 15.8 % population increase. However, for that period, in the steppe zone, it decreased by 40.5 % (Table 3), which can only be caused by poaching. Also, it should be noted that during the years of the development of the Ukrainian state, many forest plantations were cut down, which provided significant habitats loss for all wild ungulates, but especially for moose.

Therefore, the inclusion of moose in the Red List of Ukraine without real conservation by hunters cannot have a significant positive effect on the population of this forest animal.

4. Conclusions

The steppe population of moose in Ukraine has been formed due to the introduction of strict protection measures in a major part of its range and also due to the development of a great number of artificial forest habitats in the southern part of the country.

During expansion, moose used intrazonal landscapes such as floodplain forests. It allows them

Table 3 Number dynamics of moose in the steppe zone of Ukraine, individuals

Region	Years											
	1962	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2019
Dnipro	1	200	100	215	76	109	51	20	10	13	1	1
Donetsk	–	312	470	510	156	204	77	25	29	26	20	27
Zaporizhja	–	26	130	40	–	–	–	–	–	–	–	–
Lugansk	74	720	1000	800	690	797	415	44	47	40	29	25
Nikolaev	–	5	4	5	–	–	–	–	–	–	–	–
Odessa	–	14	60	65	74	20	20	–	–	–	–	–
Kherson	–	16	60	40	18	4	4	–	–	–	–	–
Total:	75	1293	1824	1675	1014	1134	567	89	86	79	50	53
Ukraine:	2889	13649	14280	11461	11785	15214	9060	4946	4510	5524	6613	6375

to migrate without significant resistance of the environment and morphological adaptations.

The steppe zone of Ukraine holds a pulsating southernmost border of the moose range represented by small isolated groups. The population shows low stability and is highly dependent on different factors, mainly hunting and poaching.

To increase the population number and restore the range of the European moose in Ukraine it should be returned to the list of hunting species since only hunters can really conserve the wild animals. Judging from the experience, under the conditions of weak state power, the following measures are highly important: increased penalties for poaching and intensive activities for the restoration and development of forest plantations.

Summary

The moose population in the steppe zone of Ukraine has been formed at the end of the 20th century. The main moose habitats were natural floodplain and planted forests, location of which greatly influenced the spatial structure of the population in dominating agrocenoses. At the end of the 20th century, the moose could be found in fragmented spots of planted and natural forests, connected by a network of artificial shelter belts. During the range expansion in 1955–1971, the distance between core areas and individual animals equaled to 106.6 ± 9.12 km (13.1–300.2 km). In 1980–1990, when the steppe population reached maximum, the distance contracted to 24.4 ± 5.67 km (3.1–135.0 km). The occurrence of moose in forest habitats reached 62.9 % and if taking into account forest shelter belts – 80.8 %.

Calves were recorded in 40.7 % of herds with adult females, with the mean calving rate equaling to 1.4 ± 0.08 . On average there were 65.1 % singletons, 32.6 % twins, and 2.3 % triplets. Low reproduction of the moose steppe population in Ukraine was mostly associated with a large distance between forest lands where during the copulation period 52.2 % males and 47.7 % females were far from each other. As they could not participate in reproduction it resulted in low population growth (~ 6 % an-

nually), a small number of calves (17.1 %) and yearlings.

The steppe zone of Ukraine holds a pulsating southernmost border of the moose range represented by small isolated groups. As a consequence, the population shows low stability and is highly dependent on different factors, mainly hunting and poaching.

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Address of the author:

Prof. Dr. ANATOLIY VOLOKH
Tavria State Agrotechnological University
Department of Geocology and
Land Management
B. Khmelnytsky Street 18
72310 Melitopol / Ukraine
E-Mail: volokh50@ukr.net