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Management of the red deer (*Cervus elaphus* Linnaeus, 1758) population in the Azov-Syvash National Park, Ukraine

Key words: area, hybridation, hunting, mammals, management, population, red deer, Cervus elaphus, steppe zone, trophy, Ukraine

Introduction

The red deer (*Cervus elaphus* Linnaeus, 1758), an object of our research, is a complex hydrid raised in Askania Nova Reserve. There, in 1902–1950, were at first crossed the Central European deer (*C. elaphus hippelaphus* Erxleben, 1777) and Siberian red deer (*C. elaphus sibiricus* Severtzov, 1873), then their hybrids were crossed with the Siberian red deer, Caspian red deer (*C. maral* Ogilby, 1840), Crimean deer (C. elaphus brauneri Charlemagne, 1920), Manchurian deer (*C. elaphus xanthophygus* Milne-Edwards, 1867) and the wapiti (*C. elaphus canadensis* Erxleben, 1777). Since 1961, the Bactrian deer (*C. elaphus bactrianus* Lydekker, 1902) (Treus 1968) was added to the reproduction. The breed received as a result of this cross-breeding was called the Askanian steppe maral. Artificial relocation has formed a several groups of this animal in Ukraine isolated from each other and being independent populations. The largest one is located in the steppe zone in the Azov-Syvash National Nature Park (NNP) on Biriuchyi Peninsula (the Sea of Azov). The open landscape of the island, covering an area of 6400 ha, in 2018 has supported more than 1000 deer (Fig. 1), more than 1600 fallow deer and over 100 onagers.

Fig. 1: male of the Askanian red deer
(Azov-Syvash National Nature Park, Biriuchyi Peninsula: 05.05.2009). Photo by A. Volokh

Fig. 2: Giving instructions on the census of wild ungulates (Azov-Syvash National Nature Park, Biriuchyi Peninsula: 14.02.2018). Photo by A. Volokh

This has lead to an extremely high density of the ungulates population and consequently resulted in the degradation of phytocenoses and high mortality. Animals regularly left the territory of the national park and apparently reduced their reproduction capacities. Therefore, we have selected the analysis of the number of the Askanian red deer and efficiency of its population management as the purpose of our research.

Material and methods

The paper is based on the results of our research carried out during 2006–2018 in the largest steppe population of the red deer located in the Azov-Syvash NNP on Biriuchyi Peninsula. Given the dominance of an open landscape, isolation of the territory from the west, south and east by the sea, and from the north – by a high fence, this area have been used for a long time for carrying out absolute censuses of wild ungulates. To make counts, the park employees, after receiving the necessary instructions (Fig. 2), move in parallel by several vehicles at a distance of 100–150 m from each other and visually record all the animals seen on the right side.

In each vehicle there are 2 people, one of them registers in a written form a species, sex and age of the animals found and also takes photos and (or) video of large herds. The population is counted twice a year – in November and February. In autumn, it gives a possibility to assess the reproduction success, and in winter – the mortality rate after the most difficult season. On finishing the census, all photos are deciphered (Fig. 3), and the age and sex of wild ungulates are verified.

Fig. 3: Photo of a large herd of deers (Azov-Syvash National Nature Park, Biriuchyi Peninsula: 05.05.2009). Photo by A. Volokh

Table 1: Characteristics of the reed deer biotopes

N	Biotopes	Area of lands	
		ha	%
1.	Sandy steppes (cl. Festuceta vagitatae)	1831.9	28,9
2.	Steppified meadows (cl. Festuco-Brometea)	497.9	7,9
3.	Couch-grass meadows (cl. Molinio-Arrhenatheretea)	1239.4	19,6
4.	Marshy meadows (cl. Bolboschonetea maritimi, Juncetea maritimi)	1474.5	23,3
5.	Halophytic cenoses (cl.л. Phragmito-Magnocaricetea)	179.3	2,8
6.	Reed cenoses (cl. Festuceta vagitatae)	687.9	10,8
7.	Cenoses of dunes (cl. Ammophilletea)	142.6	2,2
8.	Tree-shrub cenoses (cl. Robinietea)	284.0	4,5
Total:		6337,5	100.0

In addition to the results of our own research, we used materials from the Central Statistical Department of the Ukrainian SSR and the State Statistics Service of Ukraine covering the period since 1928. Despite the known imperfection of animal counts, their results in most cases adequately reflect basic patterns of their number dynamics, and therefore are suitable for understanding important population phenomena.

Habitat conditions

The main biotopes of the red deer on Biriuchyi Peninsula are coastal meadows, occupying more than 50 % of its territory (Table 1). In addition, a large area is covered by sandy steppes (28.9 %) and vegetation associations dominating by the reed (Phragmites australis). In reed beds, which area in recent years has decreased, the deer hide from piercing winter winds and summer heat, give birth to their calves or rest. Halophytic cenoses are usually located on the shores of numerous small lakes and puddles, most of which are completely dry in summer and covered with a salt layer. They are also often used by deer as resting places in hot days.

Fescue-gramineous-forb and couch-grass meadows, dominating in phytocenoses of the peninsula have the highest foraging value. Feeding deer are seen there the most often (Fig. 4).
Sand dunes represent another important biotope. Despite a small concentration of nutrients, trampling and intensive eating out of grass, they are annually enriched by excrements of numerous wild ungulates. Tree-shrub thickets are especially important for all animals and often visited by deer, irrespectively of their small area. The deer willingly eat there young shoots, leaves and fruits of the Rusisan olive (*Elaeagnus angustifolia*) and silverberry (*E. argentea*), and also rest in rainy weather.
Numerous European fallow deer, and until recently – European mouflons, have a high negative impact on the red deer (Table 2). The diet of these ungulates in the Steppe Ukraine is very similar that intensifies trophic competition be-

Fig. 4: Meadows are the most preferable habitats in the Azov-Syvash NNP. Photo by A. Volokh

Table 2: Number dynamics of wild ungulates on Biriuchyi Peninsula

Animals	Years												
	1955	**1960**	**1965**	**1970**	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**
Deer	116	325	798	987	850	701	620	650	663	604	1187	1076	857
Fallow deer	–	25	48	79	250	493	750	1181	830	605	2114	2444	1741
Mouflon	–	–	–	–	–	129	220	242	431	54	85	42	–
Onager	–	–	–	–	–	–	16	18	51	59	89	92	137
Total:	116	350	846	1066	1100	1323	1606	2091	1975	1322	3475	3654	2735

tween them (Domnich 2008). Since, according to the Gause's law, two species competing for the same liminting resourse cannot coexist at constant population values.

Number dynamics of the red deer

The deveopment of the red deer population on Biriuchyi Peninsula was started in 1928 by introducing 5 (1♂ and 4♀) adults from the Askania Nova Reserve. Despite a small initial number of animals, in 1933 the peninsula was already inhabited by 8, in 1934 – 11, and in 1941 – by 60 animals (Treus 1968). For 15 years (1928–1941), the annual increase in the number of red deer on Biriuchyi Peninsula was 26.4 ± 3.20 (5.6–45.8) %. The successful development of the Biriuchyi population during the initial period of its formation was facilitated by the establishment of a protected regime in 1927, absence of wolves and serious trophic competitors, and by a low human population density in the adjacent area.

During the Second World War, a significant number of animals were exterminated that significantly slowed the population growth. After the renewal of the protection regime on Biriuchyi, the number of deer began to grow. To accelerate this process, 12 females from Ascania Nova were introduced in 1946 and 4 males in 1951 that increased the number to 126 animals in 1953. Unfortunately, the severe winter of 1953/1954 caused deaths of 68 deer or 54.0% of the population (Ishunin 1960).

In 1956–1959, the reorganization of reserves in the Ukrainian SSR, has led to the destruction of some of them and reduction in the size of protected areas. As a result, the Azov-Syvash Nature Reserve, which included Biriuchyi Peninsula, was in 1957 reorganized into a state protection hunting farm. This gave him the status of a governmental structure with all the ensuing consequences, including the strict protection of the territory, limited visits, and lack of access to the information, especially that concerning shooting of wild animals.

The new situation had a considerable positive impact on the development of the Biriuchian population of the red deer. Since 1957, its number demonstrated rapid increase, and in 1968 reached 1132 animals with the annual growth rate of 18.0 ± 2.99 (5.1–43.7)%. For 8 years (1960–1967), the number of red deer increased threefold as a result of laborious work of employees of the protection hunting farm.

In 1955–1959, when the red deer population density on the peninsula ranged within 16–42 ind./1000 ha, the average growth rate (calves in relation to the number of adult females) was 44.8% (maximum 71.2%). In 1964–1968, with an extremely high density of animals (90–162 ind./1000 ha), it decreased to 36%, with maximum of 39.2%. In 1955–1959, the deer population density comprised 28.3 ± 4.32 (16.0–40.9), and in 1964–1968 – 122.8 ± 11.17 (89.4–155.9) ind./1000 ha. Correspondingly, during the first period, the average annual growth (we mean changes in the percentage in relation to the previous year) was 28.0 ± 3.95 (20.0–40.5), and during the second period it constituted 16.0 ± 2.80 (6.4–23.0) %. Despite apparent differences, they are not statistically reliable ($t = 2.46$). In addition, in 1955–1959 a significant negative correlation between the deer population density and their increase in numbers ($r = –0.82$; $P < 0.05$) was observed, while in 1964–1968 it was totally absent ($r = –0.37$). The latter could indicate the death of a larger number of animals than showed

in official documents, since the studied population demonstrates a clearly visible dependence between the growth rate and the total population numbers, which is realized through the change in the population density (Bannikov, Lebedeva 1972). Since in 1964–1968 on Biriuchyi Peninsula no epizootics or extreme weather events were recorded, the main reason for the drop in the numbers and, consequently, density, could only be the shooting of animals. Moreover, judging by the structure of the population, it was directed mainly to the hunting of males. Indirect evidence is the fact that at the beginning of the use of hunting resources (1960, 1961), their percentage in the population equalled to 46.2 and 40.9%, and in 1962–1966 – 33.6 ± 0.33 (32.7–34.6)%. In principle, for such a polygamous species as a red deer, it was a necessary measure. Indeed, the removal of a small number of males only weakened intraspecific competition and did not at all affect the reproduction level.

In 1968/1969, when the red deer population on Biriuchyi Peninsula reached its maximum density for the entire period of the USSR observations (155.9 ind./1000 ha), a hard winter with severe winds and dust storms came to Ukraine. Stormy weather contributed to the flooding of a major part of Biriuchyi with the sea water, and for many days turned it into an inaccessible island. Due to the prolonged exposure to frost and strong wind, 254 deer or 22.4% of the entire population died from hunger, hypothermia and accompanying diseases (Bannikov 1975). Though these losses were partially replenished at the expense of the reproduction of surviving females, by the end of 1969 the reduction in the Biriuchian population had made up 14.1% compared with December 1968 (Fig. 5).

By 1971, the studied group of the red deer had completely restored and contained 1000 animals. However, after the mass death of animals in 1968/1969 the environmental risks became more understandable, that was subsequently taken into account when developing measures to manage the deer resources. These measures basically include the limitation of the population density and management of the sexual structure to maintain approximately 1 : 2 ratio between the number of males to females. During 15 years since the exploitation of deer resources and until 1974 inclusively, 76.5 ± 22.89 deer were bagged on Biriuchyi annually, constituting 9.4 ± 2.37 (from 0.5 to 27.8)% of the population. The majority (52%) of the shooted animals were males. In 1970–1983, which are well documented, 1856 deer or 132.6 ± 11.83 (81–249) specimens were killed annually during hunting and selective shooting. This included 1090 (59.7%) males and brought about a substantial reduction of the island population abundance from 1112 (1971) to 609 (1991) individuals. At the same time, the population density, being equal to 104.8 ± 3.95 ind./1000 ha in 1971–1991, declined from 153.2

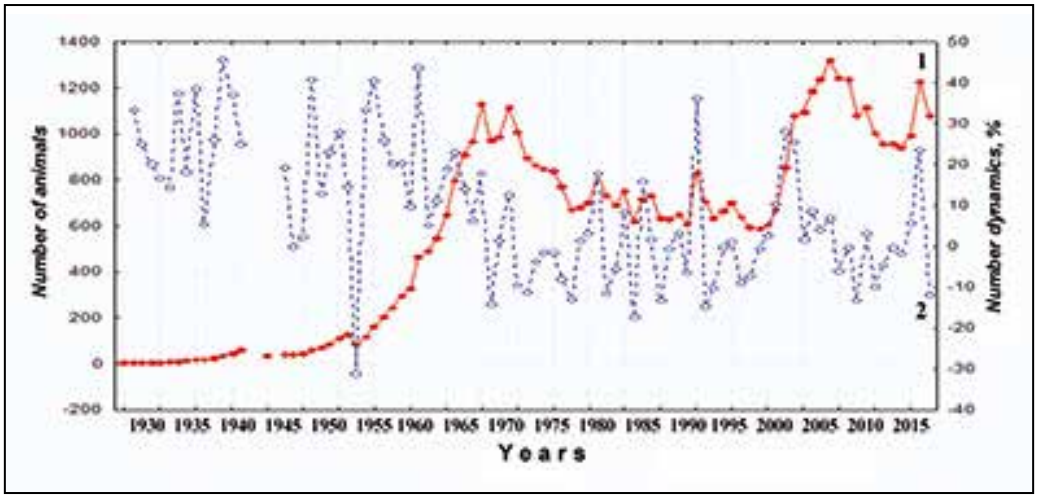

Fig. 5: Number dynamics of the red deer (1) and its increase (2) in the Azov-Syvash National Park

(1971) to 83.9 (1991) ind./1000 ha. It is quite high value even taken only the red deer alone (and in that period moufflons and fallow deer were also numerous on Biriuchyi). For example, in the best forest areas of Germany, taking into account the minimum harm to plantations, in those years it was recommended to keep 20–30 deer per 1000 hectares (Briedermann u.a. 1989). In populations of wild ungulates, the number dynamics is very closely associated with the age and sex structure, which regulation, in its turn, depends on density. When forming their relations with environment, the importance of females increases as they regulate the number of offsprings through the processes of reproduction (K-strategy). It is believed that it is through females the tactics of the populations are realized. In particular, on Biriuchyi Peninsula, it was found a close inverse relationship between the number of females with calves and the density ($r = -0.75 \pm 0.013$, $t = 5.65$), and the direct relationship between the number of calves and the population abundance (Bannikov, Lebedeva 1972).

From 1973 to 1993 inclusively, the average annual deer number on Biriuchyi constituted 609.0 ± 19.11 animals ranging from 895 in 1973 to 609 in 1991. During this period, a large number of animals died during the prolonged winter of 1984/1985, characterized by alternation of frosty ($t = -12–20\,°$) and comparatively warm weather ($t = 1–2\,°$), with rain and snowfall, ice and snowstorms. This climatic anomaly had continued until the middle of April and was accompanied by the strong eastern winds cooling over ice cover of the Azov Sea. This contributed to the formation of fogs, which, in combination with low air temperatures, hampered the development of grassy vegetation. The lack of quality forage during a critical season caused deaths of 130 deer or 17.3% of the population from starvation.

Further, from 1986 to 1997 the number of deer ranged within 609 (1991) – 830 (1992) animals equalling to 681.1 ± 17.51 individuals annually. For this period the growth rate was negative ($-14.8 \pm 4.01\,\%$) as a result of intensive shooting. The largest decrease in the deer population (by 14.8 %) occurred in 1993, when the Azov-Syvash State Protection Hunting Farm was reorganized into a national nature park (NNP) subordinated to the State Management of Affairs of the President of Ukraine. It should be noted that the time period of the establishement of the national park coincided with the collapse of the USSR, with the downfall of economy and earlier unpredictable degradation of socialist morals. According to our information, in 1991–1995, characterized by complex political events in Ukraine, a huge number of animals were bagged on Biriuchyi (Volokh 2016). Numerous guests took advantage of hospitality of the owners, who had had become political leaders of the country, and rapidly shooted the best specimens that reduced the number of animals and sharply deteriorated the quality of trophies. In 1999, the deer population decreased to 589 individuals, and although their shooting had nothing to do with the rational use of resources, a decrease in their number was a necessary measure for the renewal of pastured vegetation. Its degradation was the result of eating the most nutritious fodder grasses not only by the red deer, but also by numerous fallow deer and especially mouflons.

From 2007 to 2018, the red deer abundance on the peninsula slightly reduced from 1321 (in 2007) to 939 (in 2015) with an average annual growth rate of $-0.7 \pm 2.90\,\%$. On the one part, such low values are explained by the significant mortality of animals from overcooling and prolonged starvation during the long winter of 2009/2010. In severe climatic conditions and with extra high density of the ungulate population, which at present makes up 45.32 ind./100 ha, 163 deer died in the mentioned season. On the other part, one of the reasons for the high mortality rate is an interspecies trophic and spatial competition with more numerous and more fertile fallow deer, sharing an ecological niche with the red deer.

Management of the red deer resources

Exploitation of the red deer resources on Biriuchyi started in 1960 when hunters shooted 30 and captured 20 animals for relocation. From that time and until 1983, a total of 1905 deer were shot on the peninsula and 80 calves were caught for relocation to other places. Despite the removal of more than 2000 animals, which

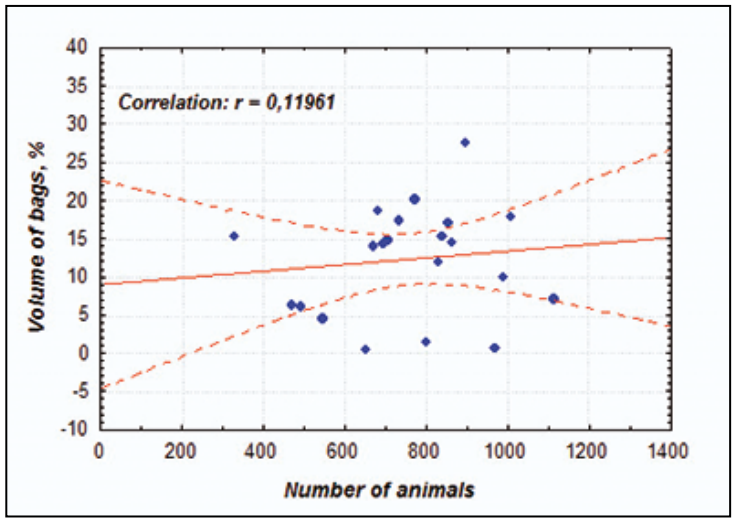

Fig. 6: The relationship between the number and shooting of the red deer in 1960–1983

amounted to 94.8 ± 13.21 deer or 12.3 ± 1.56 (0.5–27.8) % of the total number of animals per year, the population number in the study area increased from 325 (1960) to 692 (1983) animals. In the severe winter of 1968/1969, according to various sources, 197–254 deer died. Therefore, rather intensive use of the Biriuchian population was not enough effective to deter further increase in the number under the conditions of the insular isolation. The correlation analysis (Fig. 6) confirms the absence of any significant dependence between the population number and removal of deer in those years.

Even in 1992–1995, when 271 or 67.8 ± 18.78 deer were annually bagged on Biriuchyi for the fulfillment of the "Food Programme of the USSR" without taking their sex into account, this did not provide any significant negative impact on the population development. This is explained by a low level of shooting, comprising annually 10.1 ± 3.13 % of the total number of animals. However, after the reorganization of the Azov-Syvash State Protection Hunting Farm into the National Nature Park in 1993, the situation has sharply deteriorated. For almost 17 years (1986–2003), the taking of wild ungulates was poorly controlled and poorly documented. Nevertheless, in 2004, 1054 deer were counted on Biriuchyi, and from that time until 2010, 27.6 ± 7.80 (11–70) animals or 2.3 ± 0.63 (0, 9–5.7) % were taken annually. During this period, 141 deer were shot with selection purposes, and 41 were caught for relocation to other places. Meanwhile, the need for selection shooting is very high. This is dictated by a complex genotype of the Askanian maral (Kuznecova et al. 2007) which determines the significant variation in the shape and size of its horns (Bannikov, Lebedeva 1972; Volokh 2015).

A critical obstacle to the optimal management of the deer resources in the Azov-Syvash NNP became the Law of Ukraine "On the Natural Protection Areas" as amended on 21 January, 2010. This important document de facto prohibited the use of wildlife resources in the territory of all protected areas in the country. Instead of limited hunting, which involves the acquisition of a license, payment for hunting trophies and services, a new original free of charge form of "management of population numbers" has appeared. Not denying its reasonability in some cases, for example, to reduce the wolf population density, it should be noted that the amendments approved in 2010 actually allowed a narrow circle of people to conduct a free shooting of the most valuable and financially expensive wild animals in most protection areas. Meanwhile, Article 8 of the above-mentioned law declares that "one of the means to support the protected areas is the introduction of economic levers to encourage their protection." In many countries of the world, the activity of national parks, thanks to the use of various forms of recreational activi-

ties including hunting and fishing, has become an important source of financial revenues to state budgets. It should be noted that prior to 2010, in addition to hunting farms, the shooting of ungulates by foreign hunters was carried out in the Azov-Syvash NNP as well. For example, in 1994, the park received 150 licenses for ungulate hunting, and 20 foreign hunters used 53 of them (35.3%), shooted 19 red deer, 16 fallow deer and 18 mouflons, which together with the provided services brought to the park the revenue of 27.98 thousand DM and 4.53 thousand US dollars.

Nowhere in the world the resources of the red deer living in the wild, are not treated as carelessly and irresponsibly as in the Slavic countries formed in the post-Soviet space (Bragina et al. 2018). In many states this animal is a subject of special respect, and also an object of quite expensive trophy hunting. In this respect, a good illustrative example is the population management of the Ascanian maral in the Azov-Syvash NNP (Table 3). The overpopulation of its meadow-steppe lands by ungulates, which population density reached 453.15 ind./1000 ha in the autumn of 2017 (red deer-1081, fallow deer-1651 and onager –14, in total-2873 individuals), led to smaller sizes of animals, deterioration of trophy qualities and decrease in the growth rate. The removal of the red deer at the level of 0.9–5.7%, carried out for a long period of time with selection purposes and to reduce the population density, had practically no effect on the dynamics of the population number. This is evidenced by an insignificant correlation coefficient between these indices (r = 0.06). Even the increase of removal of the animals in 2013 to ~ 13% (80 individuals for relocation and 50 – selection shooting) could not solve the protracted problem. At the same time, the allowable level of the red deer hunting in hunting farms in the steppe zone in Ukraine, even at the lowest density (7.0–7.5 ind./1000 ha) is 10%. It is natural that in conditions of the extremely high density of ungulates it is impossible to avoid negative consequences despite the efforts of the employees and park administration.

In general, the management of the red deer population on Biriuchyi Peninsula is currently being provided incorrectly and inefficiently. This leads to great economic losses and low reproductive capacities of the population as the number of ungulates are depended on their density. In some years, with extreme climatic events, the level of natural mortality increases that has a compensatory nature. After all, when the population number is high, there are usually many calves, more dependent on the influence of unfavorable environmental factors than representatives of other age groups. It is only natural that in 13–17 years most deer will reach the old age and anyway leave this earth. Naturally, for animals it is absolutely not important whether they were born and lived their lives in a national park or in the territory of a hunting farm. The consequence of irresponsible attitude towards the red deer in the Azov-Syvash NNP, conditioned by the Ukrainian legislation, was not the population management but its imitation. This resulted in a sharp reduction in the shooting of the red deer to 5.9 ± 1.74 animals annually and increase in the animal catching for relocation, which in 2004–2017 reached 263 deer in total or 9.4 ± 2.51 individuals per year. However, animals are captured using primitive traps with the limited use of modern immobilization methods (Fig. 7). It does not allow reducing the number of animals to the optimal value that has led to the useless death of 277 animals or 9.6 ± 4.25 animals annualy for the mentioned period of time.

Table 3: Management of the red deer population in the Azov-Syvash NNP (2004–2017)

Indices	Mean	Min	Max	Std. dev.	Standard error
Number, ind.	1110.9	939	1321	124.61	32.18
Taken annually, ind.	35.21	11	70	19.75	5.28
Taken annually, %	3.09	0.9	5.7	1.83	0.49
Annual mortality, ind.	17.07	0	116	30.21	7.80
Annual growth rate, %	0.41	–13.2	23.5	9.27	2.39

Fig. 7: Trapping of the red deer
(Azov-Syvash National Nature Park, Biriuchyi Peninsula: 07. 10. 2015). Photo by A. Volokh

Not calling for the immediate opening of hunting in national parks, I will anywaynote that the above-mentioned legislative obstacles also hamper the full implementation of selection activities in ungulate groups. They are carried out in all the developed countries in order to remove phenotypically inferior animals from reproduction processes, as well as to form a herd of elite producers. Nevertheless, the entry of our country into the European Union will require politicians to bring the Law of Ukraine "On the Natural Protection Areas" in line with requirements of the European legislation. The latter is based, on the one part, on the conservation of traditional practices of citizens, including fishing, hunting, local crafts, etc., and on the other part, on strict measures to protect animals and their habitats, and to maintain the number of animals in accordance with the land carrying capacity.

Summary

Management of the red deer (Cervus elaphus Linnaeus, 1758) population in the Azov-Syvash National Park, Ukraine
Exploitation of the red deer resources on Biriuchyi Peninsula started in 1960, where prior to 1984 a total of 1905 deer were shot and 80 calves were caught for reintroduction to other places. Despite the removal of more than 2000 animals, the population number increased from 325 (1960) to 692 (1983) animals. Even in 1992–1995, when 271 or 67.8 ± 18.78 deer were annually bagged on Biriuchyi for the fulfillment of the "Food Programme of the USSR" this did not provide any significant negative impact on the population development. However, after the reorganization of the Azov-Syvash State Protection Hunting Farm into the National Nature Park in 1993, the situation has sharply deteriorated. For almost 17 years (1986–2003), the removal of wild ungulates was poorly controlled and poorly documented. Nevertheless, in 2004, 1054 deer were counted on Biriuchyi, and from this time until 2010, 27.6 ± 7.80 (11–70) animals or 2.3 ± 0.63 (0, 9–5.7)% were taken annually. During this period, 141 deer were shot with selection purposes, and 41 were caught for relocation to other places. Though from 2007 to 2018, the red deer abundance on the peninsula slightly reduced from 1321 (in 2007) to 939 (in 2015), this did not bring a significant reduction in the populaiton density. In the autumn of 2017 it reached 453.15 ind./1000 ha (red deer-1081, fallow deer-1651 and onager –14, in total-2873 individuals). It has led to smaller sizes of animals, deterioration of trophy qualities, decrease in the growth rate and increase of mortality.
A critical obstacle to the optimal management of the deer resources in the Azov-Syvash NNP

became the Law of Ukraine "On the Natural Protection Areas" as amended on 21 January, 2010. This important document de facto prohibited the use of wildlife resources in the territory of all protected areas in the country. Instead of limited hunting, which involves the acquisition of a license, payment for hunting trophies and services, a new original free of charge form of "management of population numbers" has appeared.

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