

Management of hunting animals population as breeding work. Part II: Hunting and breeding work on red deer (*Cervus elaphus*) and elk (*Alces alces*) populations

KATARZYNA TAJCHMAN, LESZEK DROZD

Faculty of Biology, Animal Science and Bioeconomy, University of Life Sciences in Lublin

Abstract: *Management of hunting animals population as breeding work. Part II: Hunting and breeding work on red deer (Cervus elaphus) and elk (Alces alces) populations.* The paper presents the aim and rationale behind hunting and breeding practices in hunting districts. This part of the article series describes problems and errors in the management of game populations. The example of red deer and elk breeding shows that the difficulties faced by hunters in estimation of the game population size exert a huge impact on the implemented breeding procedures. Currently, there are no excellent methods for animal stocktaking; therefore, there are problems with determination of appropriate animal harvesting, which may result in overpopulation or a drastic decline in the population size. The study indicates that improvement of living conditions by management of habitats and maintenance of appropriate densities through translocation or periodic protection of species not only results in improvement of the ontogenic quality and fitness of animals but also offers the opportunity to restore populations.

Key words: breeding, game animals, stocktaking, translocation

INTRODUCTION

For several years, there has been a steady increase in the size of big game species populations. As described in the first part of the article, excess densities of animals have a disastrous effect both on the living habitat and on the game animals themselves. Presumably, the increase in the

number of animals is caused by inappropriate methods for annual stocktaking, i.e. estimation of the size of game species population in hunting districts. In a majority of hunting districts, the stocktaking is reported to be based on year-round observations of animals. Since there are no methods for such observations, these may be only subjective estimates made by hunters, which sporadically reflect the population size of game animals. A result of such hunting management is the overpopulation of red deer, elk, and wild boars despite the apparently adequate culling schemes. Constant stress as well as a shortage of food and proper shelters lead to deteriorated immunity, increased prevalence of diseases, weakness, and mortality (in winter).

An attempt to improve the management of game populations was the establishment of hunting complexes by grouping hunting districts in 1997. Populations of game animals, especially larger or mobile ones, are not confined to single ecosystems but function within higher-order units, i.e. landscapes (Beszterda and Przybylski 2011). A principle was adopted that hunting complexes should take into account free migration of large mammals within larger forest complexes and limit errors in estimation of their

population size. Methods for estimation of the number of animals that disregard species biology and migrations yield inadequate schemes of animal harvesting. Overestimation and absence of proper selection practices have frequently led to a population decline, as in the case of elk or red deer population management, which resulted in translocation of *Cervus elaphus* by hunters and foresters or implementation of all-year species protection plans for *Alces alces*. Livestock breeders never encounter this type of difficulties. Therefore, game animals should be treated with particular care, taking into account the complexity of factors affecting their populations.

RED DEER POPULATION MANAGEMENT

Proper animal translocation can yield tangible benefits for nature conservation and hunting management. However, improper implementation thereof may contribute to destabilisation of local ecosystems. As specified in the definition proposed by the International Union for Conservation of Nature (IUCN), translocation is “premediated movement of living organisms from one area, with release in another” (IUCN 1987). These human-mediated practices have always been and still are carried out for three fundamental reasons: reintroduction, introduction, and improvement of the ontogenic quality of a local population. A good example of translocation targeted at reinforcement of local populations was the resettlement of the red deer throughout Europe, including Poland. These practices involved reinforcement of local (small-size) pop-

ulations with additional individuals and, consequently, with a new genotype, although this aspect was not considered at that time (Borowski et al. 2013).

Humans have had a huge impact on the diversity of red deer populations since the beginning of settlement. In the Middle Ages, the species was one of the major game animal. Poaching was punished with the death penalty at that time; hence, a relatively large population size of deer was maintained. According to historical sources, King Władysław IV harvested 50 deer within 4 hunting days in Niepołomicka Primeval Forest in 1644 (Rokosz 1984 after Bobek et al. 1992).

In the Polish territories in the 19th century, red deer inhabited almost exclusively the land west of the Vistula river. In Białowieża Primeval Forest, red deer were extinct probably at the turn of the 17th and 18th centuries. In 1865, 18 red deer from Silesia were introduced and kept in a closed menagerie. Unfortunately, they had low body and antler weight probably due to low-quality nutrition. Only those animals that had managed to escape had stronger antlers. To “refresh the blood”, deer from Spała, Silesia, the Carpathians, and Czech were introduced in Białowieża Primeval Forest in 1881; in total, 500 deer were introduced in the area in the second half of the 19th century. By 1914, the deer population in this region had increased to approx. 6,800 individuals. The red deer translocation brought the expected results and the population size of this species began to grow rapidly; however, the poaching practice, which was common during World War I, again reduced the population of the species in Poland. At the beginning of the 20th century, there was relatively strong

migration of deer from Białowieża Primeval Forest to Lithuanian forests, where they had been almost eradicated at the turn of the 19th and 20th centuries. At the same time, there were numerous red deer populations in Poznan Province, Pomerania, and the Carpathians (Sztolcman 1920 after Bobek et al. 1992).

Probably by the 17th century, the red deer had not been a permanent component of the Tatra fauna. The present population originates mainly from the animal menagerie maintained in 1850–1885 in Jaworzyna. The red deer in the menagerie originated from Czech, Slovakia, Ukraine, and England; there were also Asian and North American deer. After the fall of the estate, the red deer spread in the area, giving rise to the current population inhabiting the Tatra Mountains (Bragiel 1973 after Bobek et al. 1992).

Similarly, the red deer population size in Warmia and Mazury fluctuated substantially. Before the 17th century, the deer was regarded as a common species in this area. Intensive hunting and random exploitation of forests caused a rapid drop in the number of the animals. The problem was further aggravated and, in the 1930, only migrating red deer were observed in the surroundings of Mikołajki, whereas those from Piska Primeval Forest were extinct. As late as in the second half of the 19th century, the population size slowly increased and the 1897 stocktaking documentation reported approx. 1,600 deer. In 1900, restoration of red deer population was undertaken in Warmia and Mazury. To this end, red deer were brought from Hungary, surroundings of Potsdam and Berlin, and Romint. Thirty eight years after the reintroduction, there were 2,000 individ-

uals in this area. In 1938, 8,827 red deer were inventoried, and the culling rate in the 1936/1937 season was 3,179 animals, which was nearly 10-fold higher than in 1885/1886 (Dzięgielewski 1970).

After World War II, the population of this species declined again throughout the country. A particularly pronounced decrease in comparison with the pre-war period was reported from Spała, Białowieża, and Bieszczady forests. In 1956, translocation of red deer mainly from western provinces to former Białystok, Łódź, Lublin, and Warsaw Provinces was initiated. The targeted breeding activities had resulted in relocation of 1,027 individuals by 1967 (Dzięgielewski 1970).

Until 1939, red deer were present only in three regions of the central-eastern Poland macroregion. They inhabited Solska Primeval Forest and Adampol forests in the Sobibór-Włodawa forest complex, where red deer were re-introduced in 1895, and there were few in Kozłówka forests. As indicated by data from 1928, the population of this species in the state forests of former Lublin Province comprised only 8 animals. During World War II, the red deer population in Lubelszczyzna was completely eradicated and the last individual died in 1948. Until the mid-1950s, red deer were temporarily present in the south of Lubelszczyzna as migrating animals. In 1958, the first attempts were made to restore the red deer population in this area, and 271 individuals were introduced from different parts of Poland. A majority of the red deer originated from Wielkopolska, Warmia and Mazury, Pomerania, and surroundings of Opole and Katowice. The reintroduction was carried out in nearly all

large forest complexes of Lubelszczyzna. The greatest number of individuals was brought to Józefów, Biłgoraj Janów Lubelski, and Lubartów Forest Districts. The intensive breeding work carried out by foresters and hunters resulted in a substantial increase in the deer population size. Currently, the red deer inhabits all Forest Districts in Lubelszczyzna. Numerous populations of this species are also present in Warmińsko-Mazurskie, Zachodniopomorskie, Dolnośląskie, Opolskie, and Podkarpackie Provinces (Bobek et al. 1992, Drozd et al. 2000).

At the end of the 20th and the beginning of the 21st centuries, the red deer population size in Poland increased. The clear rise persisted until 2013 when the population of this species in the country was 2.5-fold greater than in 1996. Deer harvesting increased as well and reached 70.1 thousand animals in the 2014/2015 season, which was two-fold higher than 10–15 years earlier. In recent years (2012/2013–2015/2016), the red deer population size stabilised at a level of 128 thousand individuals in leased hunting districts. The deer-harvesting rate per unit of forest area, which is an indicator of the density of the species, was higher in the west of Poland than in the other regions and especially in the centre of the country (Panek and Budny 2015).

Red deer individuals from different regions of the current occurrence range of the species differ significantly in their body size, weight, and antler shape, even in nearby hunting grounds. Animals inhabiting the Carpathians and Mazury regions are characterised by high body weight, compared with the individuals from the central and western part of the country (Bobek et al. 1992, Szczepański

et al. 2006). This variability is confirmed by the genetic diversity of deer originating from the different habitats. It is inconsiderable, as shown by a country-scale analysis of the populations, whereas high local genetic variation has been revealed (Borowski et al. 2013). Such a pattern of spatial genetic variation is very likely to illustrate the impact of the historical translocations on the current population structure of this species. Besides the justifiable restoration practices described above, one of the basic targets of animal translocations was the improvement of the ontogenic quality of stags by upgrading the quality of individuals in the population. In this end, individuals from populations characterised by high body and antler weight were reintroduced. Despite all these attempts, the living environment (rather than the genotype) plays a major role in determination of the animal phenotype, as indicated in many studies mentioned in the first part of the article series (Borowski et al. 2013). This variability is probably caused by the food supplies with their varied nutritional value and the population density; all these factors are influenced by humans. As shown by Łabudzki (1993), stags living in the former Olsztyn Province weighed 79.26 kg in the second year of life. Investigations conducted in the central-eastern Poland macroregion have shown that the mean weight of stags at the same age was 85.32 kg (Krupka et al. 1986). In the analysis of material collected in three hunting grounds (former Olsztyn, Lublin, and Katowice Provinces). Dzieciółowski (1970) determined the mean the average weight of does in the following age groups: 1–3 years – 67 kg, 4–7 years – 82 kg, 8–11 years

– 89.3 kg, and older – 79.5 kg. The study presented by Łabudzki (1993) demonstrated that the mean carcass weight of 3,500 hinds from the former Olsztyn Province was 76.09 kg. In turn, female individuals from Wielkopolska Province weighed 70.19 kg on average. Comprehensive analyses of carcass weight in deer from Warmia and Mazury Province hunting grounds were carried out by Janiszewski and Szczepański (2004). The authors showed the following values of average carcass weight determined during 15 hunting seasons: stags – 114.5 kg, does – 76.6 kg, and calves – 43.5 kg. Changes in body weight (even by ca. 30 kg) may be influenced by the hunting season as well as various external factors such as weather conditions and anthropopressure or may be associated with the behaviour and physiological status of the animal (oestrus, pregnancy, lactation etc.). Every year, two factors indisputably induce reduction of body weight in stags: the rut period and the deteriorating feed supply in late autumn or in winter (Bobek et al. 1984). During the rut period, stags hardly feed, which results in loss of up to 25% of their weight over approximately 4 weeks (Krupka et al. 1986, Drozd et al. 2000). It has been shown that body weight in stags is accumulated earlier in rich habitats than in poor ones (Grudziński et al. 1972). Improvement of the habitat in terms of nutritional requirements of Cervidae is an important factor in the proper management of healthy populations of these animals. Nutrition is one of the three main determinants (besides age and genetics) of antler growth and body size in animals (Landete-Castillejos et al. 2013). Heritability in three populations analysed in

the world has been found to vary in the range from 0.27 to 0.36. This indicates that the genetic component is responsible in 30% for inheriting the antler weight by male deer from parent animals (females transfer antler weight encoding genes as well). Other factors, such as the environment quality and climate, are responsible for the other 70% of the heritage probability (Borowski et al. 2013).

In 2003–2010, an analysis of the dependence of body weight on the population density in the white-tailed deer (*Odocoileus virginianus*) was carried out in the De Soto National Nature Refuge in eastern Nebraska. The density ranged from 36.5 to 50.5 individuals per km², whereas the cropland cover ranged from 14.9 to 23.2%. It was demonstrated that the deer body weight was inversely proportional to the density (21.4 kg per 5.5 deer per km²) and proportional to the increasing crop area (21.3 kg to 3.1% of conversion of total land area to grassland). It was also shown that the estimated density of the white-tailed deer had to be reduced by 1.7 deer per km² per each 1% of conversion of total cropland area to grassland; this would ensure maintenance of appropriate body weight by the animals. In agricultural areas, female deer can consume more crops than stags, which indicates that hinds are more sensitive to changes in the agricultural land coverage. An inverse correlation between body weight and density was reported for both sexes and all age classes of deer (Hefley et al. 2013). Furthermore, another study of red deer demonstrated higher dependence of animal fitness and fertility on the density than on other factors, e.g. ambient temperature and precipitation. The effects of varying nutrition result-

ing from overpopulation during summer (the period of accumulation of supplies) had a significant effect on the fitness and reproduction. Fewer females conceived as the density increased, since their ontogenic quality declined. The percentage of two-year-old pregnant does was significantly lower in an area characterised by high density (20.1 individuals per km²) than at lower density (4.1 individuals per km²). However, larger differences were observed in middle-aged females (4–9 years) and the highest differences were noted in six-year-olds (the age of the highest productivity) (Stewart et al. 2005). The density of a Cervidae population is another determinant of animal health and body weight (Kie et al. 1983, Keyser et al. 2005), and this factor can be managed by hunters and foresters. As shown by the examples discussed above, hunting and breeding practices have an effect on not only animal condition but also female fertility and the health of offspring.

ELK POPULATION IN POLAND

The fate of the elk in Poland was slightly different. As demonstrated by historical records and archaeological excavations, under the pressure of a rapidly growing human population, the elk with its large population size across the forest zone of Europe, shared the fate of the aurochs, bison, and tarpan (Raczyński 2006). Poaching and increasing demand for skins led to eradication of elk in most western and central European countries. At the beginning of the 19th century, it was classified as a nearly extinct species in Sweden, Finland, Russia, or Poland

(Rülcker and Stalfelt 1986, Schmöölcke and Zachos 2005). In Poland, the degree of the elk population collapse was so high that the forests near Rajgród in the Biebrza river valley were the only westernmost refuge of this species (Brincken 1826). The distribution of elk in Poland did not change substantially until the interwar period when the species was present only in the eastern regions of the country (Raczyński 2006). A population consisting of several individuals inhabiting the Biebrza river valley was the only one to have survived World War II. This was possible thanks to the establishment of the Czerwone Bagno Reserve in 1925 with the aim of preservation of the occurrence of this rare species in Poland at that time (Lublinerówna 1935). The elk population from this area managed to survive World War II and gave rise to a group consisting of descendants of the native population, which was continued through elk restoration in this area in the 1950 (Dzięciołowski and Pielowski 1993, Raczyński 2006). The species was fully protected in Poland by virtue of the Regulation of the Minister of Forestry from 1952 until the publication of the Act of 17 June 1959 On breeding, protection of game, and hunting law. The Act defined elk as game animals with an all-year protection period, which in practice preserved the protection status of this species (Raczyński 2006). Besides the Biebrza population (developing since the late 1940s), a dynamic increase in the elk population size was also observed in the Kampinoski National Park. In contrast to the animals from the Biebrza river valley, this population was established by humans in 1951 by translocation of three young cows and

two bulls from Belarus (Dzięciołowski and Pielowski 1993). For about seven years, the animals and their offspring were kept in a specially prepared fenced area. The elk were released after a few years and they formed a new population (Dzięciołowski and Pielowski 1993). As shown by Gębczyńska and Raczyński (1999), the dynamic development of the Kampinos population led to colonisation of areas in western Poland by the elk and emergence of previously non-existent local populations.

After World War II, there was the so-called demographic increase of elk in the period from 1950 to 1970s. This was caused by the restoration of the species in Western Siberia, Kazakhstan, and the Baltic zone. The main breeding and hunting practices implemented by humans included introduction of rational population management principles, reduction of the abundance of predators threatening the elk population such as wolves, enlargement of the feed base by intensification of forest management, and establishment of large areas of forest crop cultivation and coppices (mainly pine).

As a large herbivore, the elk exerts a significant effect on the phytocoenoses and forest communities of its habitat (Hofmann 1985, Ratkiewicz 2011). As a result of the above-mentioned activities, the population size in the country in 1981 was 6,200 individuals, as indicated by the official hunting statistics (Dzięciołowski and Pielowski 1993, Gębczyńska and Raczyński 2001). As suggested by Raczyński (2006), an important role in the population restoration was played by the natural migration of elk from the territory of Belarus, Lithua-

nia, Kaliningrad District, and Ukraine. Unfortunately, the excessive hunting exploitation in the 1980s and 1990s reduced their population size to 0,25 of the numbers recorded at the beginning of the 1980s. This reduced the occurrence range of the species in Poland. As in the case of other Cervidae, elk stocktaking carried out with the available tools and methods has serious limitations, which results in errors in the design of other breeding practices, e.g. reduction by culling. In 2001, the Minister of the Environment imposed a *moratorium* on elk harvesting, and 16 years of protection contributed to restoration of the population size. According to official statistics, the number of elk increased in 2013 to approximately 16 thousand individuals. Currently, there are three main elk refuges in Poland. The largest one, comprising ca. 70% of all living individuals, is the population in the northeast of Poland together with the Biebrza population. Another refuge is the population inhabiting the Kampinoski National Park and neighbouring forestry districts; it originates from individuals reintroduced from Belarus and from descendants of a Swedish stag introduced through secondary translocations from the Białowieża Primeval Forest (Karpiński 1951, Świsłocka 2014). The third group is formed by elks living in the Poleski National Park.

The annual rate of elk population growth within the last few years has decreased. It was approximately 20–25% at the beginning of the *moratorium* period; since 2008, it has dropped to 15% (Budny et al. 2010). This phenomenon is probably an effect of intrapopulation mechanisms triggered by an increase in population density (density dependence)

and primarily by the impoverishment of the feed base (Komenda 2001). Pullin (2004) has proved that the phenomenon can be observed when the species reaches half of the environmental capacity.

The elk population size in spring 2015 was estimated at 16.7 thousand animals. It was nearly 10-fold greater than at the turn of the 20th and 21st centuries, when the lowest population size over the last four decades was recorded (less than 2 thousand individuals) as a result of the decline in the 1990s. There was also an increase in the number of hunting districts inhabited by elk from ca. 400 at the turn of the centuries (8–9% of existing districts) to 1,500 in 2015 (32% of districts). The area of the occurrence of the species increased four times in this period. The highest elk density is reported from the northeast and east Poland, where 9–12 individuals per 1,000 ha of forests were noted in spring 2015 (Panek and Budny 2015).

As indicated by data on elk density in Estonia, the highest productivity of the species population (allowing maximum harvest) has been recorded at a density of ca. 5 animals per 1,000 ha of forest and wetland areas. In turn, the most optimal elk density in terms of species biology and ecology is 7–8 individuals per 1,000 ha, and the maximum capacity of forest and wetland habitats at which the population discontinues to grow is over 9 elks per 1,000 ha (Tõnisson and Randveer 2003). Assuming that similar parameter values can be adopted for the elk population within its permanent occurrence range in Poland, the population density of this species will range from 1–2 individuals per 1000 ha to ca. 10 individuals

per 1,000 ha of forest and wetland areas (Ratkiewicz 2011).

Overpopulation and reduction of the feed base may be a stimulus for elks to wander over long distances in search of better refuges, which may result in expanding the occurrence range of the species (Dzięciołowski and Pielowski 1993). However, migrations of these animals are a cause of the increasing number of vehicle collisions, which unfortunately have very serious consequences. Maintenance of an appropriate density of the animals in a given area not only brings benefits to the game but also ensures safety to humans (Tajchman et al. 2017). The effect of multi-species and intense parasitic invasions on the condition of elk is yet unknown. Some of the recently recorded parasitoses may be a sign of the increased population density of these animals and environmental pressure (Filip et al. 2017).

The ranges of the elk population size presented above indicate that the density of this species in Poland has already been exceeded, and regulation of the population size by culling is an advisable hunting-breeding practice in this situation. It would prevent damage to forest complexes and reduce the danger associated with the frequent migrations (wildlife–vehicle collisions) as well as falls as an effect of epidemics or other pathologies.

CONCLUSIONS

Management of game populations may have not only positive effects, as in the case of roe deer, but also negative consequences related to errors resulting from

insufficient knowledge of animal biology and behaviour and, hence, inadequate application of stocktaking methods leading to overestimation of abundance and over-exploitation of game populations. Therefore, a specific approach to each species, its requirements, and habitat preferences should be adopted. It should be borne in mind that populations of wild animals are subjected to the impact of external factors and environmental pressures. As proved in the case of red deer and elk, improvement of living conditions and maintenance of appropriate density values in habitats not only results in improvement of ontogenic quality of animals and health status but also offers a possibility to restore populations. An example of a hunting-breeding practice targeted at upgrading of the quality of local populations is the translocation of the red deer, which contributed to an increase in the population size and genetic variability of this species. Currently, research is being carried out on development of new reliable game counting methods, as further hunting and breeding procedures can be implemented only with sufficient knowledge of animal density and the quality of the habitat.

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- ziano, że trudności, z jakimi spotykają się myśliwi przy szacowaniu liczebności gatunków łownych, mają ogromny wpływ na późniejsze zabiegi. Nie ma obecnie doskonałych metod inwentaryzacji zwierzyny, a w związku z tym pojawiają się problemy z określeniem odpowiedniego pozyskania, co może skutkować wystąpieniem przegęszczeń lub drastycznego spadku liczebności populacji. W pracy udowodniono, że poprawa warunków bytowania, poprzez kształtowanie środowiska życia oraz utrzymywanie odpowiednich zagęszczeń poprzez przesiedlanie lub okresową ochronę gatunku, prowadzi nie tylko do polepszenia kondycji osobniczej zwierząt i ich zdrowotności, ale też stwarza możliwość odbudowania populacji.

Słowa kluczowe: hodowla, zwierzęta łowne, inwentaryzacja, przesiedlenia

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Streszczenie: *Gospodarowanie populacjami zwierząt łownych jako hodowla. Część II: Prace łowiecko-hodowlane na przykładzie jelenia szlachetnego (*Cervus elaphus*) i losia (*Alces alces*). Praca przedstawia cel i zasadność prowadzenia zabiegów łowiecko-hodowlanych w obwodach łowieckich. W tej części cyklu artykułów przedstawiono problemy i błędy, którymi obarczone jest gospodarowanie populacjami zwierząt dzikich. Na przykładzie hodowli jelenia i losia wyka-*

Authors' address:

Katarzyna Tajchman,
Zakład Hodowli Zwierząt Dzikich
Katedra Etologii i Dobrostanu Zwierząt
Uniwersytet Przyrodniczy w Lublinie
ul. Akademicka 13, 20-950 Lublin
Poland
e-mail: katarzyna.tajchman@up.lublin.pl