

DOI: <http://dx.doi.org/10.15679/bjwr.v1i1.6>**DYNAMICS OF POPULATION SIZE AND HARVEST RATE  
OF RED DEER (*CERVUS ELAPHUS*) IN NORTHERN POLAND**Ziółkowska E<sup>1</sup>

*Summary:* In Poland during last decade number of red deer increased from 130 000 to 217 000 individuals despite increase in numbers of animals harvested from 38 000 to 69 000. The increase in the population size of deer raised the level of damage exerted in cultivated fields, and increased the cost of protecting forest plantations against browsing and bark stripping which amounted in 2012 to 14 million and 40 million euro, respectively. Preliminary results of estimation of the population size, made by objective methods, indicate that data obtained from hunters on the numbers of red deer are gross underestimates. For this reason, an attempt was made to verify the official data on red deer population size within the 433 000 hectares of forest administered by the Regional Directorate of State Forests in Torun. In the period 2007-2013 period there was an increase in the population size from 8 300 to 10 600 individuals, despite systematic increase in the number of animals harvested from 2 800 to 4 700. The respective rates of increase in population size and harvest measured as the finite rate of increase ( $\lambda$ ), amounted to 4%, and 9% per annum. Using the harvest data, and the finite rate of increase in population, and assuming that the annual net population reaches 20 % of the deer number after the closure of hunting season, the probable population size was calculated. The calculations showed that, depending on game management unit, the population size was higher by factor of 2 to 3 than the data provided by hunters, and the population density fluctuated from 8.7 to 106.5 individuals /1000 hectares of forest. The estimated population density of red deer in the studied area was thus higher by 139 % than the official data, and amounted to 24 400 individuals or 49.5 individuals per 1000 ha of forest. It is suggested that the density of red deer should be reduced to 35 individuals/1000 ha by the increase of the harvest quotas to the level of 27% of the population size at the closure of hunting season in March.

*Key words:* population census, hunting statistics, rate of increase, population density, hunting bag

**Introduction**

Data from the Central Statistical Office, collected according to statistics provided by hunters, indicates that during the last decade the population size of red deer increased almost twofold (1.7 times). In the same period, the hunting bag of this species also increased from 38 000 to 69 000 animals. The analysis of the population dynamics of red deer carried out using the finite rate of increase ( $\lambda$ ) indicates the mean annual rate of increase in population size amounted to 5.3%. It was lower than the rate of increase in population harvesting which reached 7.0% (Fig. 1).

In Poland, after the closure of hunting season, the lessees and managers of hunting districts are obliged to carry out an inventory of game animals which then constitutes the basis for harvesting plans for the next hunting season (Bobek et al. 2007, 2009). Unfortunately, the currently valid hunting law does not specify which methods should be used in order to obtain a credible figure of population size for a given species. For this reason, in the majority of hunting districts the red deer population size is determined on the basis of conjecture and speculation among hunters which are unjustly called all-year-round observations (Bobek et al. 1992). It is a widespread practice that hunters estimate the number of animals members of a hunting club can bag, and the matching population size of animals is calculated back, which is given as a

<sup>1</sup> Ewa Ziółkowska

Department of Ecology, Wildlife Research and Ecotourism, Pedagogical University of Cracow, Podbrzezie 3, 31-054 Krakow, Poland

e-mail: ziolkowska.ewa@o2.pl

result of an inventory for a given species. As a result of this game management practice, there was spontaneous growth in Poland, uncontrolled by hunters, in population size of red deer, fallow deer, roe deer, and wild boars, occurring simultaneously with a dramatic drop in population size of moose, a species which is covered by an all-year-round protection period (Bobek et al. 2005). An increase in the level of damage caused by red deer and wild boars in cultivated fields was also observed, as well as in the costs of protecting forest plantations against browsing and bark stripping, which in 2012 amounted to 13.9 million, and 39.0 million euros, respectively, for the whole national territory (Frąckowiak et al. 2012).

For a long time now, the verification of official game statistics on red deer numbers has unambiguously indicated that hunters markedly understate the numbers of this species (Bobek et al. 2013). Therefore, in this study an attempt was made to compare official red deer inventory results within the area of the Regional Directorate of State Forests (RDSF) in Toruń, with the results of calculations based on a net population increase, the harvesting of the population, and the rate of increase in population size.

### Material and Methods

The Regional Directorate of State Forests in Toruń is situated in northern Poland and covers an area of 433 000 ha of forests. The structure of the forest is predominantly fresh coniferous forest, which covers 40.1% of the Directorate's forested area. The proportions of the more important habitat types amount to: mesic mixed coniferous forest (*Pino Quercetum*) – 28.3%, mesic mixed deciduous forest (*Pino Quercetum/Tilio Carpinetum*) – 17.7%, and mesic deciduous forest (*Tilio Carpinetum*) – 7.6%. The remaining habitat types of forests such as: alder swamp forest, mixed deciduous fresh forest type, and other forest types occupy a joint 6.2% of the forested areas in the Directorate. The Scots pine (*Pinus sylvestris*) is a predominant species, forming – together with larch (*Larix europea*) – 86.7% of all forest stands. Deciduous species such as: oak, maple, elm, and ash cover 5.3% of the forested area, whereas birch – 3.5%. The remaining deciduous species constitute 4.5%. Within the Regional Directorate of State Forests in Toruń there are 281 hunting districts which are grouped in 12 game management units.

The materials used in this study include official inventory and harvesting numbers for red deer in 2007-2013 within 12 large game management units. Between each two subsequent years of hunting seasons, the indices of the finite rate of increase (decrease) of population size ( $\lambda_N$ ), and population harvesting ( $\lambda_P$ ) (Caughley 1977) were calculated. The values of the finite rate of increase (decrease) of population size and population harvesting were calculated separately for each game management unit and for the whole of the Directorate. In the last stage, the arithmetic mean of the calculated indices was provided.

In order to verify the results of the official inventory of red deer, it was assumed that the annual net population increase reaches 20% of the population size after the end of the hunting season (Csanyi 2013). Therefore, when no increase or decrease of population size occur, that number can be estimated at fivefold the number of red deer harvested. Because the population size was not stable but had increased systematically, the result obtained was increased by the average value of the index of the finite rate of increase ( $\lambda$ ). The value of annual net population increase was also used to simulate the dynamics of population size and harvesting, assuming the target population size envisaged in the so-called long term game management plans to be reached in 2017.

### Results

The data obtained from the Regional Directorate of State Forests in Toruń indicates that in the period 2007-2013, in all game management units the red deer population size increased. The rate of the increase varied between individual game management units, and the average annual index of finite rate of increase  $\lambda$  for 7 hunting seasons ranged from 1.02 – 1.07 i.e. from 2 to 7% (Table 1). It resulted in an increase in population density, which in particular game management units, in 2007, ranged from 5.1 to 29.0 individuals/1000 hectares of forests, and in 2013 fluctuated within a range from 7.1 to 42.1 individuals/1000 hectares of forests. In the period under discussion, in the majority of game management units, the harvesting rate was higher and more diversified than the rate of increasing in population size, and ranged from 1.02-1.14 i.e. from 2-14% (Table 1). In 2007, the percentage share of harvested red deer in relation to their population size ( $H/N*100$ ) ranged in particular game management units from 24.2% to 42.3%, whereas in 2013 this variable increased to values from 32.4% to 57.1%, respectively.

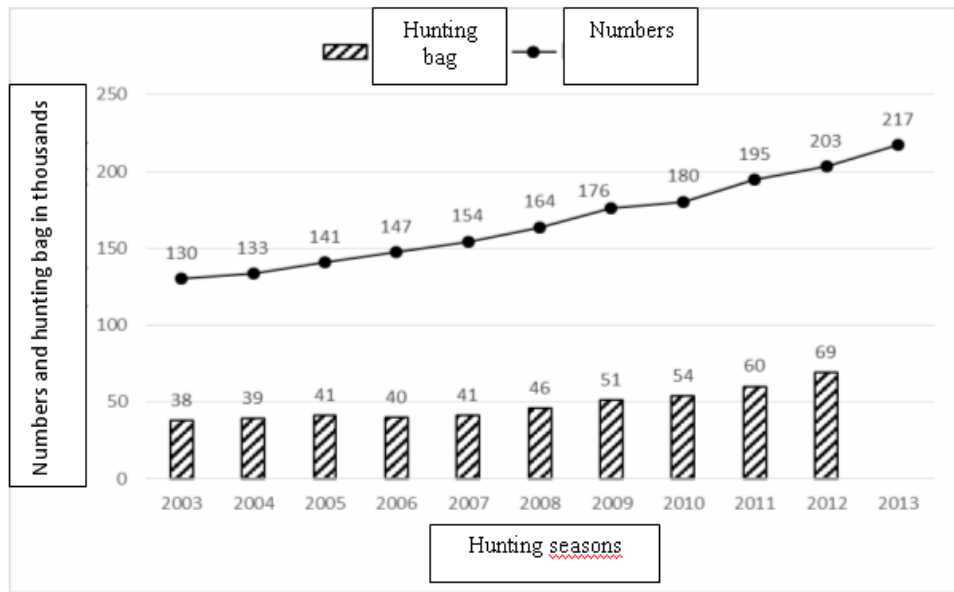
According to official data, in the period 2007 – 2013 the population size of red deer within the whole area of the Regional Directorate of State Forests in Toruń increased from 8 345 to 10 596 animals, as well as harvesting rate from 2 744 to 4 743 animals (Figure 1 & 2). The mean annual rate of population size increase was 4% ( $\lambda=1.04$ ), whereas the index of harvest increase was more than twice higher ( $\lambda=1.09$ ) and amounted to 9% per annum.

**Table 1.** Population size (N) , hunting bag (H) and density (D=N/1000 ha of forest) of red deer inhabiting the Regional Directorate of State Forest (RDSF) in Toruń in 2007 and 2013.

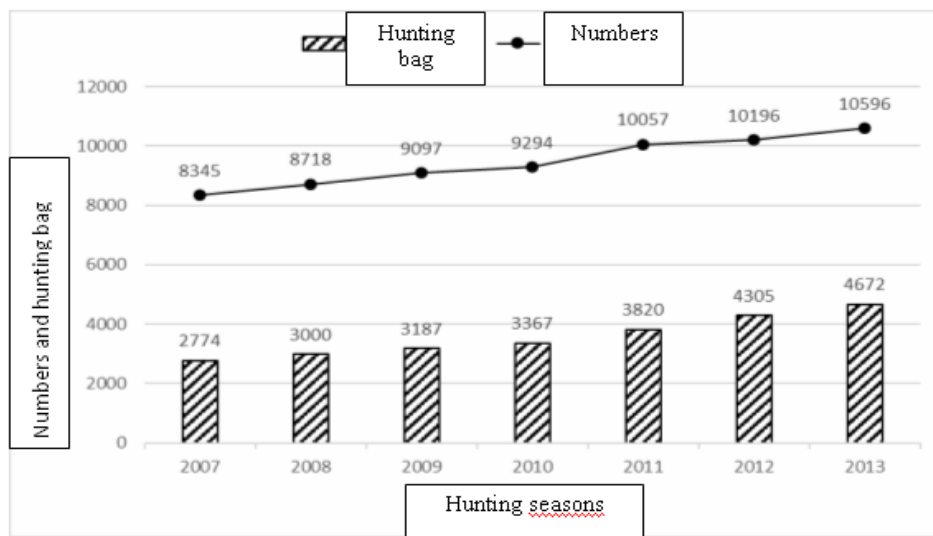
Game management unit	Area of forest (ha*10 <sup>3</sup> )	2007			2013			$\lambda N$	$\lambda P$
		N	H	D	N	H	D		
Bory Tucholskie Południowe	82,0	1621	547	19,8	2096	1051	25,6	1,05	1,10
Bory Tucholskie Północne	118,7	1262	365	10,6	1878	707	15,8	1,07	1,11
Brodnicki	30,3	668	223	22,1	744	377	24,6	1,02	1,10
Bydgoski	87,7	2347	815	26,8	2609	1171	29,7	1,02	1,07
Dobrzyński	22,6	227	55	10,1	312	104	13,8	1,06	1,14
Golubski	18,0	142	60	7,9	202	71	11,2	1,06	1,04
Grudziądzki	11,7	108	32	9,2	126	53	10,7	1,03	1,04
Krajeński	28,3	820	301	29,0	1191	547	42,1	1,07	1,10
Kujawski	25,4	289	85	11,4	427	172	16,8	1,07	1,11
Nadwiślański	25,9	133	39	5,1	183	60	7,1	1,06	1,02
Pałucki	24,8	579	211	23,3	655	374	26,4	1,02	1,14
Toruński	15,2	149	41	9,8	173	56	11,4	1,03	1,09
Total RDSF Toruń	490,5	8345	2774	17,0	10596	4743	21,6	1,04	1,09

**Table 2.** Population size N-1, N-2 and density (D-1, D-2) of red deer in March 2012 in game management units located in the Regional Directorate of State Forest (RDSF) in Toruń. N – population size according to hunting statistic (1), calculated in this paper (2) and assumed to reach in 2017 (3). D – population density (N/1000 ha of forest) calculated from N-1; N-2 and N-3 and from area of forest.

Game management unit	Area of forest (ha*10 <sup>3</sup> )	2007			2013			$\lambda N$	$\lambda P$
		N	H	D	N	H	D		
Bory Tucholskie Południowe	82,0	1621	547	19,8	2096	1051	25,6	1,05	1,10
Bory Tucholskie Północne	118,7	1262	365	10,6	1878	707	15,8	1,07	1,11
Brodnicki	30,3	668	223	22,1	744	377	24,6	1,02	1,10
Bydgoski	87,7	2347	815	26,8	2609	1171	29,7	1,02	1,07
Dobrzyński	22,6	227	55	10,1	312	104	13,8	1,06	1,14
Golubski	18,0	142	60	7,9	202	71	11,2	1,06	1,04
Grudziądzki	11,7	108	32	9,2	126	53	10,7	1,03	1,04
Krajeński	28,3	820	301	29,0	1191	547	42,1	1,07	1,10
Kujawski	25,4	289	85	11,4	427	172	16,8	1,07	1,11
Nadwiślański	25,9	133	39	5,1	183	60	7,1	1,06	1,02
Pałucki	24,8	579	211	23,3	655	374	26,4	1,02	1,14
Toruński	15,2	149	41	9,8	173	56	11,4	1,03	1,09
Total RDSF Toruń	<b>490,5</b>	<b>8345</b>	<b>2774</b>	<b>17,0</b>	<b>10596</b>	<b>4743</b>	<b>21,6</b>	<b>1,04</b>	<b>1,09</b>



**Figure 1.** Population dynamics and hunting bag of red deer (*Cervus elaphus*) in Poland in the period 2003-2013. Based upon data from Central Statistical Office in Poland (GUS).



**Figure 2.** Population dynamics and hunting bag of red deer (*Cervus elaphus*) in the Regional Directorate of State Forest in Toruń in the period 2007 - 2013.

### Discussion

The verification of official data on red deer population size, with the use of assumptions adopted in this paper, indicate that the probable population size of red deer in all game management units is markedly higher than the numbers calculated by hunters and managers of hunting areas. According to calculations, 24 376 red deer inhabit the entire area of the Regional Directorate of State Forests in Toruń, which is more than two times (2.4 times) higher than indicated by the official inventory of this species (n=10,196). In March

2012 in individual game management units, the population size estimated in this paper were higher by 27.4%-266% compared with the official inventory of this species (Table 2).

The error in estimation of population size provided in this paper may result from a lack of credible information on the level of annual net population increase. In this study, it was assumed to be 20% of the population size at the closure of hunting season, as such a figure was given by Csanyi (2013) for the lowland red deer populations in Hungary.

It is very likely, however, that the calculations of population size made in this study reflect, to a high degree, the actual numbers of red deer in particular game management units of RDSF-Toruń. In 2012-2014 in the Dąbrowa Forest District, situated within the "Bory Tucholskie Południowe" forest, the population size of red deer was estimated by tracking on line transects. The population densities obtained ranged from 50-60 red deer/1000 hectares of forest (Ziółkowska, unpublished data), thus being similar to the red deer population density (59.5 individuals/1000 hectares of forest) which were calculated in this paper for the whole of the "Bory Tucholskie Południowe" forest game management unit.

The range of red deer population density calculated for individual game management units in RDSF-Toruń (8.7 – 106.5 individuals/1000 hectares of forest) is similar to the density of this species obtained in various regions of Poland by applying statistical methods. Density exceeding 100 individuals/1000 hectares of forest is characteristic of forest divisions situated in the Regional Directorate of State Forests in Katowice (Kopeć 2012; Albrycht et al. 2012). Population density of red deer of 50-70 individuals/1000 hectares of forest is recorded in the Bieszczady Mountains, the Beskid Żywiecki Mountains, and in the Puszcza Niepołomicka forest (Bobek et al. 2013). Relatively low population density, from 20 to 35 red deer/1000 hectares of forest were found in the Elbląg upland, and in the Puszcza Piska forest (Ćwieluch and Trętowska 2011; Maślanka et al. 2013).

The assumptions of the long-term management of red deer indicate that for the whole area of the Directorate, the target population size for March 2017 should be 7351 individuals or 15 individuals/1000 hectares of forest. The current population size given by sources in RDSF-Toruń in 2013 amounted to 10196 individuals (20.8 animals/1000 hectares of forest), i.e. exceeded the assumptions of the long-term management plan by 38.7%. The population size achieved by calculation in the presented study amount of 24371 individuals or 49.5 red deer/1000 hectares of forest and deviated even more from the target number given in the long-term management plan.

The performed simulations of population dynamics and harvesting (Bobek, unpublished data), indicate that reaching the target population size in 2017 would require harvesting more than 40% of the population size which is – for various reasons – a task which cannot be implemented.

## Conclusion

In Poland, it is assumed that a population density of 35 red deer/1000 hectares of forest does not cause damage to forest regeneration. Thus, the red deer population size planned to be achieved in 2017 in the area of RDSF-Toruń could amount to ca. 17 000 individuals. Changing the assumptions of the long-term management plan for red deer should involve increasing the annual harvest rate to ca. 27% of the population size which seems feasible. Verification of the red deer population size in particular game management units with the use of objective and credible methods which should include tracking, analyses of bags of collective hunts, and other statistical methods, is urgently needed. It is also necessary to calculate the annual net population increase with the help of performing the harvest in population in conditions of hunter-controlled numbers of red deer in the areas of various forest complexes.

## References

1. Albrycht M., Przystupińska A., Pigulak-Kuś M., Trętowska K. 2012. Ocena liczebności populacji jelenia w Nadleśnictwie Turawa. *Episteme* 15: 359-363. ( Polish )
2. Bobek B., K. Morow, K. Perzanowski and M. Kosobucka. 1992. The red deer – its ecology and management. Świat Press. Warszawa. (In Polish with English summ.)
3. Bobek B., D. Merta, P. Sułkowski and A. Siuta. 2005. Moose recovery plan in Poland: main objectives and tasks. *Alces* 41: 129-138.

5. Bobek B., A. Plaksej, W. Frąckowiak and D. Merta (eds) 2007. Gospodarka łowiecka i ochrona populacji dzikich zwierząt na terenie Regionalnej Dyrekcji Lasów Państwowych we Wrocławiu. Wrocław 2007. Tom I: 240pp, Tom II: 280pp.
6. Bobek B., J. Mikoś and R. Wasilewski (eds) 2009. Management and conservation of wildlife in Eastern Pomerania – Northern Poland. Gdańsk 2009. (In Polish with English summ.)
7. B. Bobek, D.Merta, J. Furtek, M. Wojciuch-Płoskonka, K. Kopeć, J.Maślanka and M. Ziobrowski.2013. Studia i Materiały CEPL w Rogowie, 36,3:89-101. Population dynamics of wild ungulates in various regions of Poland estimated by different methods. (In Polish with English summ.)
8. Caughley G. 1977. Analysis of vertebrate populations. Jofn Viley and Sons. London. New York, Sydney, Toronto.
9. Csanyi S. 2013. The importance of long and large-scale data sets in tje evaluation of red deer management. Pages 91-92 in M. Beukovic (ed). Modern aspects of sustainable management of game populations. University of Novi Sad. Serbia.
10. Ćwieluch B. and K.Trętowska. 2011. Estimating numbers of wild unqulates in Elbląg Hills. Episteme ”. Episteme 12 Tom II: 13 – 18. (In Polish with English summ.)
11. Frąckowiak W., S. Gorczyca, D. Merta and M. Wojciuch-Płoskonka. 2012. Factors affecting the level of damage by wild boar in farmland in north eastern Poland. Pest Management Sci. 69: 362-366.
12. Kopeć K. 2012. Plan regulacji liczebności jeleni w Nadleśnictwie Rudziniec. Brać Łowiecka 1: 60-61.
13. Maślanka J., A. Przystupińska, K.Trętowska and M. Ziobrowski. 2013. Dynamics of the number of wild ungulates in the Forest District Spychowo, in the Piska Forest. Episteme, 18: 217-223. (In Polish with English summ.)

Received: 31.07.2014.

Accepted: 23.11.2014.

Ziółkowska E. (2014) Dynamics of population size and harvest rate of red deer (*Cervus Elaphus*) in northern Poland, *Balkan Journal of Wildlife Research*, 1(1), pp. 7-12.