DENSITY OF UNGULATES AT PREFERENTIAL FEEDING SITES IN TWO HUNTING GROUNDS OF VRANCEA COUNTY (ROMANIA), WITH COMPARISON BETWEEN TWO STUDY METHODS

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Abstract. Two methods of estimating large carnivore prey density, based on pellet counts, were applied in autumn 2004 at preferential feeding sites of ungulates on two hunting grounds in Vrancea Carpathian mountain range, Romania, and analyzed in comparison. Density estimates were calculated with both methods and showed that red deer (*Cervus elaphus* L.) and wild boar (*Sus scrofa* L.) had the highest densities in the study sites. Roe deer (*Capreolus capreolus* L.) was little represented and chamois (*Rupicapra rupicapra* L.) was absent from the sites most likely due to nature of terrain. Red deer density estimates using randomly distributed large circles were significantly lower ($P<0.05$) than estimates using small circles on transects. The randomly distributed large circles method could be more efficient at covering large areas of open habitats while the parallel transect small circles method may be more appropriate for intensive surveys in denser habitats. Additional research and testing of new methods are recommended for estimating densities and mapping the distribution of large carnivore prey in the Carpathian Mountain range.

Keywords: density estimation, ungulates, pellet counts, comparison of methods.

Rezumat. Densitatea ungulatelor în zone preferenţiale de hrănire din două fonduri de vânătoare din judeţul Vrancea (România), cu compararea a două metode de studiu. Două metode de estimare a prăzii carnivorelor mari, bazate pe inventarierea peletelor ungulatelor, au fost aplicate în toamna anului 2004 în zone preferenţiale de hrănire a ungulatelor din două fonduri de vânătoare situate în zona montană a judeţului Vrancea, şi analizate comparativ. Estimarea densităţilor s-a efectuat cu ambele metode şi a evidenţiat faptul că cerbul comun (*Cervus elaphus* L.) şi mistreţul (*Sus scrofa* L.) au fost bine reprezentate în siturile de studiu. Căpriorul (*Capreolus capreolus* L.) a fost slab reprezentat iar capra neagră (*Rupicapra rupicapra* L.) a fost absentă din siturile de studiu, cel mai probabil datorită naturii terenului. Densităţile de cerb comun estimate cu metoda cercurilor mari distribuite la întâmplare au fost statistic semnificativ mai mici ($P<0.05$) decât estimările prin metoda cercurior mici pe transecte. Metoda cercurilor mari distribuite la întâmplare ar putea fi mai eficientă la acoperirea unor zone vaste cu habitate deschise, în vreme ce metoda cercurilor mici dispuse pe transecte paralele ar putea fi mai potrivită pentru studii intensive în habitate cu vegetaţie mai densă. Pentru estimarea densităţii şi cartarea distribuţiei ungulatelor pradă a carnivorelor mari din Munţii Carpaţi se recomandă mai multe studii, cu testarea unor metode noi.

Cuvinte cheie: estimarea densităţii, ungulate, inventarierea peletelor, comparaţie metode.

Introduction

Density estimation is one of the key issues in the effective management and conservation of wildlife populations (Primack, 1993; Sutherland, 1996; O'Connell *et al.*, 1999; Ogutu *et al.*, 2006) and for monitoring and understanding animal distribution and movements. Accurate estimation of density is of vital importance in understanding population dynamics, and resources can easily be wasted if the appropriate method and survey technique are not followed (Krebs, 1999). Considering the costs and time involved in making an absolute estimate of the true population size of different species in a certain area, using selected sample sites is a good way to overcome the lack of resources and to get reliable information on the population trends (Nichols & Conroy, 1996).

In the Carpathian Mountains of Romania, red deer (*Cervus elaphus* L.), roe deer (*Capreolus capreolus* L.), wild boar (*Sus scrofa* L.) and chamois (*Rupicapra rupicapra*

L.) are the main wild prey items of large carnivores. Estimation of ungulates has been traditionally carried out by the Romanian Forestry Commission, based primarily on track counts (Almăşan *et al.*, 1977). In many parts of North America, Scandinavia and UK, this method has been used in conjunction or even totally replaced by methods based on counts of pellets (faeces deposited by ungulates). There is a need for such new methods to be developed and tested in Romania, and the present study tried to address this issue for a number of sites located in the Carpathian Mountains.

Material and Methods

A total number of five sites were chosen in two adjacent hunting grounds (Condratu and Lepşa) located in the mountainous area of Vrancea County, Romania. Geographic coordinates of each site were taken with a hand-held Garmin e-trex Summit® GPS unit (Appendix). The altitude of the sites ranged from 650 m (site 1) to 850 m (site 5) and the area of each site was less than one hectare. The sites were typical pastures or openings in the forest stand and were known to represent preferential feeding areas of ungulates, which on early mornings, late evenings and at night time came out of the surrounding deciduous forest to graze or dig for food. Site 2 had a salt feeder installed by the Forestry Commission, while in site 3 corn was periodically brought to feed wild boar.

Two methods were applied in comparison to assess ungulate density and use of these sites. Both methods involve recording number of pellet groups (minimum 15 pellets for red deer, roe deer and chamois, one for wild boar) found within a certain radius of chosen centres of circles (Deer Commission, 2001; Ogutu *et al.*, 2006; Smith & Smith, 2000). The first method involved counting pellet groups on circles with large areas (R = 4 m), which have been randomly placed at the site. Following recording of pellet groups with this method, a second method was employed, involving circles with smaller areas (R = 1.5 m), distributed on parallel linear transects. In choosing the number of circles to be employed at each site, two factors were taken into account: the size of the site (site 3 was larger and was allocated 5 large circles, while the other sites were smaller and were allocated 4 large circlers each), and the size of the areas covered by the circles (summed areas of large circles were equal to the summed areas of small circles) (Fig. 1). The centre of each circle was marked by

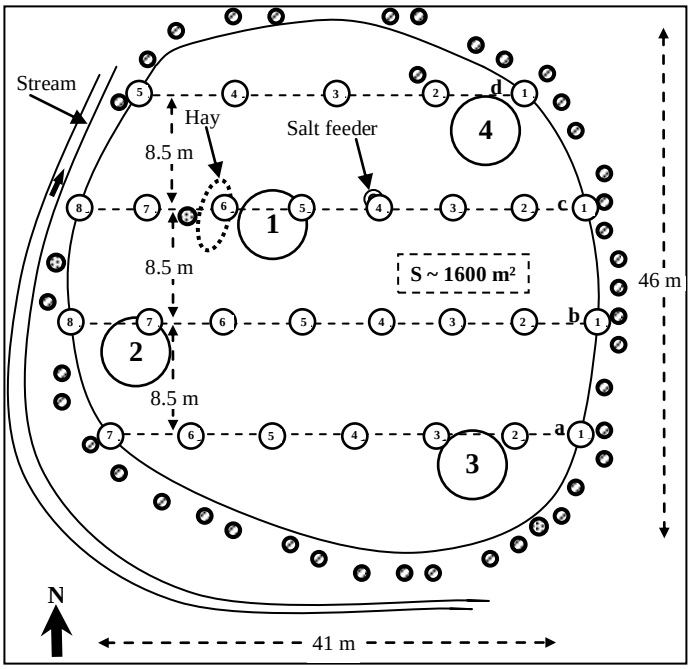

Figure 1. Top down view of one of 5 study sites of estimating ungulate density, with the distribution of random large circles and linear transect small circles (example shows site 2, Codratu hunting ground, Vrancea mountain range).

sticking a short pole into the ground, and a rope of a length corresponding to the radius employed was used to delineate each circle. Precise measurements from reference features such as standing trees were made with a measuring tape, in case the sites would have been disturbed and the poles dug out.

The two methods were applied for the five sites in September 2004, when all censused pellet groups were marked with a colour spray to avoid double counting during the second stage. The latter stage took place in October 2004, when the two methods were repeated for the same sites, using exactly the same circles as in the first stage. Pellet groups censused during the second stage were thus new pellets, deposited by ungulates in the one month interval between the two stages. Identification of the ungulate species that had deposited the pellets was made following Bang & Dahlstrom (2001) and personal experience.

In order to test the differences between the two density estimation methods, a series of two way analysis of variances (ANOVA-s) were employed setting total pellet groups recorded and pellet groups per species as the independent variable, and method and site as dependent variables.

Pellet density was calculated following equation (1):

$$P_n = \frac{M \times 10.000}{N \times A} \qquad (1)$$

where P_n represents grouped pellet density (n = stage number, in this case 1 or 2), M the number of grouped pellets recorded, N the number of circles used and A the area of the circle.

Overall pellet density was calculated following equation (2):

$$P = \frac{P_1 + P_2}{2} \qquad (2)$$

where P_1 represents pellet density following stage 1 (September 2004) and P_2 pellet density following stage 2 (October 2004).

An ungulate density index was calculated following equation (3):

$$D = \frac{P}{F \times T} \qquad (3)$$

where D represents ungulate density per hectare, P overall pellet density, T the time period (days) in which pellets can accumulate and F the defecation rate. Defecation rates for red deer, roe deer and chamois were considered as 19 per day, and for wild boar 4.5 per day, according to literature.

Results and Discussion

The total number of pellet groups recorded during the two phases of the study for all sites and species and with both methods are given in Fig. 2.

The two methods recorded different numbers of grouped pellets, with the large randomly distributed circles coming up with lower numbers of pellet groups than the small circles on transects. This result was reflected in calculation of densities, with the large circles method coming up in most cases with lower densities than the small circles method (Table 1).

Red deer and wild boar pellets were identified in both hunting grounds, while roe deer pellets were only found in site 5 of Lepşa hunting ground.

For Condratu hunting ground, the ungulate species with the highest density in the investigated sites was red deer (0.19 ind./ha with the large circles method, 0.38 ind./ha with the small circles method). In the case of Lepşa hunting ground, the species with the highesty density was wild boar (0.34 ind./ha with the large circles method, 0.74 ind./ha with the small circles method).

Red deer densities estimated with the small circles method were twice higher than estimates with the large circles method, for sites from both hunting grounds. None of the methods identified roe deer in Condratu, while in the case of Lepşa roe deer density estimated with the small circles method were twice higher than those estimated with the large circles method. In the case of wild boar, for Condratu both methods came up with the same densities, while for Lepşa the small circles method came up with a density estimate twice as big as the large circles method.

Although the results show that there appeared to be an evident difference between the density estimates by the two methods, this difference was statistically significant (ANOVA, F = 197.57, P = 0.005) only in the case of estimating density for red deer. However, due to relatively small sample size, results should be interpreted with caution and more investigations would be recommended to assess the differences between methods.

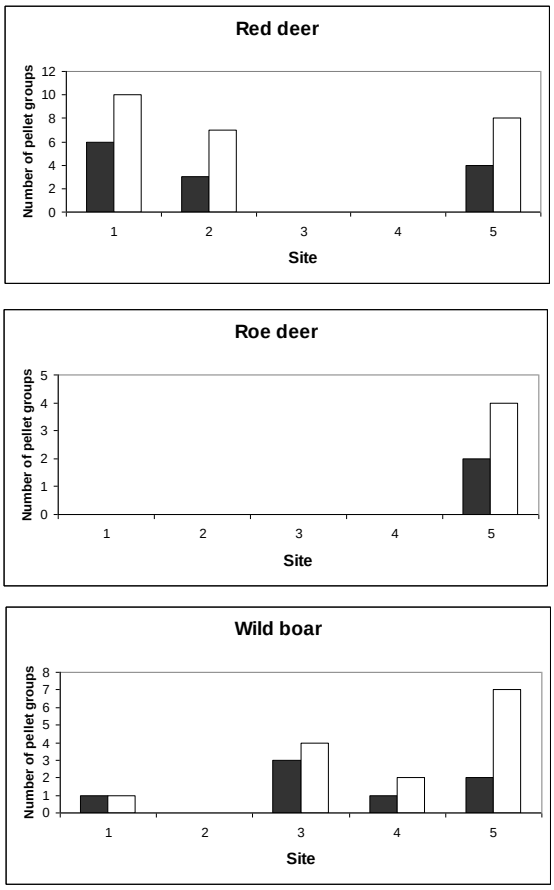

Figure 2. Total number of pellet groups recorded during the September and October 2004 ungulate density estimation sessions at 5 sites in 2 hunting grounds of Vrancea mountain range. Black-large circles method, white-small circles method.

In Condratu and Lepşa hunting grounds, red deer, roe deer and wild boar spend much of the time at the cover of forests but use relatively open pastures and clearings as preferential feeding sites. This makes these sites ideal spots to monitor the populations of these animals. While the presence of red deer and roe deer may be less obvious, wild boar presence is evident due to its habit of digging the ground for food.

Chamois pellets were not found in the study sites, but individuals of this species were visually observed on several occasions in rugged terrain on Condratu hunting ground. At least in autumn, this species probably doesn't typically descend from the rocky, rugged areas to graze on the pastures in valley bottoms.

This study assessed densities of ungulates at preferential feeding sites. Results should not be extrapolated over the entire area of the hunting grounds, due to the differences in habitat and time budgeting by the animals. In many cases, most ungulates are likely to spend more time in pastures and clearings for feeding than in closed forest, which is probably mainly used for shelter. If an assessment of ungulate densities for the entire surface of a hunting ground is required, one should at the very least take into account the relative percentages covered by each habitat type within the given area. In such an instance, a combination of methods applied at a selection of sites with different

characteristics is recommended, as otherwise the estimates are likely to be very far from accurate and may even fail to pinpoint some species.

We therefore stress the fact that choice of methodology should be made in accordance with the objectives of the study and nature of terrain. Similarly to track counting, pellet counting is a non-invasive method of studying animal populations in that it doesn't affect the animals and uses clues rather than direct observations to study them. Contrary to what Romanian Forestry Commission practices have been for decades, standardization although desirable is not as straight-forward a task as it has been traditionally thought to be.

If large areas are to be investigated, the large circles method may be more appropriate, particularly in view of the fact that circles are distributed randomly. If, on the other hand, more precise estimates are needed for a certain area, then small circles distributed on transects may give a more rigorous result. The radius of the circles can be adapted to field conditions, for example it is difficult to use a 4 m radius on steep terrain with a lot of under storey growth which deters finding the pellets. In methods based on pellet counts, as in any field-based ecological survey, a compromise needs to be reached between desired precision and sampling effort.

Table 1. Autumn 2004 ungulate density estimates at 5 sites on 2 hunting grounds in Vrancea mountain range, following 2 methods based on recording pellet groups.

		Condratu (sites 1,2)			**Lepşa (sites 3,4,5)**		
		Red deer	Roe deer	Wild boar	Red deer	Roe deer	Wild boar
Ungulate per hectare density (D)	Large circles (R=4 m)	0.19	0	0.09	0.05	0.02	0.34
	Small circles (R=1.5 m)	0.38	0	0.09	0.1	0.05	0.74

Conclusions

The approach for estimating ungulate densities based on pellet counts used in the present study is relatively new for Romania. To our knowledge, only one pellet count study has been carried out in the country before, by Forestry Commission researchers, but has not led to the technique being recommended for ungulate surveys, although pellet count methods have been widely used and recommended in The Western world.

In most cases, the large circles method produced lower density estimates than the small circles method. However, this was statistically significant only when the two methods were applied for red deer. The main advantage of pellet counting as shown in this study is the flexibility in choosing the sampling regime which is most appropriate to given field conditions. Counting pellet groups in randomly distributed large circles may be suitable when investigations are required for large areas. On the other hand, when more precise data is needed, for smaller surfaces, the small circles on transects method may be more appropriate. With accurate density estimates needed for the management of a variety of animal populations, more studies are required to assess the effectiveness and appropriateness of new methods, both between themselves and compared with older, traditional ones.

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Appendix

Table. Approximate geographic coordinates in degrees, minutes and seconds for the 5 sites in Vrancea mountain range, where recording of ungulate pellet groups was carried out in autumn 2004.

	Site 1	Site 2	Site 3	Site 4	Site 5
Latitude	45º55'28"	45º55'25"	45º58'23"	45º58'22"	45º59'27"
Longitude	26º33'56"	26º33'57"	26º34'32"	26º34'36"	26º34'36"
Altitude (m)	650	668	718	720	842