1.7. DENSITY ESTIMATION OF TWO RODENT POPULATIONS USING A TRAPPING WEB AND DISTANCE SAMPLING METHOD ON THE DRÁVA LOWLANDS

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1.7.1. INRTODUCTION

The estimation of population size (*N*) using capture-recapture (CR) data is usually conceived as a capture-recapture problem (White *et al.* 1982). When using CR-method for data collection, traps are positioned at intersections of a rectangular grid. In the boundary lines, however, animals in the surrounding areas are attracted by the smell of baited traps and therefore they are also subject to being captured. Accordingly, the effective sampling area becomes larger than the grid and density cannot be estimated as simple as N / A_g, where A_g is the area covered by the trapping grid, because it leads to the overestimation of the real density on the observed habitat (Buckland 1993). The problem of edge effect has been known for a long time in CR literature (Dice 1938, Stickel 1954, Tanaka 1972) and for a solution the area of the trapping grid was to be extended by a boundary strip. Dice (1938), in assuming that animals have circular home ranges, suggested that the area of the boundary strip (*W*) should be equal to one-half the average home range of the individuals trapped. Home range estimates though proved to vary as a function of trap spacing, which has an effect on the number of recaptures, too (Stickel 1954, Tanaka 1972). As studies progressed, Otis et al (1978) interpreted the traps on the grid as concentric cycles of equal width. Starting from the centre the population size is overestimated on the subgrids, but as grid size increases the edge effect decreases, and the estimated density decreases as well (Demeter és Kovács 1991). The expected value of density (*D*) and the area of the boundary strip *A*(*W*) are best estimated by the weighted nonlinear least square procedure using a minimum number of four subgrids (Otis *et al.* 1978). The method to estimate density using distance sampling theory and the trapping web was first proposed by Anderson *et al.* (1983). Here density is estimated directly instead of calculating population size and the effective trapping area separately. This study introduced the new method on small mammals particularly. A detailed review of the theory of models using distance sampling for density estimation can be found in Buckland (1987), Wilson and Anderson (1985) and Buckland *et al.* (1993).

Small mammal live trappings have been performed in different forests and open habitats since 1994 at the Department of Ecology and Zoogeography, Janus Pannonius University. Our sample small mammal assemblage was chosen around Lake Matty along the River Dráva, where a long-term monitoring is carried out on the fauna and population dynamics. This choice was also reasonable since the lake and the Hótedra are objects of the chemical water monitoring project run by the Department and its distance from the city allows inexpensive and frequent sampling. The trapping web was laid out in a damp grassy association next to the lake. Its practical application could be with great help in designing the national monitoring project. The results of sampling with this method in 1997 are reported in Horváth (1998) according to which paper the most frequent species in the area were *Apodemus agrarius* (Pallas, 1771) and *Microtus arvalis* (Pallas,1779). The present study focuses on the density estimation of these two species with the method of distance sampling.

1.7.2. Material and Methods

Our study area near Lake Matty used to be a pasture grassland, but presently it is not cultivated, reaped or used for grazing cows. The lack of disturbance allowing a higher undergrowth provided better conditions for small mammal trapping. The area is partly a damp, meadow with weeds taking over and with different tall grass species like *Alopecurus pratensis*, *Poa pratensis*, *Dactylis glomerata*, and those indicating and enduring disturbance like *Daucus carota*, *Cichorium intybus*, *Rumex crispus* The herb layer comprises *Trifolium repens*, *Lolium perenne*, *Cruciata ciliata*, *Taraxacum officinale*, *Galium verum*. The south-west part of the study area is damper, here *Typha latifolia*, *Juncus effusus* and sedge (*Carex vulpina*, *Carex hirta*, *Carex acutiformis*) are also present, in company with *Mentha longifolia*, *Mentha arvensis*, *Rorippa austriaca*, *Crisium vulgare* and *Rannunculus repens*. Aggressive, non-indigenous weeds had established themselves in great amounts in the northern, north-western part of the area covered by the trapping grid, such as *Solidago gigantea* and *Sambucus ebulus*, which created a thick, high coverage.

Plastic and wooden box-type live traps were used, the applicability of which is discussed in Horváth *et al.* (1996). The trapping web was laid out according to Anderson *et al.* (1983) and Buckland *et al.* (1993), with 16 line-transects radiating from the cetrum of the circular grid, so that traps form concentric rings. The trap-lines were situated at 22.5 angles to each other, having T traps (T=20) in a distance of 3 metres (θ), which left us with a cycle of 120 meters in diameter. Thus, 320 live-traps were placed in the grid altogether. The radial distance of the rings is a_i which is expressed according to the equation by Wilson and Anderson (1985): $a_i = (i\text{-}1)\theta + (\theta / 2)$, for $i = 1, 2, \ldots, T$. The sampling grid covered an area of 1.13 hectare.

Traps were baited with bacon and whole cereals. Sampling was performed in two 6-night periods. Traps were operating from July 28^{th} to August 1^{st} (1^{st} period) and from August 30^{th} to September 5^{th} (2^{nd} period) 1997, yielding a total of 3480 trap nights. Traps were checked twice daily (8^{00} CET and 19^{00} CET). After the morning checking traps were left open due to the hot summer conditions and they were set again only between 17^{00}-18^{00} before the night checking. For individual identification of the captured animals, the removal of the first knuckle of certain toes was applied, and the following data were recorded: species, sex (gravidity or lactation in females), body weight. The present estimation includes captures during the nights only, i.e. we analysed data collected in the mornings.

The basic data for the estimation is given by the number of individuals captured in a certain ring, with recapture data ignored. Density was estimated for each period separately in both species. The estimation was performed using the program DISTANCE 3.5 (Thomas *et al.* 1998), which was developed for data of distance sampling methods. The program allows to run several models. Being the most basic one, the uniform model uses the Fourier series without any parameters (Burnham *et al.* 1980) and it estimates detection probability of individuals in point transect methods. The half-normal model has one unknown parameter to be estimated from the distance data and the hazard-rate model, which is a derived one, uses two estimated parameters in the analyses. Model selection was carried out by calculating AIC (Akaike's Information Criterion) values (Anderson *et al.* 1994).

Just like in the square-shaped grid, the outer rings of the trapping web attract animals from around the area of the trapping grid, which can bias the estimation, therefore Anderson *et al.* (1983) left out the data collected in the 19th and 20th rings in their density estimation in an American mice (*Peromyscus sp.*) population. After the model selection procedure using AIC-values had been developed, Buckland *et al.* (1993) performed an estimation with the same input data without the two outer rings, thus creating 18 distance groups. From our two observed species *A. agrarius* showed the same problem, therefore the outer rings with high numbers of captures were left out from the estimations.

1.7.3. Results

During the two sampling periods 12 small mammal species were captured. The order of insectivores (*Insectivora*) was represented by 5 species belonging to the shrew family (*Soricidae*), whereas 7 species comprised the order of rodents (*Rodentia*) in the trapped area. A thorough investigation of the fauna can be found in Horváth (1998). The two most frequent species were *A. agrarius* and *M. arvalis*: their populations were analysed with the density estimators of distance sampling method. *A. agrarius* was captured in a greater area on the trapping grid, which is showed in the graph of the radial lines (Fig. 1). The graph also indicates that the population used the north-western part of the grid and its expansion was not concentric. The area where *M. arvalis* was encountered in the traps was much smaller (Fig. 2) and in the outer rings there were even less captures, sometimes even none at all. Its distribution was concentrated around the centre, on the north-west to south-east line. Its presence was minimal in the lines perpendicular to this expansion.

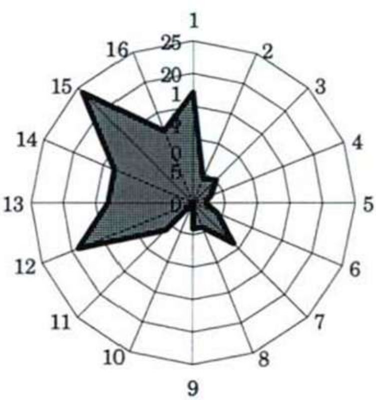

Fig. 1. Number of captures of *A.agrarius* in the radial lines of the trapping web

The total number of first-captured and marked individuals and the measured value of radial distances used in the estimation, with both sampling periods considered, appear in Table 1.

The detailed data of concentric trap circles indicate the high number of *A. agrarius* in the outer rings. The 19th and 20th rings had to be ignored in the first period, while in the second the three outer rings (18th, 19th, 20th) had to be left out from the estimations. In the case of *M. arvalis*, data from all 20 rings were used in both periods; no animal was captured in the 20^{th} ring during the first six days.

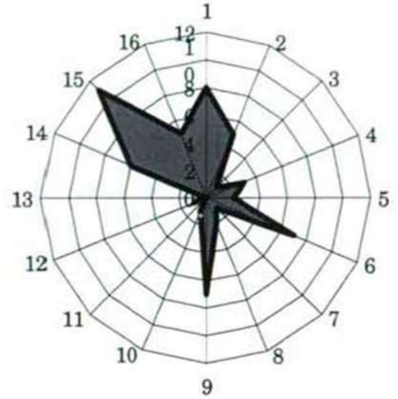

Fig. 2. Number of captures of *M. arvalis* in the radial lines of the trapping web

Table 1. The total number of first-captured individuals and the measured value of radial distances

		Total number of marked individuals			
	Distance	*Apodemus agrarius*		*Microtus arvalis*	
i	a_i	*First period*	*Second period*	*First period*	*Second period*
1	1.5	2	-	-	-
2	4.5	-	2	-	1
3	7.5	1	-	-	3
4	10.5	-	-	-	
5	13.5	1	1	4	2
6	16.5	4	1	-	1
7	19.5	3	1	4	5
8	22.5	5	1	2	6
9	25.5	1	-	2	4
10	28.5	2	3	4	8
11	31.5	4	-	4	2
12	34.5	6	5	-	4
13	37.5	6	6	6	1
14	40.5	2	2	3	2
15	43.5	6	3	7	5
16	46.5	6	2	3	2
17	49.5	4	5	5	5
18	52.5	2	10	3	2
19	55.5	8	9	3	2
20	58.5	10	5	-	5
Total		73	56	50	62

i = ring number, a_i = the distance of each ring from the centre

All three models were run by DISTANCE. The result of model selection showed that our data best fitted the uniform model applying the Fourier series. This model had the smallest AIC value and its coefficients of variation were also valid (Table 2). The value of the latter was below 20% in all cases, which range is accepted in estimations of short-term CR data.

Table 2. The results of model selection

	Apodemus agrarius		*Microtus arvalis*	
MODEL/Parameters	*First period*	*Second period*	*First period*	*Second period*
UNIFORM MODEL				
Number of parameters	0	0	0	1
AIC value	**426.22**	**308.16**	**381.13**	**428.09**
Coefficient of variation (cv [%])	**13.48**	**15.43**	**14.14**	**19.39**
HALF-NORMAL MODEL				
Number of parameters	1	1	1	1
AIC value	427.17	310.16	382.99	429.57
Coefficient of variation(cv [%])	25.65	27.63	28.17	21.42
HAZARD-RATE MODEL				
Number of parameters	2	2	2	2
AIC value	429.18	312.16	384.88	429.95
Coefficient of variation (cv [%])	21.05	15.43	21.29	32.84

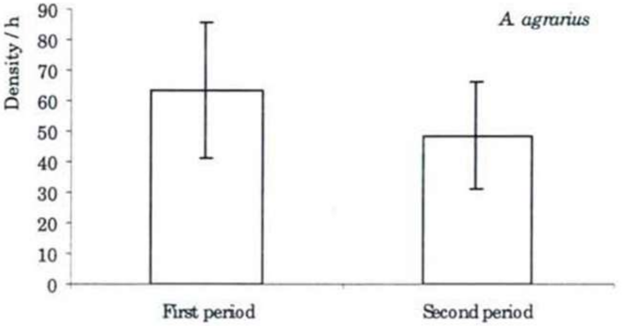

Fig. 3. Density estimates of *A.agrarius* with 95% confidence intervals

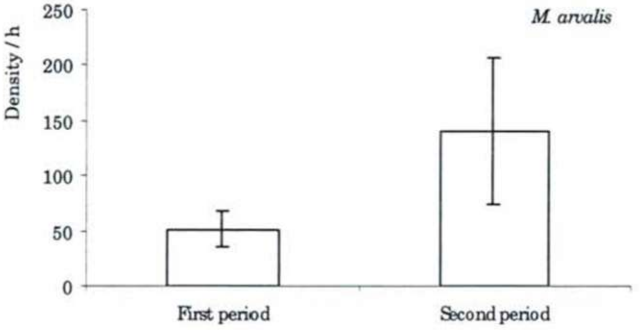

Fig. 4. Density estimates of *M. arvalis* with 95% confidence intervals

The estimated density of *A. agrarius* was higher around the end of July in the first sampling period, and it decreased by the second period (Fig. 3). The 95% confidence intervals of all the estimations were plotted. In the case of *A. agrarius* the two confidence intervals overlap, thus the decrease of density in September is statistically unacceptable. *M. arvalis* had a low estimated density in the first period, but it became higher in September

(Fig. 4). Despite the large confidence interval in the second estimation, the two confidence intervals for the two estimated densities do not overlap, which proves a statistically significant increase in the density of *M. arvalis*.

1.7.4. Discussion

The trapping web proved to be an appropriate method for estimating the density of our two observed small mammal populations that had enough data available in the different trapping rings. Anderson *et al.* (1983) and Buckland *et al.* (1993) recommend this method because density can be estimated directly with the edge effect being taken into consideration. *A. agrarius* had a higher number of captures in the outer rings, so truncation was necessary. A possible explanation for the decreased number of individuals could be the species' ability for great expansion. It also covers much larger distances in its movements than *M. arvalis*, which has already been established in several earlier studies (Liro and Szacki 1987, Skacki and Liro 1991). The high number of individuals caught in the outer rings points to the high attracting capacity of the bait and the smell of traps that lure the animals from the surrounding area, causing significant bias in the estimated density in the effective study area. *M. arvalis* did not have such a large-scale movement at all, which was shown by the low number of individuals captured in the outer rings and by the distribution of capture numbers in the radial lines. The best model fitting our data proved to be the uniform model applying the Fourier series, the one that had been used by Anderson *et al.* (1983).

The density of *M. arvalis* had increased by September, which phenomenon was expected to be characteristic of *A. agrarius* particularly, because earlier studies had proved a sudden autumn peak in its population size. The explanation for this contradiction could be that *A. agrarius* changes its habitat for autumn, which could be investigated by other trapping methods.

1.7.5. Summary

Two 6-night trapping periods were carried out using a trapping web near Lake Matty on the Drava Lowlands in 1997. Based on CR-data (capture-recapture), densities of *Apodemus agrarius* and *Microtus arvalis* were estimated applying the distance sampling method in the two periods. In the case of *A. agrarius* truncation was necessary to correct bias in density estimation caused by edge effect, which resulted 17 and 18 rings instead of 20 to be included in our study. Density values per hectare were different in both species. The density of *A. agrarius* decreased by the second period, while it increased in the case of *M. arvalis*. Significant difference between density estimates could only be proved statistically, considering the 95% confidence intervals, only in the case of *M. arvalis*.

1.7.6. Acknowledgements

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1.7.7. References

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