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APPLICATION OF BIVARIATE REGRESSION METHOD FOR ESTIMATING THE SECONDARY NATALITY IN THE EUROPEAN BROWN HARE

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Abstract: Knowledge of reproductive performance of the European brown hare (Lepus europaeus, Pallas, 1778) is an essential condition for planning rational utilization. The direct possibility of estimating the number of leverets is the placental scar counting of the eviscerated females in the hunting bag. A condition for a reliable estimate is a sufficient sample quantity and the timing of sampling. Late sampling leads to a risky and unreliable estimate due to the disappearance of placental scars (amount of reproduction), which will result in under- or over-utilization. The goal of study is to test a method that enables reliable estimation for the amount of reproduction by using individual biological parameters and eliminates the risk resulting from timing. This case report is an attempt to estimate the number of placental scars (born leverets) by using the dried eye lens weight and body weight of fertile females by bivariate linear regression method.
Based on the real placental scar number (y), three classes were created: class I: y=1-4; class II: y=5-9; class III: y=9-13 placental scares. The estimated values of the placental scar numbers (y') using the regression model was only accurate for values belonging to class II. For those belonging to class I the model resulted over-, and to class III an underestimation. The linear regression model using eye lens weight and body weight as independent variables did not result in a reliable estimate of secondary natality for the entire stock in the given situation.

Keywords: brown hare, dry eye lens, estimation of reproduction, placental scares, secondary natality

1. Introduction

The reproduction of brown hare populations ensures the possible utilization. The condition for planning utilization is a reliable estimate of the amount of reproduction. The presence of the placental scars is the proof of fertility and the born leverets at the same time. Each leveret leaves a placental scare when it is born, so counting the scars provides information on the amount of offspring born per female within a given reproductive period (Majzinger & Barta 2011). This is one of the indispensable data which is needed to estimate the annual reproduction at the stock level, and thereby to plan the harvest (Bray et al. 2003; Drews et al. 2013; Majzinger, 2013; 2014; Majzinger & Csányi 2017). The amount of reproduction depends on the age of the female: The net reproduction rate for those younger than 1 year is 0,02; 0,63 for 1,5-2,5 year olds and 0,35 for over 3 year olds (Faragó & Náhlik 1997). According to more recent studies, 64,9% of females older than 1 year, while 37,5% of younger females participated in the reproduction (Gál, 2006). In English studies 60% of young females shot in winter were found to be pregnant, in other areas it was 37% (Jennings et al. 2006). Age is also related to body weight (Felis et al. 2022), so it can be assumed that age and body weight together influence the amount of reproduction. We are investigating whether the relationship between the mentioned variables can be described with a mathematical model.

2. Materials and methods

We collected eye lenses and internal genitalia from 138 females between 2014 and 2016 in a hunting area under agricultural cultivation in Hungary. The dried eye lens weight of the individuals was measured by the method of Caboń-Raczyńska & Raczyński (1972) and Suchentrunk et al.(1991). The real reproduction (y) was estimated by counting the placental scars. Using the dried eye lens mass (x) and the body mass (w) as independent variables, we estimated statistically the reproduction (y') using the linear regression method for the prediction of secondary natality. The estimated parameter thus obtained was compared with the real value (y). Microsoft Excel was used for statistical analysis.

3. Results

The result of the bivariate linear regression calculation is shown in *Table 1*.

Table 1: The result of the regression statistics

Model	Coefficients	Std. Error
Constant	-4,177*	1,912
Eye lens weight (x)	0,016**	0,005
Body weight (w)	0,001**	0,001

*: p<0,05; **: p<0,005

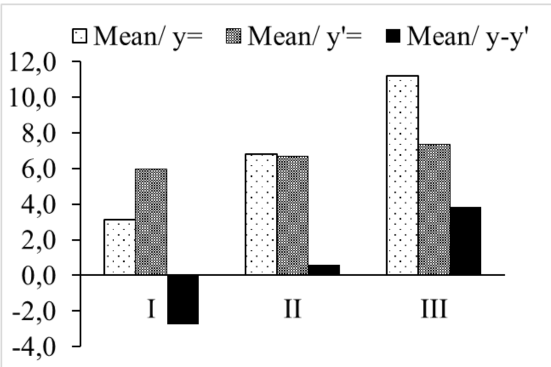

Figure 1: Real (y) and estimated number of placental scares (y'), and their difference (y-y') by classes

The regression equation: $y' = 0{,}016x + 0{,}002w – 4{,}1778$ which can be used to calculate the estimated placental scar number. Comparison of estimated (y’) and actual placental scar numbers (y) using the equation (*Figure 1*) proves that the estimated values in the lower (y=1-4) and upper intervals (y=10-13) differ greatly from the real ones.

Based on the real placental scar number (y), three classes (I, II, III) were created. The mean values (*Figure 1*) and the level of significance for each class can be seen in the *Table 2*.

Table 2: The mean values of dry lens weight (x), body weight (w), number of placental scars (y) according to classes (I-III), and average difference between the estimated and real number of placental scars (y-y’), N=138

Class	Range/y	N	x*	w*	y**	y'	y-y'
			Mean±SE	Mean±SE	Mean±SE	Mean	Mean
I	1-4	36	281±56	3525±493	3,11±1,06	6,0	**-2,7**
II	5-9	77	306±47	3729±451	6,81±1,33	6,7	**0,6**
III	10-13	25	327±39	3929±367	11,2±1,22	7,3	**3,9**

*: p<0,01; **: p<0,001

The differences between the means of examined parameters (x, w, y,) are significant for all three classes. The difference between the real and estimated placental scar numbers (y-y’) shows the reliability of the estimation and the accuracy of the regression equation at the same time (*Figure 2*).

The smallest difference between the real and estimated placental scar numbers is experienced in the class II (0,6/6,7x100=8,9%).

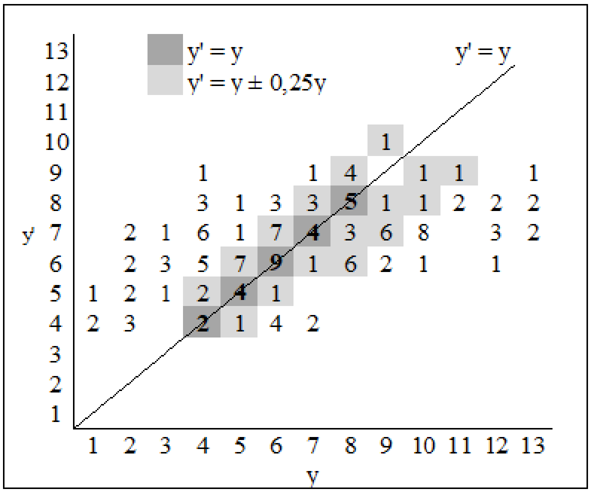

Figure 2: Accuracy of the estimated placental scar numbers (y’) compared to the real ones (y). The numbers show the number of cases (N=138).

Although this rate is 45% in class I and 53% in class III (*Table 2*). The reason for this is that the estimated values do not follow the development of the real values (*Figure 1*).

Figure 2 and *Table 3* show the distribution and accuracy of the estimated values compared to the corresponding real value.

Table 3: The number and distribution of estimated values

Num. of cases	y'=y	y'=y±0,25y	y-0,25y≤y'≤y+0,25y
1	0	1	1
9	0	6	6
23	5	5	10
43	4	16	20
37	9	14	23
11	4	3	7
14	2	1	3
∑ = 138	24	46	70

4. Discussion

The estimate proved to be accurate in 17,4% (24/138) of all cases (y'=y) and overall in 50,7% (70/138) it was within a 75% confidence limit (y-0,25y≤y'≤y+0,25y). The model gave accurate estimates for actual placental scar numbers between 4-8, and acceptable estimates for between 4-9 (this corresponds to class II). For those belonging to class I the model resulted over-, and to class III an underestimation.

The linear regression model using eye lens weight and body weight as independent variables did not result in a reliable estimate of the secondary natality for the entire stock.

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