A C T A T H E R I O L O G I C A

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Studies on the European Hare. XI. Estimation of Population Density and Attempt to Plan the Yearly Take of Hares

[With 4 Tables & 2 Figs.]

The density of European hare population on the hunting grounds of Polish Hunting Union Research Station in Czempiń was estimated by regression function of the number of hares caught in subsequent drives. The estimation was based on the catch from 20 sampling areas, the total of 2,361 hectares. The realized production of young from one female was determined and the mortality of foundation stock was estimated from retrapping of marked hares. From these data the optimal yearly take of hares from this population was calculated. Large fluctuations of realized production of young and inaccurate information on the foundation stock mortality make precise foreseeing of these values difficult and consequently, it is necessary to plan the take very carefully in order to maintain the population numbers in autumn on the desired level. Nevertheless, the proposed method together with the studies of realized young production allow correcting the plan of catching for the actual population numbers at the very beginning of catching season.

I. INTRODUCTION

Controlling the density of natural populations of economically useful animals requires maintaining population numbers on planned level. It can be achieved by different procedures which increase the birth rate and reduce the natural death rate of utilized species. This calls for estimating population numbers, birth and death rates as well as natural population increase. On this base the take (shooting, catching, etc.) should be controled to ensure planned density of utilized species in the following year.

In previous shooting practice there were no examples of so strictly directed management of hare populations. It usually results from the difficulties in precise estimating the above mentioned parameters. One of most serious difficulties is estimating precisely the population density of hares on given area. Three methods of estimating were used.

The first is used traditionally and assumes that hunting in more or less standardized conditions yields the distribution of shot hares proportional to the density.

The second method in use is called the "zonal taxation". In this method group of people is walking down the zone of fixed width (50 or 100 m) and counting specimens flushed from this area (Jezierski & Pielowski, 1958; Pielowski, 1962). The length of covered zone is multiplied by its width to get the area hares were flushed from. Theoretically it should allow estimating the mean density of hares per 1 ha. However, recent studies indicate that results obtained in this way can be used only as a relative density index (Pielowski, 1962).

So called "test flushing" is the third method of estimating the density of hares. The animals are driven from large area (many hectares) by a group of people and flushed specimens are counted (Szederjei, 1958). Theoretically this method would approach estimating the absolute numbers of animals. In practice however, some hares usually remain in studied area and results are again relative.

Methods of estimating reproductivity of European hare are elaborated in some detail (Bloch *et al.*, 1954; 1958; 1963; Stieve, 1952; Kolosov & Bakeev, 1947; Rieck, 1956; Raczyński, 1964). However, it requires taking (shooting off) considerable number of animals from studied population over extended period of time. This decreases both the density and the planned take. The number of young hares grown up before shooting season can be estimated from the proportion of this year animals to older ones (Rieck, 1956; Hell, 1964; Jezierski, 1959; 1965; Pielowski, 1962; Petrov & Dragoev, 1962 and many others). This allows estimation of the mortality of young in given year. The age of animals is estimated from ossification of ulnar bone epiphysis (Stroh, 1931) or from the changes in lens weight (Lord, 1959; Rieck, 1962). These methods appear very inaccurate (Bujalska *et al.*, 1965).

Equally important for planning of the take of hares are information on yearly losses (death rate) of the foundation stock, i.e. adult specimens between subsequent shooting seasons. However, up to date there are no methods for approaching this problem.

The purpose of this study was precise estimation of the density of hares in given hunting area to provide some basis for planning the take of this species. The plan will consider all parameters bearing on the size of take.

II. AREA OF STUDIES

This work was conducted on the experimental hunting grounds of Polish Hunting Union Research Station in Czempiń, Kościan county, Poznań province. This hunting area consists of 18,984 ha of fields and 1,077 ha of woods, the total of 20,061 ha. The results of this work concern fields only.

Roughly 35% of field areas is owned by State and Cooperative Farms and cultivated in big units. Remaining 65% is owned by private farmers. The average size of private farm in this area is about 9 ha. The villages and settlements in this area are usually compact. The woods are scattered throughout these grounds as small complexes and game shelter woodlets. Studied hunting area is flat and divided by small river (the ratio of resulting parts being about 1:4). Thanks to river control the floods do not occur. Along the river there are meadows. The soil is podsolic with light sands with clay in the surface layers and light clay beneath.

The yearly sum of precipitation is about 500 mm, snow cover stays on the ground for the average of 42 days, mean temperature is —1.4°C in January, 8.0° in April, 17.7° in August and 8.6° in October.

On the grounds of Research Station the take of hares is exclusively by catching live animals for repopulating low density areas in Poland and for export. The number of hares caught yearly is planned beforehand and the plan is always fullfilled.

Most of studies reported in this paper were carried out in winter of 1964. Besides, the data obtained by marking hares in 1957—1960 were used, as well as the data concerning the proportion of young specimens in populations of hares over many years (J e z i e r s k i, unpublished data).

III. MATERIALS AND METHODS

The estimation of density of the European hare in studied area was based on slightly modified method employed for catching hares for economic purposes. Thus the necessary data were collected without disturbing routine course of catching animals for repopulating and at minimal expense.

The course of catching hares is the following. On the map of Research Station the fields for catching are marked. The location and the length of nets (maximum of 5 km) are set. Marked fields are usually square or polygonal (with few sides). The fields are numbered and the time schedule of catching is prepared.

On the day of catching whole field is surrounded by the catching net starting early in the morning. The net is transported by tractors or horse carts that are moving in two opposite directions along the circumference of the field, and it is immediately put up. The net is usually put up along roads or other well pronounced lines in the area. Flushing of the hares during spreading nets is very small and the animals move both toward the middle of surrounded area and outwards. Consequently, the hares are not flushed from the area being surrounded. The average size of the field surrounded by nets was 118.01 ha (Table 1).

When the field is surrounded the hares which are inside are being driven into the net. To do it, the beaters are stationed along one side and then move in scattered order across the field. Then they return and cross the field again. In our experiments the average of 22 beaters was driving the hares.

Netted hares are removed from the net by so called "catchers" stationed along the net, 150—200 m from each other, and put in transportation boxes. The number of hares passing the net without being caught is small and amounts to about 3%.

For this study 20 catching fields were used. They were distributed over the hunting grouds of Research Station approximately randomly. Total area of these fields was 2360.7 ha or 11.3% of whole area managed by the Station [1]).

On each of these 20 fields 4 drives were made — the beaters were moving across

[1]) Sampling 10% of the area seems to provide sufficient representation of studied grounds. Experimental areas of similar size were used by many authors (R u s k o v & P e t r o v, 1957; S z e d e r j e i, 1959 and others).

the field four times (twice in one direction and twice back). The number of netted hares was noted after every passage of the beaters.

The routine catchings for repopulating were carried out on the Station grounds between December 7, 1964 and February 8, 1965. In this period 3823 hares were taken.

As every year, all caught hares were sexed and the proportion of specimens born in 1964 (less than one year old) was determined using the method of Stroh (1931).

Table 1.

The results of catching hares on sampling areas.

No. of sample	Area of sample in ha	Number of hares caught					
		Drives				Total	per 100 ha
		I	II	III	IV		
1.	110.874	28	7	3	5	43	38.8
2.	123.886	45	13	8	7	73	58.9
3.	99.146	52	5	2	0	59	59.5
4.	92.365	36	8	3	0	47	50.9
5.	124.588	36	14	1	1	52	41.7
6.	139.522	54	14	2	1	71	50.9
7.	129.867	51	16	7	3	77	59.3
8.	125.282	33	10	0	4	49	39.1
9.	106.995	9	11	5	0	25	23.4
10.	108.005	52	15	6	3	76	70.4
11.	102.864	20	9	3	0	32	31.1
12.	130.366	19	13	13	5	50	38.3
13.	139.640	39	5	1	0	45	32.2
14.	129.390	50	4	1	0	55	42.5
15.	113 765	50	15	5	1	71	62.4
16.	104 560	40	8	3	2	53	50.7
17.	91.495	22	2	2	0	26	28.4
18.	135.296	25	6	2	1	34	25.1
19.	94.749	14	5	1	0	20	21.1
20.	158.002	45	11	1	3	60	38.0
Total	2,360.657	722	191	69	36	1,018	43.1

On the grounds of Research Station certain number of hares was caught every year between 1957 and 1960 and marked with numbered earmarks. Their sex and age were determined using Stroh's method (*l.c.*). After being marked the animals were released in the same area. When during catching for economic purposes these hares were netted again, their numbers were noted and the animals were released. Many retraps of marked hares occured in years following marking. Some of these data were used in present study.

Part of Czempiń Station materials concerning the estimation of hare density on this area was also used. Such estimations are made several times every year using "zonal taxation" method (Jezierski, 1958; Pielowski, 1962) and covering the total of 41 km.

IV. ESTIMATION OF HARE POPULATION DENSITY

In the area surrounded by nets the number of hares caught in each of four subsequent drives rapidly decreases (Table 1, Fig. 1). However, it appears that some more hares would be caught if further drives were made. Consequently, the number of hares in the area surrounded by nets equals total number of hares caught in four drives plus the hares that remained in the area and the hares that passed the net without being caught.

The total number of hares that were present in the surrounded area was estimated from the linear dependence of the number of hares caught in given catching (y) on the number taken before this catching (x) (Fig. 1).

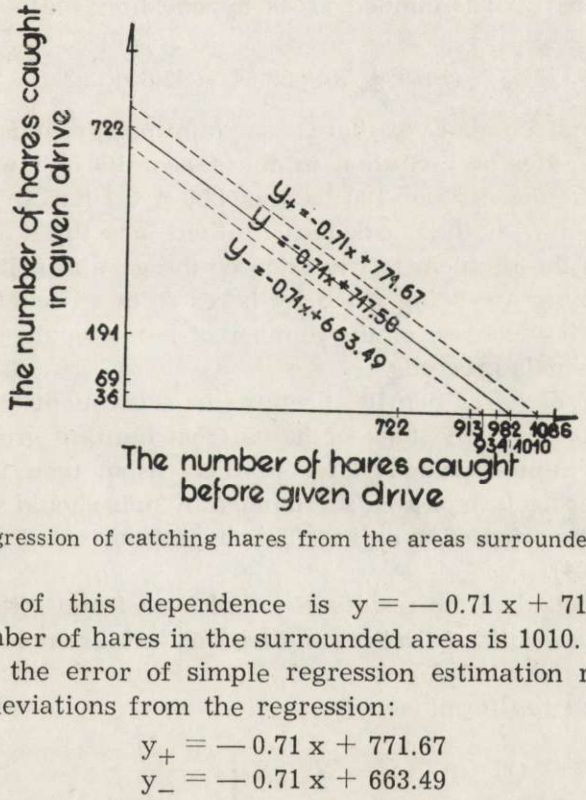

Fig. 1. Regression of catching hares from the areas surrounded by nets.

The equation of this dependence is $y = -0.71\,x + 717.58$ and the estimated number of hares in the surrounded areas is 1010.

Considering the error of simple regression estimation results in two equations of deviations from the regression:

$$y_{+} = -0.71\,x + 771.67$$
$$y_{-} = -0.71\,x + 663.49$$

Consequently, the number of hares in considered area was between 934 and 1086 (1010 ± 76).

The actual number of hares caught in the area surrounded by nets was 1018. This number is within the limits of error of the estimated total number of hares in this area. It indicates that the number of hares that remained in the area was small, probably not exceeding 68 animals.

The total number of hares on studied grounds and their mean density per 100 ha can be estimated from the number of hares in areas surrounded by nets assuming, that these areas were the representative sample of Research Station hunting grounds. The premises of such an assumption were discussed above.

The total number of hares (N) on hunting grounds in the season of catching 1964/1965 can be estimated by multiplying the number of hares in surrounded areas by the ratio of total area to the area surrounded by nets

$$N = 1010 \pm 76 \cdot \frac{18\,984}{2361} = 8110 \pm 610$$

Mean density ($\bar{Z}$) of hares per 100 ha can be estimated by dividing total number of hares in surrounded areas by one hundredth of surrounded area:

$$\bar{Z} = (1010 \pm 76) : 23.61 = 42.8 \pm 3.2$$

Thus the total number of hares on hunting grounds of the Polish Hunting Union Research Station in the season 1964/65 was 8110 ± 610 animals and the density per 100 ha was 42.8 ± 3.2 hares.

In connection with these calculations there are three additional problems. First is the problem to what degree the gaps in population resulting from catching are being filled by hares from adjacent areas. If this would occur, the decrease of the number of hares would be expected as the take of animals proceeds.

The number of hares per 100 hectares in subsequent samples is very variable (Table 1). If the take of hares from hunting grounds does not influence the number caught later in the season, then the number of hares taken per hectare of area surrounded by nets should vary randomly over the whole period of sampling. This hypothesis was tested as follows (Elandt, 1964).

It is tested whether the results of samples n+1 and following are different from the results of first n samples. For first n samples the tolerance interval was calculated for $\alpha = 0.05$. The limits of this interval are calculated from the formulae:

$$(1) \quad q_1 = \bar{x} - W_{\frac{\alpha}{2}} \cdot S \sqrt{\frac{n-1}{n}}$$

$$q_2 = \bar{x} + W_{\frac{\alpha}{2}} \cdot S \sqrt{\frac{n-1}{n}}$$

where the statistics $W = \frac{\bar{x}-x}{S} \cdot \sqrt{\frac{n}{n-1}}$ is distributed according to the formula:

$$(2) \quad P(W < W_\alpha) = C_{n-2} \int_{-\sqrt{n-1}}^{W_\alpha} \left(1 - \frac{W^2}{n-1}\right)^{\frac{1}{2}(n-4)} dW$$

(C_{n-2} — constant dependent from the number of samples x; S — standard deviation).

The tolerance limits were computed for first 10 samples. From subsequent samples only the sample 19 (21.1 hares caught per 100 ha) was outside these limits. Thus the hypothesis that the take from hunting grounds influences the number of animals in further sampling should be rejected.

Consequently it can be assumed that, in case of our studies, the movement of hares in hunting grounds during the sampling period was so small that the take did not cause the decrease of animal density in the samples taken late during this period.

The second problem concerns the efficiency of catching hares within the area surrounded by nets. This efficiency can be expressed as the per cent of all hares caught in the area which was netted after one, two, three and following drives (Table 2). The estimation of this rate can be useful to decide how many drives pays off, considering the expense of one drive and the number of hares caught.

Table 2.

The per cent of hares caught in subsequent drives.

Drive	I	II	III	IV
Per cent of hares caught	70.9	18.7	6.7	3.7

It appears that the efficiency of catching hares from the surrounded area may depend on meteorologic conditions in given day, especially on temperature. However, our data are too few to consider it in any detail.

The third problem is the number of drives necessary for sufficiently accurate estimations.

The number of hares caught in third and fourth drives is small (Table 1). Thus in catching hares for economical purposes these drives are hardly worthwhile. Moving the nets to different area may result in bigger catch within the working day. However, for calculating the line of regression the minimum of three drives is necessary. In our study the estimation of number of hares based on three drives does not differ significantly from that based on four drives. Corresponding equations based on three drives are:

means: $y = -0.715\,x + 716.97$;

estimation of error: $y_{+} = -0.715\,x + 756.67$

$y_{-} = 0.715\,x + 677.29$

In this case the estimation of density on surrounded areas is 1002 ± 56 hares and seems sufficiently precise.

However, the increase of error when using only three drives can vary with factors influencing the efficiency of catching.

V. PLANNING OF THE TAKE

Both the mortality of foundation stock and the realized fertility depend on the factors of environment (climate, food, etc.) biocenosis (predators, parasites, etc.) and population (density dependent factors, structure and organization of the population). In the case of European hare very important are antropogenic factors resulting from agriculture, mechanisation of transport and population density. Corresponding ecological models are constructed. They describe the influence of these factors on realized fertility, mortality and in effect the density dynamics (for example Alle *et al.*, 1950; Chapman, 1928; Christian, 1950; Gause, 1934 and others).

Using these models in planning the take of hares is not possible in the present stage of studying this species, as the experimental data describing functions of different relationships are lacking. Thus plans of the take have to be based on relatively primitive informations on European hare populations. The model has to be simplified and one has to remember that the probability of realizing any prognosis is low.

For our purposes the described below equation of increase and losses of hare populations over the year was assumed. The breeding program was meant to maintain the population density on previous level.

If: N_0 — is estimated population density in autumn,
P — planned take of hares,
a — realized production of one female,
b — mortality of foundation stock in per cent,
N_1 — planned population numbers in the following autumn,

then the equation of population losses and realized fertility is:

$$(3) \quad N_0 - P - b\,(N_0 - P) + \frac{1}{2}\,a\,[N_0 - P - b\,(N_0 - P)] = N_1$$

Consequently, the planned take of hares (P) expressed in per cent of autumn population density is:

$$(4)\quad P = \frac{b - \frac{1}{2} a\ (1 - b)}{b - \frac{1}{2} a\,(1 - b) - 1} \cdot 100\% \text{ when } N_0 = N_1$$

In the above equation (3) we introduce some error by subtracting the foundation stock mortality from the total population numbers and calculating population increase (reproduction) only for this difference. In fact the hares die throughout the year and some hares do multiply before the death. However, we do not know what is the mortality of foundation stock (adult specimens) in the year cycle. Consequently, introducing in our calculations any relationship between the mortality in year cycle and the production of young would be based on untested assumptions. As the error in estimating the size of take (P) resulting from the accepted simplification is small, it appears that introducing additional assumptions is redundant.

In previous part of this paper we have discussed the method of estimating the autumn population numbers in the areas being utilized by catching live hares. Calculating the take is based on this determination.

Planning the take requires in addition the prognosis of reproduction and foundation stock mortality in considered year.

Table 3.
Realized young production per one female, 1957—1964.

Year	57	58	59	60	61	62	63	64	Avg.
Realized production	2.0	1.8	3 2	1.1	2.4	1.2	0.8	1.1	1.7

The expected fertility was assumed to be equal to the mean production of young by one female (R a c z y ń s k i, 1964). The realized increase is very small and ranges from 0.8 to 3.2 (Table 3).

The natural mortality of foundation stock that remains after catching is the second parameter for balancing the losses and the increase of population.

There were no special studies of foundation stock mortality in the Station hunting area. There are no published data on the natural mortality of European hare that could be used in the above equation.

However, the data on retrapping previously marked hares on the Station grounds between 1957 and 1960 provide some information. Some of hares marked and released were caught in following year during catching for repopulating. The proportion of animals marked in the previous year among all caught hares was calculated. It was assumed, according to the rule of Lincoln, that the per cent of marked hares in whole population is the same (Allee *et al.*, 1950). In this way it is possible to estimate the number of marked hares that remained in the studied area one year after the release. The estimation is obtained by multiplying the proportion of marked hares by the total number of animals in the population.

The data of the density of hares collected on the Station grounds using zonal taxation (compare chapter 3) were used to estimate the populations numbers between 1958 and 1961. In this period zonal taxation indicates quite constant density of 70 hares per 100 ha corresponding to 14,000 hares on considered area. The data from three subsequent years were pooled to simplify further calculations. Between 1958 and 1961 the total of 8.263 hares was caught including 91 animals (or 1.101% of the total) that were released one year before. According to the mentioned above rule of Lincoln it indicates that with the population of 14.000 hares in each catching season there was

$$3 \cdot 14.000 \cdot \frac{1.101}{100} = 462$$ previously marked hares in this population.

As 995 hares were released, their loss was about 47% yearly. This decrease could have been due to both the mortality and the migration of marked hares from the hunting grounds. However, the latter seems unlikely considering the size of Czempiń hunting grounds (20,061 ha), and generally accepted view that hares migrate little (Bieger, 1941; Kokeš, 1948; Koenen, 1956 and others). Consequently, it appears that the migration of marked hares from the grounds was not responsible for considerable decrease of their numbers.

The degree of loss of marked hares may be overestimated if the method of zonal taxation results in underestimating the population density. However, even the assumption that population numbers were slightly higher than estimated does not influence signicifantly the estimation of proportion of marked hares that one year after the release were still present on the grounds.

As there are no reasons to expect higher mortality among marked hares than in the remaining population, it seems that the results obtained may estimate the foundation stock mortality in one year.

The mortality of foundation stock can be also estimated from the density of hares in 1958/59 to 1960/61 together with the production of young by one female (Table 3) using the balance of losses and increase of population (formula 3). In this case P is the realized catch instead of the planned one and N_1 is the population numbers reached after one year and not the expected numbers.

To compare both methods we will estimate the foundation stock mortality for the same period, in which the mortality was estimated, from the number of retrapped hares. Because of low accuracy of the data calculations will be again based on the yearly means, 1958 through 1961.

The population numbers ($N_0 = N_1$) were about 14,000, the take (P) was about 2,800 yearly and the mean production of one female (a) was 2.2 young. Based on these data the mortality of foundation stock is about 41%.

The resulting value is very close to that obtained from retrapping of marked hares. However, because of the mentioned above inaccuracy of the data, we consider this result only as an indication of the order of magnitude of the foundation stock mortality actually occuring on the hunting grounds.

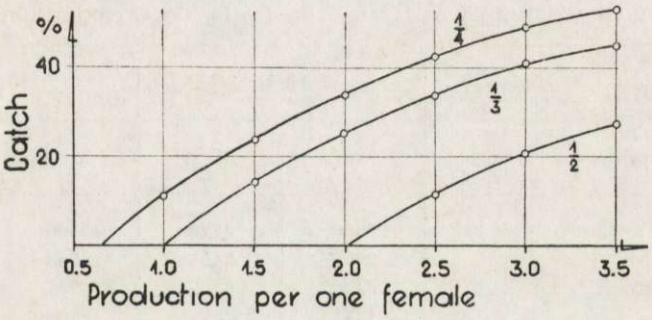

Fig. 2. The dependence between the catch (%) that does not decrease the foundation stock, the foundation stock mortality and the realized young production per one female.

From the formula (4) it is possible to compute the dependence curve of maximum permissible catch (maintaining constant population numbers $N_0 = N_1$) on the realized production of young by one female, for different values of foundation stock mortality (Fig. 2).

Available experimental data indicate that both the range of realized young production and the range of foundation stock mortality given on the figure 2 can occur in our hunting grounds.

From the experimental data together with the above computations and considerations one can attempt to plan the catch on studied Czempiń hunting grounds. We assume that the yearly production by one female will be close to the average between 1957 and 1964, i.e. about 1.7 young. Assuming the foundation stock mortality of about 40% per year (in accordance with previous calculations) the maximum admissible catch should be between 740 and 860 hares for the estimated population numbers of 7,500 to 8,700 animals. In more optimistic prognosis, assuming that with good protection of hunting grounds the mortality of foundation stock will be only 25%, the take could be increased to 2,100 to 2,400 hares (Table 4).

VI. DISCUSSION OF RESULTS

Presented method of estimating the numbers and the density of hares in hunting grounds appears to be reasonably accurate. It is very important that this method, unlike the others in use, depends only very slightly on the efficiency of flushing animals from the sampled area. Consequently, the factors influencing flushing efficiency (weather, number of beaters, etc.) are of little significance. The degree of flushing hares

Table 4.

The balance of take, mortality and young production in Czempiń hunting grounds.

Foundation stock mortality	25 %		40 %	
Estimated numbers	Min.	Max.	Min.	Max.
Numbers in autumn	7500	8720	7500	8720
CATCH	**2095**	**2435**	**743**	**864**
Foundation stock	5405	6285	6757	7856
Mortality	1351	1571	2703	3142
Remainder	4054	4714	4054	4714
Production (1.7 per ♀)	3446	4006	3446	4006
Numbers in following year	7500	8720	7500	8720

from the sampled area is directly proportional to both the number of hares in each drive and the angle of the regression line of flushing. Consequently, this line will cross the abscissa in about the same point independently from the intensity of flushing animals in consecutive drives. However, the degree of flushing hares can influence to some extent the range of error of the estimated numbers.

Estimating the density of hares by catching with nets is practically possible only in research or in large hunting areas being exploited by catching live animals. In these areas precise estimation of population numbers is critically important in planning the take of animals. This method can give good results by estimating population numbers from first catches in a season. From these data the necessary corrections can be made in the planned take for given year.

The realized production of young on the hunting grounds that are used for catching can also be estimated using the method of Stroh (1931). However, the results seem somewhat biased (Bujalska *et al.*, 1964).

The eight year study of realized young production (Jezierski, unpublished data) indicates big variation of young production from year to year. Data to explain this variation are lacking and consequently, it is very difficult to foresee the production. This is the most serious difficulty in planning the take.

The problem of intensity of foundation stock mortality is not solved in the European hare and there is very little published data on this subject. The calculations of mortality are usually based on very inaccurate data. This is especially true for the estimations of population numbers by zonal taxation. The results obtained in this way are expressed in number of animals per 100 ha but according to Pielowski (1962) this number is not the absolute measure but rather the relative index of population density. Estimation of foundation stock mortality from both the retrapping of marked hares and the balance of population increase and the take yields only approximate results.

Consequently, calculating the extent of catching (Fig. 2) we assumed wide range of this value, from 0.25 to 0.50% of the foundation stock. It is possible to estimate the foundation stock mortality in the areas where the population numbers were precisely estimated in two consecutive years and extensive data on realized young production were collected. The value of take has to be known as well. The lack of information on foundation stock mortality and resulting inability to foresee it are the second basic difficulty in rational planning of the take of hares. Consequently, it is necessary to remember that planning the take is based on considerably simplified model of the balance of increase and losses of population (take and mortality) and it has to assume very conservative parameters of the plan of catching. This is due to still very small precision in making necessary prognoses.

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BADANIA NAD ZAJĄCEM SZARAKIEM. XI. OCENA ZAGĘSZCZENIA POPULACJI I PRÓBA ZAPLANOWANIA ROCZNEGO POZYSKANIA ZAJĘCY

Streszczenie

W grudniu 1964 i styczniu 1965 r. na terenach hodowlano-badawczych Stacji Naukowo-Badawczej PZŁ w Czempiniu (20.061 ha), w czasie gospodarczych odłowów zajęcy przeprowadzonych systemem tzw. pola zamkniętego, całkowicie otoczonego sieciami, zebrano dane dotyczące ilości zajęcy, odłowionych w każdym z czterech kolejnych pędzeń wewnątrz pola. Powyższe dane zebrano dla 20 pól odłowowych (Tabela 1). Łączna powierzchnia tych pól stanowi 11,3% terenów Stacji. Oprócz tego, z innych materiałów Stacji, wzięto dane dotyczące: ogólnej liczby zajęcy odłowionych dla celów gospodarczych w latach 1958/59—1960/61 (8.236 sztuk) oraz w sezonie 1964/65 (3.823 szt.); wielkości zrealizowanego przyrostu młodzieży od samicy w latach 1957—1964 (Tabela 3); ilości zajęcy wypuszczonych na tereny Stacji, po oznakowaniu w latach 1957—1960 (975 szt.) oraz ilości zajęcy oznakowanych i powtórnie odłowionych w latach 1958—1961 (91 szt.); wreszcie szacunku liczebności zajęcy na terenach Stacji w latach 1958—1961, dokonanego metodą taksacji pasowej (około 70 zajęcy/100 ha).

Na podstawie regresji liczby odłowionych zajęcy w kolejnych czterech pędzeniach obliczono liczbę zajęcy, jakie przebywały na terenach objętych sieciami (Ryc. 1) a z tego ogólną liczbę zajęcy (8.110 ± 610 szt.), jakie w okresie jesienno-zimowym znajdowały się na terenach Stacji. Dla zweryfikowania tych obliczeń sprawdzono, że wyłowienie pewnej ilości zajęcy z łowiska w pierwszych próbach nie wpływa na zmiany liczebności zwierząt w następnych próbach. Dokonano tego przy pomocy sprawdzenia (wzory 1 i 2) hipotezy, że jeżeli odłów zajęcy z łowiska nie odbija się na liczbie zajęcy w dalszych połowach, to liczby wyławianych zajęcy na hektar terenu otoczonego sieciami powinny wahać się losowo w całym okresie przeprowadzanych prób.

Stwierdzono również, że nasilenie wyłowu zajęcy z terenu otoczonego sieciami jest tak duże, iż dla celów gospodarczych trzecie i czwarte pędzenie może być już nieopłacalne. W związku z tym stwierdzono, że wyliczenie liczebności na podstawie prostej regresji liczby zajęcy z trzech kolejnych pędzeń daje wynik nie odbiegający istotnie od wyliczenia opartego o cztery pędzenia.

Opracowano wzór (3) dla obliczenia bilansu przyrostu i strat populacji zajęcy w ciągu roku, w którym wykorzystano liczebność populacji w jesieni (N_0), zreali-

zowany przyrost od samicy (a), śmiertelność stada podstawowego w procentach (b) obliczoną w oparciu o zasadę Lincolna z liczby zajęcy oznakowanych, jaka po okresie roku pozostaje w łowisku oraz planowane pozyskanie zajęcy (P). Odpowiednio przekształcony wzór ten (4) może służyć do wyliczenia wielkości pozyskania zajęcy, przy założeniu niezmienności stada podstawowego zajęcy co roku ($N_0 = N_1$). W oparciu o wzór (14) wyliczono krzywe zależności między dopuszczalnym odłowem a wielkością zrealizowanego przyrostu młodzieży od samicy, przy różnym nasileniu śmiertelności stada podstawowego (Ryc. 2), jak również wielkość pozyskania zajęcy (Tabela 4). Zwrócono uwagę na trudność w prognozowaniu wielkości zrealizowanego przyrostu młodzieży wobec dużych rocznych wahań tego wskaźnika i orientacyjnych tylko danych odnośnie wielkości śmiertelności stada podstawowego. Stąd konieczna jest ostrożność przy wyliczaniu wskaźników planu pozyskania zajęcy przy pomocy podanego wzoru, mimo, że jesienne określenie liczebności populacji daje dobre rezultaty.

Zaproponowana metodyka oceny liczebności populacji w łowiskach o gospodarce odłowowej, w połączeniu z badaniem zrealizowanego przyrostu młodzieży, umożliwia wprowadzenie korekty do planu pozyskania zajęcy w pierwszej fazie odłowów każdego sezonu łowieckiego.