

STUDIES ON THE EUROPEAN HARE. XXII.

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Sex Ratio and Weight of Hares in Poland

[With 2 Figs. & 6 Tables]

Studies were made over a period of four years of almost 50,000 hares from different parts of Poland, and their sex and weight ascertained. Results show that the sex ratio during the autumn—winter period is 48.6:51.4 in favour of females. It was also found that hare shooting later in the season is more favourable to the population, as sparing more females. The weight of hares in addition is on an average 110 g higher during this period than at the beginning of the shooting season. The mean weight of hares in Poland increases from west to east by over 1 kg. Maximum weight may be as much as 7 kg.

I. INTRODUCTION

The paper presented here forms part of the complex research work on the European hare initiated by the Institute of Ecology, Polish Academy of Sciences, in 1956. The purpose of the work was to obtain data, based on comprehensive material from the whole of Poland, on such elements of the ecological structure of hare populations as age composition, sex ratio and the physical condition of individuals. Even at that time the theoretical assumption had been put forward (Andrzejewski & Pielowski, 1957) that, in addition to factors such as habitat and biocenosis, the population structure exerts a considerable influence on the course taken by such basic population processes as reproduction and mortality, which in the final effect shape the dynamics of population numbers. Information on some of the structural elements may form a starting point for future, more detailed investigations, enabling us to get closer to the problem of planned management of population processes in the direction most advantageous to us. In the case of the hare this would, of course, primarily be the question of increasing the biological productivity of populations.

Such investigations may, however, be additionally useful in hunting practice, supplying data from the whole of Poland on variations in weight of hares depending on the geographical region, year, shooting season *etc.* In view of the fact that hare populations are strongly influenced by man who, by shooting or catching a considerable percentage of all individuals, interferes considerably in the structural relations of the population, the correct establishment of the extent of such interference may be of considerable importance in rational utilization of the productivity of hare populations.

II. MATERIAL

Investigations were carried out in 1958, 1961, 1962 and 1963 in the game purchasing centres of ten voivodships, chosen from the total number of 17 voivodships in Poland. When making this choice attention was paid primarily to ensuring that the chief geographical, physiographical and climatic regions of Poland were represented (Fig. 1).

The principal drawback in examining mass material obtained from shoots only after the kill has reached the purchasing stations, and not immediately on the site of the shoot, is the lack of certainty as to whether the data obtained there are fully reliable, *i.e.* can they be considered as a reliable »sample« of the population, such as formed by the full range of hares from a shoot. The material

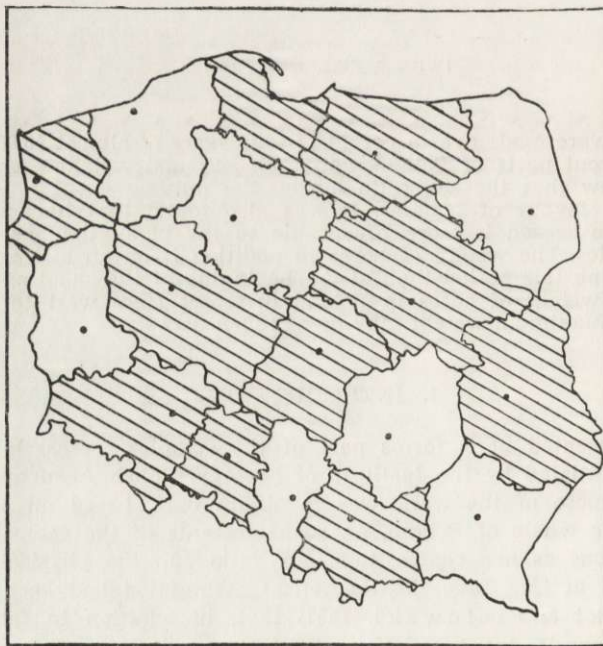


Fig 1. Map showing areas (shaded) from which the material used for studies was taken.

available in purchasing stations is a collection of animals which have already been sorted to some extent, since the members of the shoot take some of the hares home for their own use directly after the shoot ends. While it can be assumed that this selection is fortuitous in so far as sex is concerned, it is certain that the picture of the occurrence of different weight classes in the material, and in consequence also the mean weight of hares in the whole sample, is distorted. It can, however, be assumed with a fairly great degree of likelihood that this error will be identical in the whole material, since the hares chosen by members of the shoot will as a rule be large and wellgrown hares.

The plan was to examine 1,600 hares, in parties of 400 hares, every two weeks, beginning with the first half of November and ending in the second half of De-

Table 1.
Numbers of hares examined in different voivodships, divided into years and half-monthly periods.

Voivodship	1958						1961						1962						1963					
	Nov.		Dec.		Total	Nov.	Dec.		Total	Nov.		Dec.		Total	Nov.		Dec.		Total					
	I	II	I	II			I	II		I	II	I	II		I	II	I	II						
	I		II		I		II		I		II		I		II		I		II					
Poznań	—	—	798	300	1098	400	400	400	400	1600	400	400	400	400	1600	400	400	400	400	1600				
Szczecin	—	—	—	—	397	400	400	400	400	1600	400	400	400	400	1600	400	400	400	400	1600				
Gdańsk	—	—	—	—	—	400	400	400	400	1600	—	800	—	800	1600	400	400	400	400	1600				
Wrocław	—	—	—	118	918	160	840	—	600	1600	400	400	400	400	1600	160	240	800	400	1600				
Opole	—	—	—	—	—	400	400	400	400	1600	400	400	400	400	1600	400	400	400	400	1600				
Kraków	—	—	—	1000	1778	400	400	400	400	1600	400	400	400	400	1600	—	—	—	—	4978				
Łódź	—	—	—	—	—	326	838	520	—	1684	400	400	400	400	1600	—	—	—	—	3284				
Warszawa	—	—	—	710	1463	400	400	400	400	1600	400	400	400	400	1600	—	800	400	400	1600				
Lublin	—	—	—	700	1500	400	400	400	400	1600	400	400	400	400	1200	400	400	400	400	1600				
Olsztyn	—	—	—	—	203	320	280	400	600	1600	120	160	360	600	1240	—	—	—	—	3043				
Total	—	3931	798	2828	7357	3606	4758	3720	4000	16084	3320	4160	4360	3400	15240	2160	3040	3200	2800	11200	49881			

ember, each year during the hare shooting season, in each of the 10 voivodships. In practice, however, it proved impossible to achieve this for various reasons. This applies particularly to the first study year, *i.e.* 1958, when as the result of technical difficulties it only proved possible to examine less than half the planned number of hares, and even then not at the intended intervals of time. On this account and on account of the two-year interval which took place during research work, the material from 1958 must be treated as a guide only.

During the whole study period almost 50,000 hares were examined (Table 1) which appears to be sufficiently comprehensive material to allow of drawing reliable conclusions. The sex, age (one year old or older) and weight were examined in respect of the dead hares supplied by the guns. Examination of a fixed number of hares in each of the stations took place according to the principle of random choice. The aim was to examine every fifth animal out of all the hares hanging in the stores of the purchasing station. Rigorous adherence to this condition was not always possible for technical reasons.

Sex was determined on the basis of inspection of the external genital organs, which is a sufficiently accurate method. The basis for estimating age in different hares was the basal thickening on the ulna (Stroh, 1931). As shown by later studies on the suitability of this character in identifying age, it is not an absolute character during the hare shooting season (Rieck, 1962; Bujalska *et al.*, 1965), particularly when examination is only superficial and inexact, which is unavoidable when identification is carried out by not one person, but by different people.

Body weight was determined by means of a decimal balance, using divisions of every 0.5 kg. This small degree of exactitude in the measurements was dictated by technical considerations.

III. SEX RATIO

The sex ratio found was subject to certain fluctuations in different years, sometimes in favour of females, and sometimes in favour of males (Table 2). This would not appear to be connected, as Hell (1964) states, with a »bad« or »good« hare year, that is, with a complex of factors exerting a certain definite effect on the dynamics of population numbers in a given year. When the results from the different voivodships are analysed it is easy to see that the sex ratio is very variable in each year, not exhibiting any regularity in its distribution, which forms evidence of a certain degree of fortuitousness in the results obtained from investigations, even with series of approximately 1,600 hares yearly in each purchasing centre. The observed tendency for numerical preponderance of male animals to be evident in the distribution from voivodships representing areas richest in hares (Poznań, Wrocław, Opole) merits attention.

Yet another regularity is interesting, and also of some importance in hunting practice. During shoots arranged at the beginning of the shooting season 2.6% more females are shot, taking the whole of Po-

land into consideration, than at the end of the season. The greatest differences, amounting to 5% and upwards, occur in the east and north-east regions of Poland (Table 3). This can be explained by the different reaction of individuals of the two sexes to shooting as such carried out at different periods. With the one method permitted in Poland for hare

Table 2.

Percentage of male hares in different voivodships.

Voivodship	1958	1961	1962	1963	Total
Poznań	48.5	50.2	57.6	50.6	50.9
Szczecin	—	50.9	48.7	45.2	48.4
Gdańsk	—	50.0	38.1	44.2	39.9
Wrocław	39.9	53.6	54.3	53.5	51.6
Opole	—	53.1	66.8	51.6	57.2
Kraków	50.5	48.4	45.9	—	48.4
Łódź	—	45.4	48.3	—	46.8
Warszawa	44.7	46.3	51.7	54.8	49.5
Lublin	44.1	46.0	45.5	51.5	46.9
Olsztyn	—	50.4	43.8	—	47.5
Poland	46.3	49.4	51.0	50.2	49.3

Table 3.

Difference in percentage of females in kills from the beginning of the shooting season (Nov. 1—15th) and the end of the shooting season (Dec. 16—31st).

Voivodship	%
Poznań	+ 5.7
Szczecin	+ 3.6
Gdańsk	+ 1.7
Wrocław	- 3.9
Opole	- 2.0
Kraków	+ 1.4
Łódź	+ 2.6
Warszawa	+ 5.0
Lublin	+ 4.0
Olsztyn	+ 8.2
Poland	+ 2.6

shooting — that is — shoots with beaters, a large percentage of individuals are able to escape from the guns, and these individuals, depending on the way they react to the actual shooting operations themselves, may escape to the side or run through the line of beaters to the rear. This indicates that shoots later in the season are more favourable to the head of hare.

IV. BODY WEIGHT OF HARES

When analysing material from different years it can be seen that with numbers of about 15,000 hares examined yearly, the mean weight of an individual varies only slightly (Table 4). It must be borne in mind here that this mean value is characteristic of Poland as a whole, which of course includes many different geographical regions. In different voivodships differences in weight are as much as 0.5 kg, which may indicate that local factors are of no slight importance. It would however seem that factors common to the whole of Poland also affect weight. In 1962, for example, an increase in the mean body weight of hares was found in all the voivodships. On the other hand in 1958 in the east of Poland weights were maintained below the mean values for four years, whereas in the west and south voivodships a marked increase in weight was noted. This last phenomenon has already been elucidated (Pielowski, 1962).

Table 4.
Mean weight of hares in different years — given in kg.

Voivodship	1958	1961	1962	1963	Avg. 4 years
Poznań	3.63*	3.32	3.41	3.43	3.39
Szczecin	3.62**	3.54	3.74	3.86	3.71
Gdańsk	—	3.73	3.87	3.56	3.72
Wrocław	4.14	3.35	3.87	3.70	3.76
Opole	—	3.67	3.77	3.64	3.69
Kraków	4.05	3.82	3.82	—	3.90
Łódź	—	3.89	4.02	—	3.95
Warszawa	3.68	3.89	4.03	3.83	3.86
Lublin	3.82	3.91	4.19	3.94	3.96
Olsztyn	—	4.30	4.52	—	4.41
Poland	3.82	3.74	3.92	***	3.83

* — Dec. + Jan.; ** — Nov.; *** — Average weight was not calculated on account of incomplete data.

A regular phenomenon is the gradual increase in the mean weight of hares from west to east. Extreme differences exceed 1 kg. The weight of the most numerous weight class (over 30% of the individuals) increases from 3.1 — 3.5 kg in the west to 4.6 — 5.0 kg in the east (Fig. 2). Maximum weight increases analogically. The range of body weight of different individuals is fairly wide and may be as much as 4 kg. The maximum breadth of range occurs on the east borders, where it is possible to encounter in kills individuals weighing less than 2.5 kg and over 6.5 kg. The lowest weight classes (2.5 kg and

2.6—3.0 kg) are represented in all voivodships. These are almost entirely not fully grown individuals.

A striking phenomenon is that the minimum mean weight (3.39 kg) occurs in the Poznań voivodship, situated in the same geographical longitude as the Szczecin, Wrocław and Opole voivodships, in which this mean value is approx. 3.70 kg. This may be connected with the fact that optimum hare areas for Poland, with relatively numerous head of hare, are situated in the Poznań voivodship.

The determinations made of differences in mean weights of hares shot at the beginning of the shooting season in Poland, *i.e.* during the first half of November and towards the end of the season, *i.e.* in the second

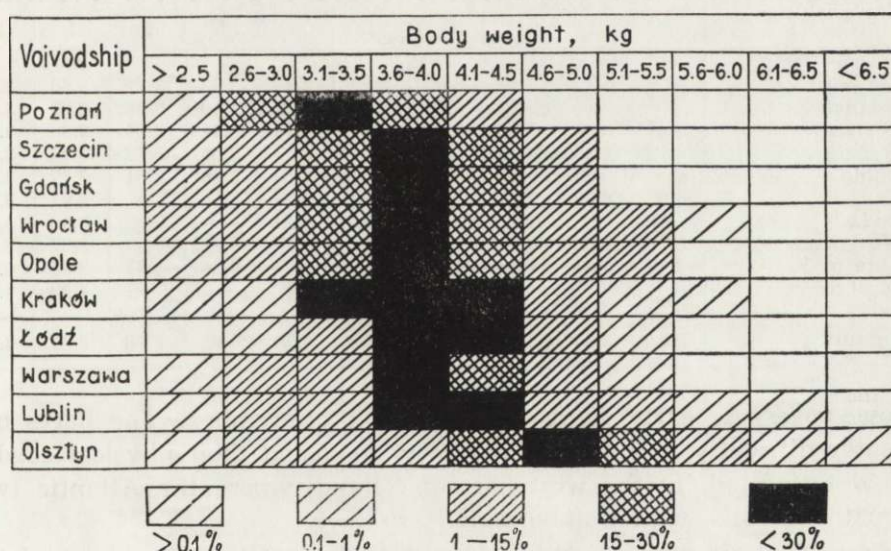


Fig. 2. Variations in the body weight of hares in different voivodships jointly for the years 1958, 1961—1963.

half of December, may be useful in hunting practice. These differences are 110 g for material from the whole of Poland. With annual yield in Poland of about 500,000 hares shooting too early in the season would cause on a national scale the loss of about 20 tons of valuable hare meat annually. The above differences in weight of hares are greatest in the Poznań voivodship where they are more than 300 g. This phenomenon occurs every year (Table 5). This is probably connected with the large percentage in kills of young hares which at the start of the season are not yet fully grown. Szederjei (1959) reached a similar conclusion on the basis of his studies in Hungary. He states that the mean weight of hares in autumn is the lower, the greater the natural increase in

a given year. In »bad« hare years more old hares are shot, and as a result the mean weight per individual is higher.

This is, however, not always the case. In 1961 in the central and east voivodships the mean weight of hares shot in autumn was higher than the weight of hares shot towards the end of the season (Table 5). One of the causes of this phenomenon may have been the early start of winter that years, in which the ground was covered by a fairly thick

Table 5.

Weight of hares at the beginning (1) and towards the end (2) of the shooting season.

Voivodship	1958		1961		1962		1963		Avg. 4 years	
	1	2	1	2	1	2	1	2	1	2
Szczecin	3.62	—	3.49	3.63	3.62	3.88	3.93	3.77	3.68	3.76
Gdańsk	—	—	7.70	3.90	3.97	3.78	3.40	3.66	3.69	3.78
Poznań	3.54	3.88	3.30	3.63	3.42	3.60	3.07	3.94	3.33	3.76
Wrocław	4.12	4.26	3.32	3.41	3.79	3.87	3.65	3.72	3.72	3.82
Opole	—	—	3.63	3.69	3.77	3.76	3.86	3.51	3.77	3.65
Kraków	4.00	4.09	3.95	3.75	3.77	3.85	—	—	3.91	3.89
Łódź	—	—	3.96	3.86	3.83	4.09	—	—	3.90	3.98
Warszawa	3.70	3.66	3.92	3.88	4.03	4.03	3.76	3.87	3.87	3.87
Lublin	3.70	3.95	3.96	3.88	4.36	4.17	3.89	3.97	3.98	3.99
Olsztyn	—	—	4.04	4.57	4.42	4.57	—	—	4.23	4.57
Poland	3.81	3.97	3.73	3.82	3.90	3.96	3.65	3.78	3.77	3.88

snow cover as early as the beginning of December. The hares had greater difficulty in obtaining access to food and their physical condition deteriorated. In the west part of Poland, where the Atlantic type climate prevails, winter did not start so early.

As a whole it may be said, however, that from the standpoint of the productivity of hare population, shoots are more profitable in the second half of December and beginning of January, when the weight of hares is greatest. Andrzejewski & Pucek (1965) reached the same conclusion on the basis of material collected by Caboń-Raczyńska (1964).

V. DISCUSSION

The majority of researches express the conviction that in natural hare populations the sex ratio of males to females is 1:1 (Andrzejewski & Pielowski, 1957; Hell, 1960, 1964; Jezierski, 1959, 1965; Koenen, 1956; Pielowski, 1959, 1962; Rieck, 1956a; Szedrzej, 1958, 1959). In a certain sense an isolated standpoint is adopted here by Petrov (1963), who on the basis of his own investigations

concludes that a certain predominance of females occurs in nature, dating from the embryo stage (32:68), but which the passage of time gradually evens up to the ratio of 48:52 in hares more than one year old. The value of this finding is reduced by the fact that R a c z y ń s k i (1965) found that in 145 embryos the ratio of males was 52%. In order to obtain fully reliable data on this otherwise extremely interesting problem, it would be necessary to examine embryos from large series of pregnant females, which in practice would be very difficult to carry out. All data on sex ratio in hares based on mass investigations are of necessity obtained from the autumn—winter shooting season, that is from the period when hare populations are in principle composed of adult individuals only. Some authors draw attention in this connection to the documented fact that depending on the way the hares are obtained, we in effect receive a picture of the sex structure of populations which may be slightly distorted (S z e d e r j e i, 1959; H e l l, 1960, 1964; P i e l o w s k i, 1962).

In order more fully to illustrate the extent of our knowledge of the sex ratio in hares, data on this subject have been collected from available literature and set out in Table 6. In all, in different countries of Europe during the last 15 years, nearly 180,000 hares have been examined, which were obtained by various methods of hunting and catching. In all cases it was found a slight predominance of females or the ratio 1:1. Greater deviations from a balanced ratio were noted only when small series of hares were examined, which would suggest that the result is random in character. The sex ratio, calculated for the whole material together with the data given in the present study, is expressed in percentages as 48.6:51.4 in favour of females. There is thus no doubt that slightly more females than males are obtained every year, which in a certain sense contradicts all statements as to balanced sex ratio which is in fact also based entirely on analyses of kills (shoots) or captures.

If it were a question of the selective effect of obtaining hares (this opinion was published several years ago by P i e l o w s k i, 1962) then although this percentage is small, it must with the passage of time have led to serious disturbances in population structure. We have not yet found anything of the sort. Hence the conclusion that there is a certain predominance of females in the autumn—winter hare populations. H e l l (1964) is also of the same opinion. The question as to whether the predominance of females is a specific character in hares, which assumption would appear very unlikely, or whether intensive reduction of males occurs during the first months of life, remains open. For the purposes of hunting practice this slight predominance of

Table 6.
Sex ratio of hares according to literature data.

Authority — country	Years of investigations	Number of hares examined	Way in which hares were obtained	Sex ratio in %	
				♂	♀
Hell, 1960 — Czechoslovakia	1957	1,671	Shooting — in drives	41	59
	1958	452	Shooting — different	46	54
	1957—1958	5,359	Captures	50	50
Hell, 1964 — Czechoslovakia	1957—1962	11,729	Shooting — in drives	48	52
		16,969	Captures	49	51
Jezierski, 1965 — Poland	1957—1962	17,516	Shooting with beaters	50	50
Petrov, 1963 — Bulgaria		4,310	Shooting	47	53
Rieck, 1956 — German Federal Rep.	1953	970	Shooting	44	56
		1,018	Shooting	47	53
Raczyński, 1965 — Poland	1958—1960	765	Individual shooting over whole year	52	48
Szederjey <i>et al.</i> 1959 — Hungary	1949	21,583	Shooting — different	47	53
		40,000	Captures	49	51
Pielowski, unpubl. — Poland	1953, 1966, 1967	6,058	Captures in enclosed squares	47	53
Pielowski — Poland	1958, 1966, 1963	49,881	Shooting with beaters	49	51
Total		178,280		48.6	51.4

females among adult hares is not important and a balanced sex ratio can be accepted in calculating the annual increase in the head of hares.

The problem of body weight of hares during the shooting season is important not only on account of the mass of game which sportsmen supply to the market in the form of shot hares. Another aspect is also important here, namely body weight as an expression of the animal's physical condition. From the standpoint of the hare population as a whole this problem can be placed in yet another plane, assuming that the mean weight of an individual is to some extent characteristic of the physical state of the whole population. Longterm comparative data could supply interesting material on this.

Interesting data on this subject have been published by Petrov (1964), who found that in Bulgaria the mean weight of hares differs depending on the physiographical region, altitude above sea level, character of the habitat and density of settlement. Further this author's material shows that in different years the mean weight of hares undergoes considerable variation, reaching the figure of 0.75 kg for the years 1957—1960. This last regularity is confirmed by the study made by Hell & Farkas (1962). These data correspond closely with the results of the present study.

The scope of the conclusions drawn in this study would have been significantly increased if it had been possible to compare and correlate the weight and age of larger groups of hares. Many authors have in fact made this type of analysis, and obtained interesting results (Rieck, 1956; Hell & Farkas, 1962; Pielowski, 1962; Petrov, 1964). In the light of the most recent investigations (Rieck, 1962, 1965; Bujalska *et al.*, 1965) identification of the age of hares by the method in general use known as Stroh's method (Stroh, 1931), does not guarantee full reliability, particularly when the presence of the epiphyseal cartilage on the ulna is established only by feeling one of the fore legs of the hare through the skin. My own investigations showed that during the hare shooting season the basal thickening had either already disappeared or is still perceptible on one leg only in some of the hares less than one year only. Probably the ossification of the epiphyseal cartilage does not always take place evenly on the two front legs. It would be necessary to feel both fore legs in order to obtain more reliable findings. Nevertheless the phenomenon of the disappearance of this cartilage at the age of 8—10 months in principle eliminates the usefulness of this method for mass identification of the age of hares during the shooting season. In January 1966 1,200 live hares were examined, and it was found that at the beginning of January the thickening was still clearly perceptible in about 50% of all young in-

dividuals and by the end of the month this number was reduced to 25%. Rieck (1965) obtained similar results when he stated that in mid-January only 25—50% of the young hares shot can be recognized as such. On this account data on the age of the hares examined have been omitted from the material described in the present study.

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STOSUNEK PŁCI ORAZ CIĘŻAR ZAJĘCY W POLSCE

Streszczenie

W latach 1958, 1961, 1962 i 1963 przeprowadzono w punktach skupu dziczyzny 10 województw, reprezentujących główne regiony geograficzne Polski, badania dostarczonych tam przez myśliwych zajęcy. W sumie przebadano prawie 50 tysięcy sztuk. U wszystkich tych zajęcy określono płeć oraz ciężar ciała.

Przy ustalaniu stosunku ilościowego płci sięgnięto obok własnych materiałów także do dostępnych w literaturze danych na ten temat. W sumie uzyskano w ten sposób dane o przeszło 178.000 zającach, pozyskanych przeróżnymi sposobami w wielu krajach Europy. Stwierdzono, że w okresie jesienno-zimowym w populacjach zajęcy występuje pewna przewaga samic wyrażających się stosunkiem jak 48,6:51,4. Dla celów praktyki łowieckiej postuluje się jednak przyjęcie stosunku jak 1:1.

Jeżeli chodzi o ciężar zajęcy, to stwierdzono, iż wzrasta on w Polsce od zachodu ku wschodowi o przeszło kilogram. W różnych latach średni ciężar zajęcy waha się tylko nieznacznie. W poszczególnych częściach kraju wahania te dochodzą jednak do 0,5 kg, co świadczy o silnym wpływie czynników lokalnych. Dalej ustalono, że późniejsze w sezonie polowania są korzystniejsze dla pogłowia zajęcy, gdyż bardziej oszczędzają samice. Różnice udziału samic w rozkładach z polowań na początku sezonu i pod jego koniec wynoszą 2,6%. Również ciężar zajęcy jest wyższy w późniejszym czasokresie średnio o 110 g, co w skali krajowej oznacza utratę około 20 ton dziczyzny. W niektórych latach w niektórych częściach kraju różnice te są jeszcze znacznie wyższe. W części centralnej i wschodniej kraju występuje w latach o bardzo wczesnej zimie zjawisko odwrotne. Zające pozyskane później są lżejsze od pozyskanych na początku sezonu. W sumie jednak z punktu widzenia uzyskanej masy dziczyzny, korzystniejsze są polowania przeprowadzone w drugiej połowie grudnia i na początku stycznia.