Monitoring of hunting resources: population-based approach

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Abstract. It is recognized that the objects of the hunting economy are populations of game animals. However, there is no term “population” in current Russian legislation, the undefined expression “hunting resources” is used instead. The monitoring of the hunting resources status is currently limited by regulatory documents only to the analysis of materials based on the winter route census (WRC). This is insufficient to establish the nature of population dynamics, acquire knowledge about population cycles in different populations, and collect the data on the qualitative composition of populations and their changes over time. For hunting providers, simple methods of collecting and processing material on the qualitative composition of populations are offered. They can be carried out both during the hunting season and during the purchase of products from hunters. Systematic observations and analysis of the obtained materials will allow accumulating knowledge about a specific exploited population. Hunting providers should use different methods of registration of hunting animals to monitor exploited populations. To control registration, state game wardens can use the WRC. The state control should proceed from the confidence in the results of the registration work of hunting providers since they are those interested in the long-term use of hunting resources.

1. Introduction
Currently the results of winter route census (WRC) are predominantly used in game management (ipso facto in practical population ecology) both in Siberia and in Russia to monitor the populations of mass species of fur animals (squirrel, sable, etc.).

The consequences of the “vertical of power” developed in Russia throughout the past years have penetrated all political, social, and industrial spheres of life, including the hunting economy. This is reflected in the low quality of the management apparatus, which is primarily interested in achieving a number of formal indicators. “…the criteria for successful implementation of changes by the lower layers of the power vertical are reduced to a number of formal quantifiable indicators. The formalization of these requirements to some extent aims to reduce excessively high agency costs within the framework of the power vertical” [1].

In the last century, during the period when the state was the only seller of furs, it was bound to establish scientific structures to track the status of hunting animal populations. This was needed to make forecasts of fur harvesting and possible volumes of fur sales at auctions. One of these structures was Research Institute for Game Management and Fur Farming named after prof. B.M. Zhitkov (VNIIOZ). The Institute’s tasks comprised collecting data on the status of populations across the country through a network of 14 branches. They provided information on fur harvesting by regional hunting enterprises. In addition, each branch had several biological research stations, where scientific...
research was carried out, and the collection of biological materials for the analysis of qualitative indicators of populations (sex and age composition, some phenotypic markers – tail color, etc.) was organized. Moreover, hunting providers supplied animal carcasses (mainly sable) in large quantities for the same purposes by the agreement with the branches of the Institute. Several indicators were also determined at furs base depots: the occurrence of skin disease in sables, the quality of pelts of sables, squirrels, and other species (grade, the presence of pigmented spots). As well as now, each hunting enterprise provided a report on the census of hunting animals. Researchers also carried out census at biological research stations, which allowed, if necessary, to introduce corrections for errors of hunting providers and monitor their performance of animal census in identical lands.

On the basis of the collected data, forecasts of the animal numbers and potential volumes of purchases by region were made. The government could predict the volume of sales of fur products and plan the development of the industry.

Notably, WRC was not the main element of the monitoring of hunting animal populations since the records were carried out mainly by the area method. The WRC was developed precisely for large territories (at the level of a federal subject) with a number of routes that allowed getting data on the number of animals and, if necessary, adjusting the data received from hunting providers.

This means that contemporary state monitoring system should provide the determination of animal numbers by several methods. Such a comprehensive analysis should produce an unbiased assessment of the status of hunting resources for the region in general and, accordingly, for each hunting enterprise. This holistic approach which employed several methods of determination of animal numbers was logical in the conditions of planned economy. However, it is even more logical in the market economy, where the level of uncertainty is quite high. Production quotas should be elaborated on the basis of this particular indicator of animal numbers with due consideration of other population parameters [2].

Currently, there is no scientific support for the development of the industry to the extent required. At the same time, the qualifications of the staff of hunting providers in most cases allow to properly collect and analyze materials on the status of populations of exploited animals. In this regard, it seems necessary that practicing game managers in enterprises can use simple methods to obtain qualitative characteristics of populations for more accurate forecasting of their status for subsequent effective exploitation.

2. Data and methods

First, the hunting enterprises staff should understand what they are dealing with. The theoretical basis of the game management is population ecology, while the primary object of hunting and trapping are the populations of hunting animals, not simply the representatives of the exploited animal species. According to the Member of the Academy of Sciences S S Shvarts [3, 4], game management has the greatest experience of targeted influence on the number of hunting animals.

Most definitions of the concept of “population” include the recognition that it is the system, which has a structural and functional unity, with the necessary exchange of genetic information between individuals that make up the population. The population has a set of properties that ensure its independent existence for a long period of time [5].

Earlier, B K Pavlov [5] showed that panmictic unity in the population of Eastern Sayan squirrels (maximum mixing of its gene pool) is carried out during the phase of depression of a population and during the first year of recovery. Over the course of the breeding season, data were obtained by tracking method and by registering the intersections of tracks on a frequent grid of transects. The data showed that it was during these periods that the radius of individual activity of squirrels was the largest for the entire cycle period.

Each population has its own population dynamics, developed in the process of the long-term evolution of habitation in a certain territory with a specific set and combination of abiotic and biotic factors.
The study was carried out in the period from 1975 to the present on the territory of the “Menza” biostation in the Khentei Chikoysky upland (the Southwest of Transbaikal Territory).

The collection of information on the qualitative characteristics of the population (sex, age composition, fertility of females in the past season, some phenotypic signs, the quality of pelts) is possible both during hunting in the taiga and at the place of purchase of furs.

Thus, the information on the sex and age ratio can be determined using the purchased pelts. The skin of young fingerling squirrels is distinct from adults’ skin by a noticeably smaller thickness and stiffness to the touch. The sex is usually easily determined.

The presence of a significant number of squirrel skins with pigmented spots (a consequence of fights between animals) indicates a high population density. Most often, individuals in squirrel populations with different tail colours are represented by brown-tailed, red-tailed, and black-tailed subjects. Their ratio in the population varies from year to year. In particular years it can serve as an indicator of the population level. An additional ossicle on the skull can also serve as an indicator of population level. It is shown that its high proportion of occurrence is specific for the year before the peak of the animal numbers in the dynamics of the population.

After receiving data on the age composition, it is possible to get the evidence about the intensity of reproduction in the population in the past season. To do this, the number of all young animals should be divided by the number of adult females (which gave birth). Through this, the indicator of the output of young animals per adult female (which gave birth) is acquired. It varies from year to year. In the years of low level of animal numbers in the Chikoy population of squirrels, it is 1.1 pcs/female (1982), and in the years with a high level of animal numbers – 9.8 pcs/female (1984). In the Sayan population, this indicator ranges from 1.7 pcs/female to 10.2 pcs/female, respectively [5]. In both populations, the size of single fertility, determined by dark spots in the uterus at the end of the breeding season, ranges from 5.0—6.0 pcs.

Information about the additional ossicle, sex and age composition, and fertility can be collected during the hunting season on the spot by hunters with minimal skills. After the removal of the skin, the additional ossicle usually is clearly visible on the bare skull (figure 1).

![Figure 1. The location of the additional ossicle on the skull of squirrels (the upper row, right skull – circled by an ellipse).](image-url)
The uterus bicorn is of females is located under the bladder. It must be taken out, stretched on a piece of paper, and viewed against a light source. Dark spots will be visible in the places where the embryos were attached through the placenta. If they are of different brightness, this may be the trace of two pregnancies (two litters). The size of the genitals can also be used to separate the squirrels into young and adults. For example, if the diameter of the base of the penis of the male squirrel is 6 mm or more, it is referred to as an adult, if less – as young.

The age of females can be determined by the thickness of the uterus (some adult females may be bachelor), in young it is filamentary.

Since the abdominal space is opened during the previous operations, it is possible to determine the fatness of animals and the contents of the stomach, which is also an important indicator for determining the status of the population.

3. Results and discussion

The results of reproduction in the population can be traced by the data on the number of dark spots in the uterus, by the size of the output of young per adult females (which gave birth), as well as by the proportion of females that were bachelors (table 1).

The analysis of the indicators in this table allows concluding about the complex processes in the population during the breeding period, expressed in the changes of animal numbers. The spring population density is determined by the results of the WRC. Considering that in 1981–82 this density was almost the same (due to the very low winter mortality in the population), we can expect the pre-harvest population animal numbers to be the same for both years as well according to the existing requirements for calculating the pre-harvest population for the next season.

| Years | Population density in spring pcs/1000 ha | Traces of spots in the uterus, pcs | Output of young per one female (which gave birth), pcs | Output of young per one adult female, pcs | Share of bachelor females, % | Population density in autumn pcs/1000 ha |
|-------|----------------------------------------|-----------------------------------|--------------------------------------------------|---------------------------------|-------------------------------|--------------------------------------|
| 1981  | 140                                    | 5.8                               | 6.3                                              | 6.3                             | –                             | 650                                  |
| 1982  | 130                                    | 5.9                               | 2.9                                              | 1.3                             | 65.0                          | 150                                  |
| 1983  | 60                                     | 6.8                               | 3.9                                              | 3.9                             | 0                             | 240                                  |
| 1984  | 90                                     | 8.3                               | 13.1                                             | 10.2                            | 27.0                          | 350                                  |
| 1985  | 70                                     | 7.0                               | 6.9                                              | 6.7                             | 2.6                           | 250                                  |
| 1986  | 90                                     | 6.0                               | 6.9                                              | 6.8                             | 0.2                           | 310                                  |
| 1987  | 120                                    | 6.3                               | 8.4                                              | 4.5                             | 46.4                          | 260                                  |

However, the analysis shows that the size of the output of young per adult (which gave birth) female and a significant proportion of bachelor adult females does not allow to expect the equality of results in this years. Therefore, the same population density at different phases of the population cycle (for example, peak and depression) will lead to different level of numbers. This should definitely be taken into account when monitoring the population.

Any population of animals in its dynamics has fluctuations in the number, which in the majority of cases are cyclical. At the same time, the population has developed several cycles in the process of evolution in order to respond to changes in environmental factors with different time durations. For example, for squirrels of the Chikoy population, the most significant population cycles have durations of 3.4 years and 23.2 years [6].

4. Conclusion
Insufficient scientific support for the hunting industry and the use of a limited number of tools for monitoring hunting animal populations does not allow us to speak with confidence about their correct exploitation.

It seems necessary to improve the legislation and consider it mandatory to move to a more democratic form of relations between management and control bodies and hunting providers in the field of the use of hunting resources. After the collapse of state-led economy and the restructuring of the hunting industry of Russia, hunting providers, on the basis of two articles of the federal law “On the Animal World”, with minimal participation of the authorities, were able to recreate a hunting industry in the new economic conditions. Total distrust to the activities of hunting providers on the part of the state is unjustified because it is the hunting providers who are interested in their long-term activities, which can only continue with the competent exploitation of resources, including the use of tools for the monitoring of the status of populations. Hunting providers and hunters should not pay for mistakes and shortcomings of the methodological support of the industry on the part of management and control bodies.

In this regard, it is possible and necessary to supply hunting providers with the opportunity to use different methods for determining the number of animals, namely: obtaining information from hunters and drawing up a map of the distribution of animal tracks mapping the data of the survey of hunters, counting of input and output traces on the site, counting tracks on routes (WRC), if necessary. At the same time, the staff of the hunting enterprises should participate in the field registration of animals. The qualitative characteristics of the population (sex and age composition, breeding data, the proportion of different phenotypes as markers, physiological indicators of animals, etc.) can be reflected in the annual reports on the animal numbers prepared by hunting providers. This data can be considered when calculating the autumn animal numbers and the status of the population for the next hunting season.

It is mandatory to consider the conduct of the WRC by game wardens. They can control the registration work, made by hunting providers, determine its quality and adjust the accounting data in their area.

Acknowledgments
The work was carried out in accordance with the State task for project of Basic research Programs of SB RAS, state registration number 121032200126-6.

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