Главные редакторы: Виктор Г. Сычёв и Лотар Мюллер

НОВЫЕ МЕТОДЫ И РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЙ ЛАНДШАФТОВ В ЕВРОПЕ, ЦЕНТРАЛЬНОЙ АЗИИ И СИБИРИ

Монография в 5 томах

Том III Мониторинг и моделирование ландшафтов

В содружестве с Академией почвенного плодородия Митчерлиха (МИТАК), Паулиненауэ, Германия

Москва 2018
Main editors: Viktor G. Sychev and Lothar Mueller

NOVEL METHODS AND RESULTS OF LANDSCAPE RESEARCH IN EUROPE, CENTRAL ASIA AND SIBERIA

Monograph in 5 Volumes

Vol. III Landscape Monitoring and Modelling

With friendly support of the Mitscherlich Academy for Soil Fertility (MITAK), Paulinenaue, Germany

Moscow 2018
ISBN 978-5-9238-0249-8 (Том 3)

Коллектив авторов и редакторов под руководством В.А. Романенкова (Москва), А.Х. Шеуджена (Краснодар), Л. Мюллера (Мюнхеберг).

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This monograph shall inform you about up to date methodologies and recent results in landscape research. It is intended as a guide for researchers, teachers, students, decision makers, stakeholders interested in the topic of landscape science and related disciplines. It provides information basis for decision makers at various levels, from local up to international decision bodies, representing the top level of landscape science in a very short form.

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ISSN 978-5-9238-0246-7
ISBN 978-5-9238-0249-8 (Том 3)
DOI 10.25680/1490.2018.71.71.003

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Chapter III/35: POPULATION-ECOLOGICAL, MORPHOLOGICAL AND GENETIC CHARACTERISTICS OF WILD REINDEERS IN WEST TAIMYR

Глава III/35: Популяционно-экологическая, морфологическая и генетическая характеристика диких северных оленей Западного Таймыра

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DOI 10.25680/5591.2018.25.46.228

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ABSTRACT. In the conditions of increasing influence of anthropogenic factors on wild reindeer population of Western Taimyr and their habitat, a reduction of the census size, a decrease in reproductive capacity, a change in spatial distribution and calving sites, and negative tendencies in sex and age structure are observed. Currently, this population is characterized by a relatively high level of genetic diversity, which indicates its good adaptation to the environment. However, the continuing impact of these factors on this population and its habitat can cause a decrease of its census size to a critical state (up to complete extinction) and loss of unique genes, which negatively affects the level of genetic diversity
INTRODUCTION
Large-scale industrial development of the northern territories within the range of the Taimyr population of wild reindeer influenced the change in the migration routes of animals and their spatial distribution, and as a result, the formation within the population of groups with their places of calving and wintering. It is again this background, large-scale poaching of the Taimyr population has intensified rangewide, which has become one of the main eliminating factors in the last few years [1, 2]. The purpose of the research is to characterize the ecological, morpho-physiological and genetic characteristics of wild reindeer in Western Taimyr, which will serve as a basis for further development of recommendations for sustainable conservation, reproduction and rational use of species resources.

MATERIAL AND METHODS
The investigations were carried out in the area of the Taimyr population of wild reindeer in the Western Taimyr on the area of about 300,000 km². Surface observations were conducted according to generally accepted methods of ecological studies [3]. The age of the animals is determined by the layered structure of the incisors of 5984 yearlings. It was examined and processed (sex ratio, fecundity) in the spring -157, in the autumn -517 individuals, the sex was revealed in 67 fetuses at the last stage of development. 1617 deer were processed by the method of morpho-physiological indicators [4, 5]. Genetic studies were carried out on samples of the Taimyr population selected during the expeditionary surveys in various geographical regions of Western Taimyr (n = 57), using microsatellite markers [6, 7].

RESULTS
Abundance, territorial distribution, sex and age composition
By the beginning of the 90s of the last century the number of wild reindeer of the Taimyr population in the Western Taimyr had reached 349.0 thousand heads (Figure 1). Over the past years, the number of animals in the region has declined to -164.0 - 135.thousand heads or decreased by 53% - 61.3%. The greatest decrease in the number of animals was recorded in the Yenisei grouping from 199.0 thousand to 62.0 thousand individuals (68.5%). The decrease in the number of wild reindeer occurred under the influence of a number of factors. So, during the autumn migration deer collided with a barrier in the form of the Messoyakha-Norilsk gas pipeline line.

The obtained materials on the age distribution, variability of sex ratio, reproductive capacity and mortality depending on age allowed to establish a certain differentiation of animals by sex and age. Over the past 15-20 years there has been a change in sex and age composition among the deer of Western Taimyr. The greatest decrease was observed among adult males, which is associated with intensive hunting and uncontrolled withdrawal of adult males in the autumn-winter period, as well as in the spring period when harvesting antlers.

The analysis of fishery samples and their comparison with aerial survey data and ground-based observations of the structure of the population showed that the proportion of calves and young animals under 2 years in the fishery samples is understated. In our study, it was 18.7%, which indicates a preference for fishers to harvest larger animals.
Hunting had a significant impact on animals 3-7 years of age, that is, the most reproductive part of wild reindeer in Western Taimyr. Their share decreased from 82.1% to 70.9%, while the share of the least reproductive part of animals increased from 17.9% to 29.1%. According to the generalized hunting sample over the past 10 years, the tendency of increase in the average age of animals from 4 years (without separation by sex) has been observed in Western Taymir, to 5.6 years. Changes in the sex-age composition of wild reindeer in Western Taimyr affect the sex ratio.

If at birth it is close to 1: 1, then by the end of the first year is 1: 1.68 in favor of females. With age, this ratio increases: at the age of 3-7 years to 1: 2.88, at the age of 8-10 years, reaches 1: 1.39, that is, with age, there is an increased elimination of males, females are always greater.

The revealed sex ratio, the materials of hunting samples and aerial surveys by the age distribution of individuals allowed us to calculate that in the modern structure of deer groupings in Western Taimyr, the proportion of 3-7 year olds is about 50%, that is, the most productive part of the animals is taken out by the fishery.

Thus, in the last 15 years, the number of wild reindeer in Western Taimyr has decreased, they have changed their spatial location, calving places, negative trends in sex-age structure, gender ratio of the deer region have been outlined - all this is the response of animals to changes in habitat conditions and the influence of anthropogenic factors.

**Reproductive abilities of wild reindeer**

In recent years, the increase in the number of females in the western migration stream has been noted. There was a significant increase in fecundity of the four-seven year old female reindeer of the most reproductive nucleus, the proportion of which is predominant in the migratory flux. In fact, the natural increase in the Puropyasinsky group, identified by the number of lactating females in the hunting sample, was 14.8%. The fatness of a significant part of the animals from these migratory flows was low. The results of the study of the fatness of the wild reindeer of Western Taimyr showed that 70% of the females and 60% of the males had a fatness below the average. In recent years this regularity has been constantly found in the animals of the migratory flow of the upper reaches of the Pyasina River.

The reduction of the reproductive capacity of wild reindeer in Western Taimyr is due to the fact that the herds are in pastures with low productivity in the zone of permanent anthropogenic and technogenic impact of industrial enterprises and large-scale poaching in the period of migrations.

Under the constant impact of the disturbance factor, animals are forced to graze on poorly productive pastures. It is extremely necessary to continue to regularly monitor fertility indicators in western groups of wild reindeer, as they “represent an elementary unit of the population, and it is on their basis that the adaptive response of the population as a whole to changes in out-and intrapopulation conditions is provided” [8].

**Figure 1.** Taimyr population of wild reindeer in summer.
Morphological and physiological characteristics of wild reindeer in Western Taimyr

Age and seasonal variability of body weight of males and females is characterized by the data of Table 1, which confirm the patterns of growth and development of wild reindeer.

Table 1. Dynamic of body mass of wild reindeer in Western Taimyr, kg.

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th></th>
<th>Female</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M±m</td>
<td>C, %</td>
<td>n</td>
</tr>
<tr>
<td>Newborn</td>
<td>21</td>
<td>5.3±0.2</td>
<td>20.6</td>
<td>-</td>
</tr>
<tr>
<td>2-3 months.</td>
<td>7</td>
<td>33.4±2.6</td>
<td>20.6</td>
<td>6</td>
</tr>
<tr>
<td>3-4 months.</td>
<td>11</td>
<td>43.5±1.1</td>
<td>8.7</td>
<td>12</td>
</tr>
<tr>
<td>9-10 months.</td>
<td>63</td>
<td>42.7±0.5</td>
<td>8.9</td>
<td>75</td>
</tr>
<tr>
<td>11 months.</td>
<td>38</td>
<td>36.8±0.6</td>
<td>10.2</td>
<td>44</td>
</tr>
<tr>
<td>22-23 months.</td>
<td>14</td>
<td>50.4±1.7</td>
<td>12.6</td>
<td>40</td>
</tr>
<tr>
<td>27-28 months.</td>
<td>7</td>
<td>71.7±2.9</td>
<td>10.9</td>
<td>10</td>
</tr>
<tr>
<td>39-40 months.</td>
<td>17</td>
<td>89.8±2.9</td>
<td>13.1</td>
<td>12</td>
</tr>
<tr>
<td>51 months.</td>
<td>18</td>
<td>132.6±2.8</td>
<td>18.2</td>
<td>31</td>
</tr>
</tbody>
</table>

Note: n - number of goals; M-average, m - error of the arithmetic mean, C – the coefficient of variation.

In general, Western Taimyr has seen a decrease in the live weight of adult deer (especially in males) over the last 20 years of exploitation of groups by 6.7-8.9% (in males) and by 4.8-6.7% (in females). In all likelihood, with regard to males, the selectivity of hunting for the withdrawal of larger individuals is more evident. This also confirms the findings about a stable tendency to reduce the proportion of adult males in wild reindeer groups in Western Taimyr.

A survey of female females also showed a decrease in their average weight and an increase in the proportion of females in the range of live weight from 50 to 70 kg. Females do not gain the permissible weight in recent years, which adversely affects the growth of the spring, the birth of weakened calves and the development of the embryo. In our opinion, the main reason for this is the selectivity of the fishery, as a result of which the largest individuals are eliminated.

The analysis of the age structure of horny females showed that hornlessness is found in all age classes, i.e. the elimination of females from the population is the same as in horned individuals. During the years of research into this feature, we found that over the past 25 years there has been a tendency to reduce the incubation of females. This indicates that the conditions of the animal habitat in Western Taimyr are deteriorating, and there are difficulties in providing full-value feeding in the mother-calf system. It is difficult for a female to protect a feeding hole in the snow period, which has negative consequences for females and her calf. The percentage of barren does is higher among hornless ones.

Genetic characteristics of wild reindeer in Western Taimyr

Based on the obtained microsatellite profiles of wild reindeer in Western Taimyr, we calculated the main intra-population indices of genetic diversity: the degree of expected (He) and observed heterozygosity (Ho), allelic diversity (Ar) and the coefficient of inbreeding (Fis): He = 0.809 ± 0.019, Ho = 0.672 ± 0.041, Ar = 10.714 ± 0.707, and Fis = 0.174, respectively. Positive values of the coefficient of inbreeding indicate a shift in genetic diversity towards a lack of heterozygotes. The effective size of the population (Ne) was used as a criterion for determining the risk of extinction and establishing the limits of conservation and development of the studied population. For a population of wild reindeer in Western Taimyr, a fairly high value of Ne = 140.7 (95% CI, 109-191.3) was found, indicating a high evolutionary potential of the population.

DISCUSSION

The number of wild reindeer in Western Taimyr tends to decrease. Over the past 15-25 years, it has declined by 53-65%. There has been the greatest decrease in the number of wild reindeer in the Yenisei group. The area of reindeer of Western Taimyr is shifting in an easterly direction affected by anthropogenic, technogenic and food factors. At the same time, the process of shifting the calving areas to the south and east is proceeding. There is a change in the sex-age composition among wild reindeer in Western Taimyr: a decrease in the proportion of adult males from 15.0 to 5.4%, which is associated with intensive hunting and uncontrolled withdrawal of adult males in the autumn-winter period, as well as in spring with uncontrolled harvesting un-ossified antlers.
The poorly controlled hunting for wild reindeer in Western Taimyr had a significant impact on animals at the age of 3-to 7, that is, on the most reproductive part of animals: their share decreased from 82.1% to 70.9%. The share of the least reproductive part of the animals increased accordingly from 17.9% to 29.1%, that is, the most productive part of the animals is taken out by the fishery. There has also been a decrease in the live weight, an increase in deer lower middle-fatness and lean ones (females of up to 70%, males to 60%), an increase in the female's fecundity to 32-36% among the wild reindeer of Western Taimyr.

These facts indicate a certain negative impact of environmental factors on the morpho-physiological indicators of wild sevens of Western Taimyr. Over the past 25 years, there has been a tendency for the reduction of non-hunting females. This shows that the conditions of the animal habitat in Western Taimyr are worsening, and there are difficulties in providing full-value feeding in the mother-calf system. There has been a trend towards a decline in productive and reproductive parameters among the wild reindeer of Western Taimyr.

It was identified on the basis of the analysis of microsatellites that the population of wild reindeer in Western Taimyr is characterized by a sufficiently high level of genetic diversity, which is shifted to the disadvantage of heterozygotes and a high value of the effective size of the population. Data on the effective size of the population of other groups of wild reindeer in our country are not yet available in the literature. Frank et al [9] calculated the values of this indicator for 600 red deer (Cervus elaphus), selected for the most part of the European habitat. It was found that Ne for most of the studied populations is within the permissible range, although with lower maximum values calculated for German and Spanish deer ([10]. However, the values of Ne (Ne = 2.0 and Ne = 8.2) were critically low for the red deer Sardinia and Mesola, which confirms their genetic "exhaustion", provoked by the effect of the "bottle neck" and their practical disappearance.

CONCLUSIONS
1. At the moment, the wild reindeer population of Western Taimyr, for its own safety, is well adapted to environmental conditions.
2. However, the further intensively increasing impact of anthropogenic and technogenic factors on this population and its habitat will lead, first of all to a decrease in its abundance, to the loss of unique genes and to a decrease in genetic diversity in general, and second to its further complete disappearance.
3. In connection with the foregoing, it is necessary to systematically monitor the state of population-ecological, morphological and genetic indicators in the wild reindeer population of Western Taimyr in order to record the direction of intra-population shifts and effectively to regulate the quantitative and qualitative composition of the population by restrictive hunting and security measures in order to maintain its stable productivity.

ACKNOWLEDGMENTS
The research was carried out with the financial support of the Russian Science Foundation, project No. 16-16-10068.

REFERENCES
Глава III/36: АНАЛИЗ ЭКОЛОГИИ РЫСИ (Lynx lynx) В ЯКУТИИ
Chapter III/36: Analysis of the Ecology of the Lynx (Lynx lynx) in Yakutia

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ДОИ 10.25680/9235.2018.93.31.229

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РЕЗЮМЕ. Распространение рыси в Якутии связано в основном с лесным ландшафтом. В отличие от других регионов России, рысь избегает близости жилья человека и практически не приближается к деревням, к стоянкам коневодов, охотничим избушкам. Основу питания хищника в районах Западной, Центральной и Северо-Восточной Якутии составляет заяц-беляк 72,9, 75,9 и 71,4% (в пик численности). В Южных, Юго-Западных и Северо-Западных районах этот показатель ниже – 42,8, 38,6 и 36,3% и это связано с тем, что заяц-беляк в этих регионах малоочислен, зато в этих регионах в пищевом рационе большей процент встречаемости мелких копытных (кабарга, косуля) и птицы. В отличие от других регионов России, у якутской рыси пищевой рацион скудный, низкая плодовитость - 1,62 котенка на одну рожавшую самку. Обнаружено 5 видов гельминтов: 2 вида цестод и 3 вида нематод. Общая зараженность составила 95 %. Численность рыси низкая и сильно колеблется по годам – от 700 до 1200 особей. В связи с низкой численности рыси необходимо запретить промысел, а вид занести в Красную книгу Якутии.

Abstract. Lynx’s distribution area in Yakutia is mainly related to forest landscapes. In contrast to the other Russia’s regions lynx avoids human habitation proximity and practically doesn’t approach to villages, horse breeders’ camps or hunters’ huts. The predator food base is consisted of mountain hare: 72.9 % – in western areas, 75.9% – in central areas and 71.4% – in north-eastern areas of Yakutia (during the hare population peak). In southern, south-western and north-western areas this indicator is lower: 42.8, 38.6 and 36.3% respectively and the reason for that is because the mountain hare population in these areas is poor, but on the other hand lynx’s dietary intake in these areas has a high percentage of the small ungulate occurrence (musk deer, roe deer) and birds. Unlike the other regions of Russia, Yakut lynx has a poor food ration and low fertility – 1.62 kittens per one female lynx that gave birth. Five helminth species were detected: 2 cestodes and 3 nematodes. Total infection rate was 95%. The lynx numbers are low and fluctuate too much throughout the years – from 700 to 1200 individuals. Due to the low numbers of lynx, it is necessary to ban hunting and include lynx to the Red Data book of Yakutia.