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Abstract. The goal of the study was to investigate the distribution of tagged wild reindeers on the territory of Evenkiya and to provide recommendations on preserving and rational use of the population. The study was performed in 2015–2016 by the Department of Hunting Resources Research and Nature Reserve Management of the Siberian Federal University. The relocations of 10 wild reindeers equipped with Argos satellite tags were monitored, land and aerial surveys of the reindeers were also performed. Besides, taxation and cartographic documents of the State Hunting Register, as well as information received from hunters and hunting providers were used during the research. The areas of divisions were delimited mostly with the help of GIS-technologies. The borders of habitats, their size and the character of animal moving were found through signals received from satellite radio tags. To assess the behavior of the animals, the speed of their movements was analyzed both by the azimuth straight line between two daily points and by a tortuous trajectory. The maximum duration of signal from collars with new battery blocks in 2015-2016 was 438 and 444 days. The total distance covered by reindeers by the beginning of the third decade of July was 1641.1 km from locations of tagging, according to the satellite positioning data. The average speed was 13.5 km per day. A radical decrease in the number of tagged reindeers occurs with the beginning of spring migration. Two large waves of reindeer migration with an interval of 20–26 days have been observed in recent years. The positioning of tagged animals provides objective information on the migration of the herds, their fawning and wintering grounds. The possibilities of using a database for complex quality assessment of the population size and location of reindeer resources of Yessey group, as well as features of their habitats, are discussed in the article, with the biotic, abiotic and anthropogenic factors being taken into consideration.

1. Introduction

The development of regional wild reindeer population resources is the main source of income for most households and for the native population of Evenkiya. The reindeers are considered not only as enormously important participants of the arctic ecological community, but also as the key factor securing the food supply for the native population of the Northern territories. Mixing of populations of the forest and tundra reindeers has been observed on the territory of the Evenk municipal region. This causes serious problems in the balance of the wild and domestic reindeer livestock, in the development

of the subgroup representing the hunting resource, and also with preserving of the subpopulation listed in the Red Book of the Krasnoyarsk Territory [1].

In spite of the keen interest in reindeers [2, 3] and their unique Taimyr-Evenk population [4, 5, 6, 7], there are no studies at the present moment assessing the maximum possible number and the optimal extent of hunting limits. What is more, there is no up-to-date information on the population size, the taxonomic status of the Evenk tundra and forest reindeer is not determined. There are almost no studies investigating the extent of anthropogenic influence associated with intensive development of the Northern areas of the Krasnoyarsk Territory.

All factors mentioned above cause significant difficulties in the planning of ecologically rational measures in the preservation and development of the wild reindeer resources of the region. Taking into consideration the widespread area of the Krasnoyarsk Territory (more than 1.5 million km^2) inhabited by the reindeer population, contemporary monitoring methods and systems that can provide objective information on the spatial and temporal positioning of the animals during different life cycle stages are essential [8]. The data on the Taimyr-Evenk wild reindeer population and habitat should be obtained not only by interviewing of the local residents and by visual observation, but also from distant monitoring systems. Such data will facilitate solving preservation and rational use problems on a fundamentally new level.

The goal of the study was to investigate the distribution of tagged reindeers on the territory of Evenkiya and to provide recommendations on preservation and rational use of the population.

The study was performed in 2015–2016 by scientists and collaborators of the Department of Hunting Resources Research and Nature Reserve Management of the Siberian Federal University.

2. Materials and methods

In the period from 2009 to 2014, several traditional animal registering methods were applied during research. In 2015, 10 wild reindeers were equipped with collars carrying Argos satellite tags on the territory of Evenkiya.

The following individuals were caught near Lake Tise-Suokh (68°14'6.42"N; 103°51'32.33"E): mature male (no antlers) noosed on April, 14, equipped with a satellite tag ID 112862; female noosed on April, 12 (ID 147057); female noosed on April, 13 (ID 112860); young male (with antlers) noosed on April, 11 (ID 144921); mature male (no antlers) noosed on April, 11 (ID 144922); female noosed on April, 12 (ID 112854); female noosed on April, 12 (ID 110724).

The following individuals were caught near Lake Talakh: female lassoed on April, 19, equipped with a satellite tag ID 108969; female lassoed on April, 19 (ID 147056); female lassoed on April, 19 (ID 112853).

Field studies of the reindeer relocations were carried out during several periods of time and in different locations of the migration area. Besides, taxation and cartographic documents of the State Hunting Register and data provided by the State Hunting Supervisory Department of the Krasnoyarsk Territory, as well as information received from hunters and hunting providers living on the territory of Evenkiya were used in research.

Data from the Russian Meteorological Service, modeling schemes from the Ventusky program and daily Google space images were used to assess the influence of the weather on the route and character of reindeer moving and to obtain general information on the snow cover and air temperature dynamics.

3. Results and discussion

Analysis of incoming signals from the satellite tags showed, that 90 % of the tagged reindeers arrived at the summering grounds by the third decade of July, 2015, 100-111 days after the date of tagging. By the first decade of September (days 149 to 179) the signals were received from 70 % of the tagged reindeers. By the end of December, the incoming signals were detected from the wintering grounds (day 244) from the Yessey (6 individuals) and Khatanga (1 individual) areas. A radical decrease in the number of tagged reindeers occurred with the beginning of spring migration. So,

only 2 reindeers (20 %) equipped with satellite tags remained in the study by the third decade of April (days 370 to 375).

In 2015-2016, the maximum duration of signal registered from tags with fully loaded battery blocks was 438 (No 112853) and 444 (No 112860) days, which allowed us to explore not only the spring-summer cycle of migration, but summer-autumn-winter as well (figure 1).

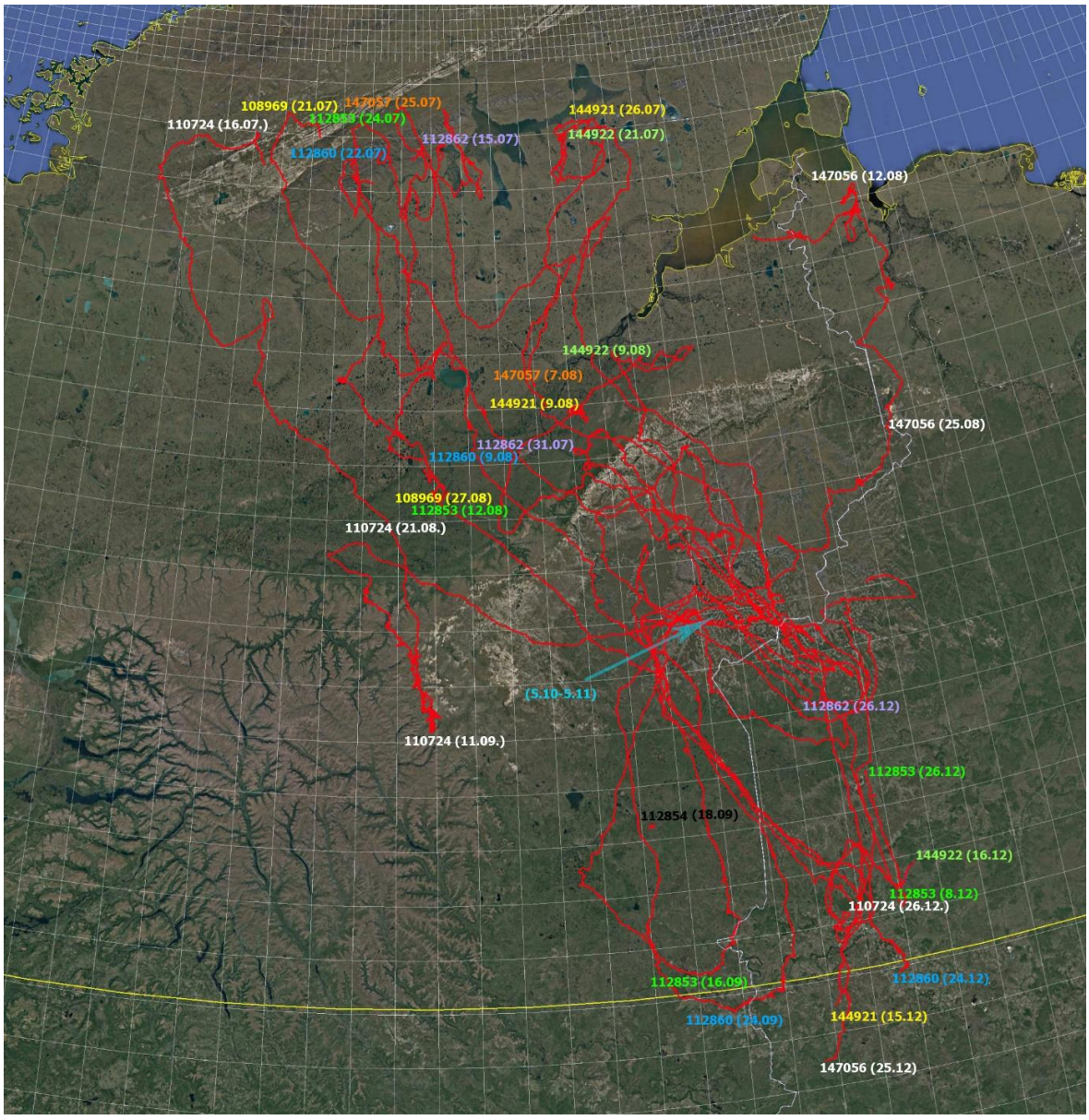

Figure 1. Summer-autumn-winter relocations of reindeers in 2015-2016. Legend: the numbers are collar numbers with GPS transmitter; day and month of registration are given in braces.

The database included 3098 geographic coordinates and azimuths representing general information on reindeer positioning and their daily relocations.

Reindeers from the Yessey group moved to the North alongside the bottom glade of the River Kotuy, which represents a topographic lowering (200 m above sea level) in the relief between the Anabar and Putorana Plateaus. According to the satellite positioning data, the total distance covered by reindeers by the beginning of the third decade of July was 1641.1 km from tagged locations. The average speed was rather high, 13.5 km per day.

Two large waves of reindeer migration with an interval of 20–26 days (26 days for the tagged reindeers) have been observed in recent years. The reindeers from the first migration wave were tagged near Lake Yessey on May, 5 and May, 6, 2017; animals from the second wave were tagged on May, 30 and May, 31, 2017. The first migrating reindeers reached the main water artery with longitudinal orientation on May, 27 and June, 24, respectively. The first herds reached the tundra zone of Taimyr (Lake Labaz) on June, 8 and on June, 9.

It should be pointed out, that in the beginning of the 1960s reindeers used to reach the Northern territories of the Putorana Plateau and the lowlands of Taimyr by mid-March, and the mass migration took place from April to the beginning of May [9]. A.V. Krechmar reported an almost 1 month delay of the migration a couple years later [10]. At the present time, the animals reach these territories by the second decade of June. The main cause of such changes in the dates (the reindeers reach the lowlands of Taimyr later) could be the dislocation of wintering grounds 1300-1600 km further, because there were no significant changes in the spring food reserves. The reserves of grass and sedge are not exhausted during the year [5].

Long distance traveling causes an increase in the energy demands of the animals and the limited availability of food reserves in the end of winter can lead to undernutrition. It is important to combine contemporary distant monitoring methods with land surveys while studying the migration of animals. This provides better understanding of the animal behavior.

The data from land surveys, analysis of the snow cover space images and information on the moving of tagged reindeers showed that during the first wave of migration, mostly consisting of cows in fawn, the reindeers cross large rivers like Khatanga, Heta, Kotuy over ice (June 6-9, 2017), without forced stops and gathering on the shores of the rivers. On June 8-9, 2017 the condition of the ice cover on the river was already unfavorable down from the estuary of Kotuy River, and no reindeer movements were detected on these dates. The interviewing of local residents and helicopter crews flying over these territories proved that the dates of the tagged animal relocations accurately concur with the general reindeer migration, and also provided information on their stop on the left bank of Heta River.

During the peak migration the activity and speed of the reindeers increase almost twofold, this leads to expansion of the daily pasture areas in comparison to the winter season. Reindeers from the Yessey group reached the 74° north latitude by the end of the spring and summer migration period. The quantitative values added to the database accurately describe the spatial and temporal positioning of the reindeers shown on cartographic materials.

The main goal of the complex quality assessment of the Evenkiya reindeer habitat is to determine the site class of the Krasnoyarsk Territory municipal hunting areas. Usually the qualitative assessment is carried out basing on the analysis of the inventory data obtained by means of general land evaluation of the hunting areas with separate assessment of each type of hunting resources. In 2017 reindeer censuring was performed on the territories of 37 entities (59539.53 thousand hectares). According to the data from winter census routes, the number of individuals on this territory was 77.24 thousand and the population density was 1.3 individuals per 1000 hectares.

The total number of reindeer individuals in the Krasnoyarsk Territory for the years 2015, 2016, 2017 was estimated as 522.8, 526.5 and 537.4 thousand individuals, respectively. The approved exploitation limit was 52.0 and 57.4 thousand individuals.

Traditionally, only the Evenkiya forest reindeer, representing 13-14 % of the Taimyr reindeer population, is taken into consideration. For some reasons, the reindeers coming to Taimyr for fawning and those wintering on the territory of Evenkiya are not mentioned in the hunting provider's reports at all. The mobility of the animals, lack of knowledge in the field of ecology, imperfect censuring methods, low availability of thematic maps – all these factors are the cause of incorrect information on the species population density.

Unsurprisingly therefore, that the Taimyr reindeer groups are not registered in Evenkiya, and they are not included in the approved hunting limit. According to the research data of the Agricultural Research Institute of the Far North, the percent of young animals born in the current year's Taimyr-

Evenk population progressively decreases. This number was 13.8 % according to the data obtained during the aerial survey performed over West and Central Taimyr regions in July and August, 2016. As a result of our visual observations and reindeer censuring in the places of River Heta crossing we obtained a similar number. This indicates an increased infant mortality rate and a generally low fertility potential of the animals. Deer hunting is carried out on the whole territory with selective withdrawal of adult individuals (up to 80 %).

What is more, the hunters work with the migration streams and population groups very irregularly. There is a clear tendency to rejuvenation of the population with a predominant decrease of the percentage of adult males. According to the results of studies and official data, the mortality of wild reindeers of the Taimyr-Evenk population is 2.5-3 times higher than the hunting rate. The number of reindeer individuals, determined by aerial surveys in 2003, 2009 and 2014 and by winter census routes, tends to decrease at the present time, from 1 billion species in 2000 to 414 thousand species in 2014, and 445-537 thousand species in 2017 (last estimations vary).

4. Conclusion

Taking into consideration the widespread area of the Krasnoyarsk Territory (more than 1.5 million km2) inhabited by the reindeer population, contemporary monitoring methods and systems providing objective information on the spatial and temporal positioning of the animals during different life cycle stages are essential. The maintaining of an up-to-date geographic information system (GIS) of the hunting areas and hunting resources (in the MapInfo format) facilitates more efficient programmed monitoring of the condition and development of the hunting areas. The up-to-date data on the current condition of the animal groups and the population in general, obtained not only by winter census routes and visual observations, but also by means of distant monitoring methods, helps to solve problems of preserving and rational use of the Taimyr-Evenk wild reindeer population on a qualitatively new level.

5. Practical recommendations

At present, illegal commercial harvesting of velvet antlers from wild reindeers in Taimyr is a major concern of the controlling and supervision bodies. Exclusively fertile adult males are shot and caught in June and July, and the hunters often take only the antlers and tongues (the latter–from the shot animals). This causes appreciable damage to the population. According to the data obtained from the aerial survey of the Central and Western regions of Taimyr performed in 2016, the number of males with harvested antlers was 5.8 % from the total number of registered adult individuals (n = 1518) who survived the antler harvesting.

The Rivers Khatanga and Heta represent a major water barrier, on the banks of which such antler harvesting is possible. Inspectors express the opinion that the reindeer migration extends widely along the river banks, and the inspection of a 330–350 km distance is almost impossible or shows poor results. The monitoring of the river area has proved that crossing reindeers can be seen in spring on the distance from the Kotuy River estuary to the Vodochanka River estuary. However, data obtained from tagged individuals showed, that 62.5 % (in 2015) and 100 % (in 2017) of the reindeers crossed the Heta River over a 68 km long river reach (Ryzhkov Island to Bulun River estuary). Considering the well-known dates of reindeer migration, such a distance can be effectively controlled and protected. Our research data prove that the present traditional census routines and reindeer hunting licensing should be revised, taking into consideration not only the Taimyr, but the Taimyr-Evenk reindeer population.

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