

Mapping long-term spatial trends of the Taimyr wild reindeer population

Andrey N. Petrov¹, Anna V. Pestereva¹, Leonid A. Kolpashchikov², & Vladimir V. Mikhailov³

¹ Arctic Social and Environmental Systems Research Lab, University of Northern Iowa, USA.

² Extreme North Agriculture Research Institute, Russia.

³ St. Petersburg Institute of Informatics and Automatization, Russian Academy of Sciences, Russia.

Corresponding author: andrey.petrov@uni.edu

Abstract: This report presents preliminary results of mapping and analyzing wild reindeer spatial dynamics in Taimyr, Russia. We collected, spatially referenced, and systematized comprehensive aerial and land survey information spanning from 1969 to 2003, which is the most complete long-term data available about a wild reindeer herd in Eurasia. The report introduces some of the mapping products and presents a summary of our observations on spatiotemporal changes in reindeer distribution and migration. Using these data and new digital products in the GIS (Geographic Information Systems) environment, we were able to observe the long-term shift of the Taimyr Reindeer Herd's summer, winter, and calving areas to the east and south with a simultaneous expansion of the habitat. We identified and confirmed locations of large reindeer concentrations (herds) seasonally formed throughout the study period. Using the most recent summer survey data (2009) we also were able to confirm the existence of two major migration flows in the fall: eastern (most reindeer) and western.

Key words: long-term observations, mapping, migration, Russia, spatial dynamics, Taimyr, wild reindeer.

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Introduction

The Taimyr Reindeer Herd (TRH) is the largest and the most monitored wild reindeer herd in Eurasia (Klein & Kolpashchikov, 1991; Kolpashchikov *et al.*, 2007, 2009). The herd has a population of about 700 000 animals and uses a vast habitat in the north of Central Siberia that spans 1 500 000 km². The TRH seasonal migration is characterized by very large masses of migrating reindeer moving across extremely long (up to 1500 km) distances (Syroechkovskii, 1984; Kolpashchikov & Mikhailov, 2004; Kolpashchikov *et al.*, 2007).

Long-term studies of *Rangifer's* spatial distribution and migration are rare since in most cases the record

of historical observations is limited. Meanwhile, in-depth longitudinal studies are able to fill the knowledge gap pertaining not only to biology and ecology of *Rangifer*, but also to the climate change impacts on reindeer/caribou and their adaptation to a changing environment (Gunn *et al.*, 2009). The TRH is a *Rangifer* herd that provides a unique opportunity to analyze population and spatial dynamics vis-à-vis environmental factors for a long period of time.

Air-based observations of reindeer population in Taimyr started in 1959 and continued with varying rate of regularity. Monitoring datasets include records of population numbers, structure, and spatial distribution. Whereas data on the demographic characteristics

are relatively well studied (Kolpashchikov, 2000; Laishev *et al.*, 2002; Kolpashchikov & Mikhailov, 2011), the vast amount of information about the spatial distribution and migration of reindeer has not been carefully analyzed. This information still needs to be systematically organized and studied using modern technologies, such as Geographic Information Systems (GIS) to identify patterns in spatial-temporal dynamics. This paper reports the initial results of digital mapping and analysis of wild reindeer geographic concentrations.

Material and methods

The data on reindeer location and count used in this study has been systematically collected by the Extreme North Agricultural Research Institute (ENARI) in Noril'sk since 1969. Between 1969 and present there were 20 comprehensive air and land surveys of the TRH. Occasional air-and ground-based observations of reindeer distribution started in 1959. From 1969 until the early 1990s, monitoring was conducted on a regular basis (at least every three years). These observations included number of animals, geographic location of herds, and spatial structure of the reindeer population. In the 1990s and 2000s, surveys were less regular and comprehensive. For example, most recently in 2009 only summer concentrations were surveyed. Early surveys conducted in the 1960s and 1970s were also partial. The data used in this study is the most reliable and high quality long-term data available about a wild reindeer herd in Russia.

Our first task in this project was to create a collection of digital maps and spatial databases that document the spatiotemporal dynamics of the TRH. To date the collected data has been stored as analog (non-digital) maps and tables. Based on newly created digital spatial data we were able to provide a comprehensive description and perform an initial spatial analysis of changes in the TRH geography over 40 years. This has significantly improved the knowledge base about wild reindeer in Taimyr and wild reindeer in general. This report introduces some of the mapping products and presents a summary of our observations on spatiotemporal dynamics of the herd. The reference map of the TRH habitat is available in Fig. 1.

Taimyr wild reindeer herd spatiotemporal change observations

As other wild *Rangifer* herds, the TRH is characterized by seasonal concentrations. Most distinct of which are: summer concentrations (documented in the end of July), winter concentrations (documented

in January or February), and calving grounds (documented in June). Due to the TRH being scattered during winter and difficult weather conditions in this season, airborne monitoring of winter reindeer distribution is much harder compared to summer. Thus, the most complete record is available for summer concentrations. For the period between 1969 and 2003 we were able to map summer reindeer habitats for 20 years, while spatial data for winter concentrations and calving grounds is available only for 10 years. Since available observations mostly follow the three distinct periods of the TRH annual lifecycle (winter, calving and summer), we can identify geographical changes in each of these important seasons (Fig. 2).

Summer

Summer has the most complete record of observations with a total of 20 surveys. Fig. 2 shows that in 1969 and 1972 two concentrations were located in the low Pyasina basin, stretching in East-West direction (the Pur-Pyasina Herd). However in the 1930s, wild reindeer summered in north-eastern Taimyr around the Taimyr Lake north of the Byrranga Mountains. Towards the second half of the 1970s, reindeer in the low Pyasina basin moved northwards and occupied areas near the mouth of the Pyasina River and the Bay of Pyasina. Another noticeable concentration (the Yenisei Herd) always stays attached to the eastern shore of the Yenisei Gulf, moving either north or south in different years. Reindeer concentrations observed between 1980 and 1983 display a tendency to gather in smaller areas and distances between the different groups. One herd still reached the Bay of Pyasina (1981 and 1983), but generally habitats moved slightly back southwards as in the beginning of the 1970s. The mid 1980s are characterized by a greater geographical spread of the reindeer with increasing group sizes and formations of new concentrations. In 1988 and 1989 years reindeer concentrations (herds) were registered in significantly more southern areas than in the years before. These concentrations notably stretched in north-south direction. The individual herds continued to spread in terms of their own area and in relation to each other. The end of the 1980s and 1990s was characterized by the persistence large-sized concentrations and the emergence of some new herds (Logata and Upper-Taimyra Herds) reaching further east with the most eastern location being the south-west shore of the Taimyr Lake. This pattern continued in the 2000s (Figs. 2 and 3).

The latest aerial survey conducted in the summer of 2009 provides the most recent information on the TRH summer distribution and migration routes (Fig. 3). We observe four large concentrations of the wild

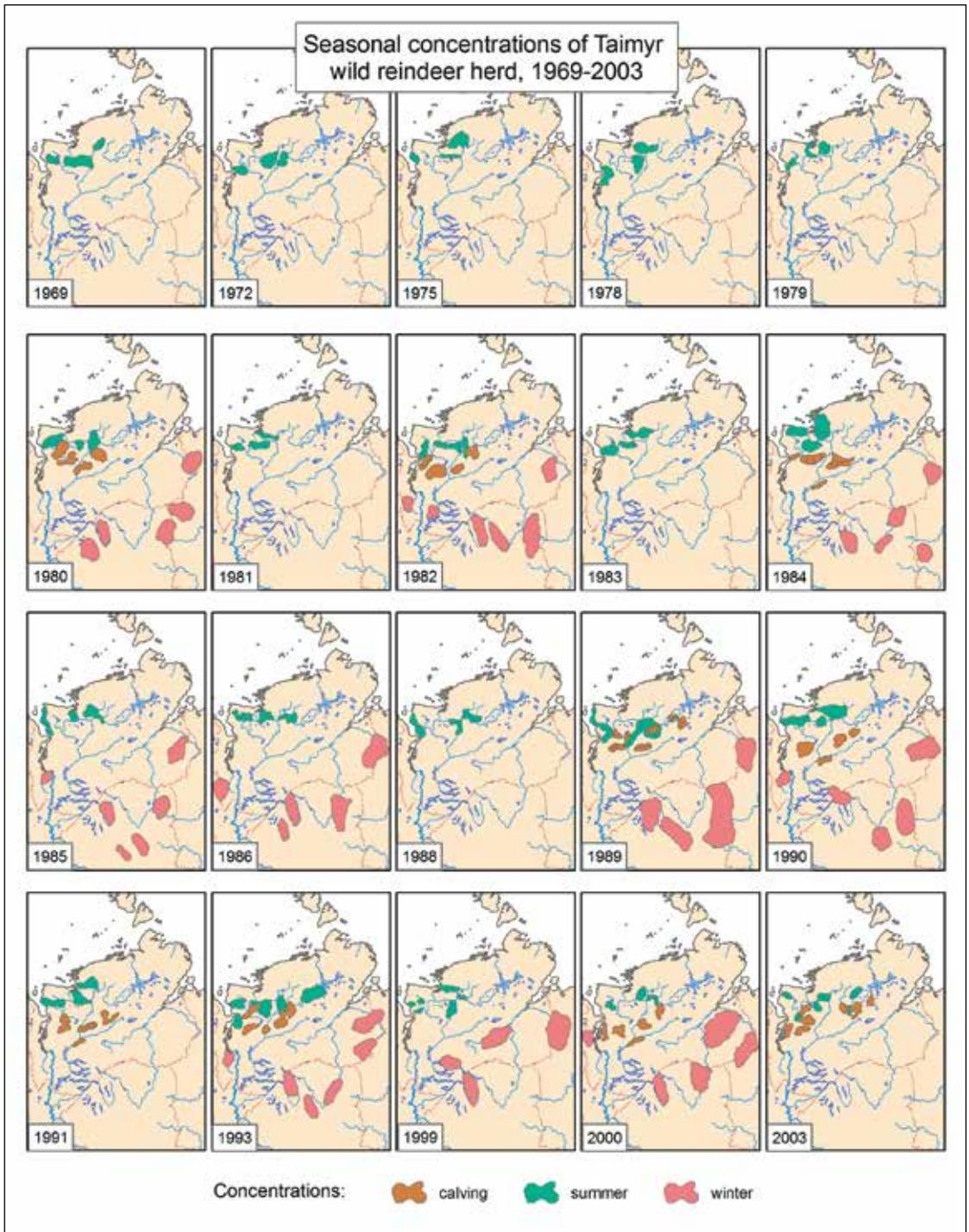


Fig. 2. Seasonal concentrations of Taimyr wild reindeer in 1969-2003.

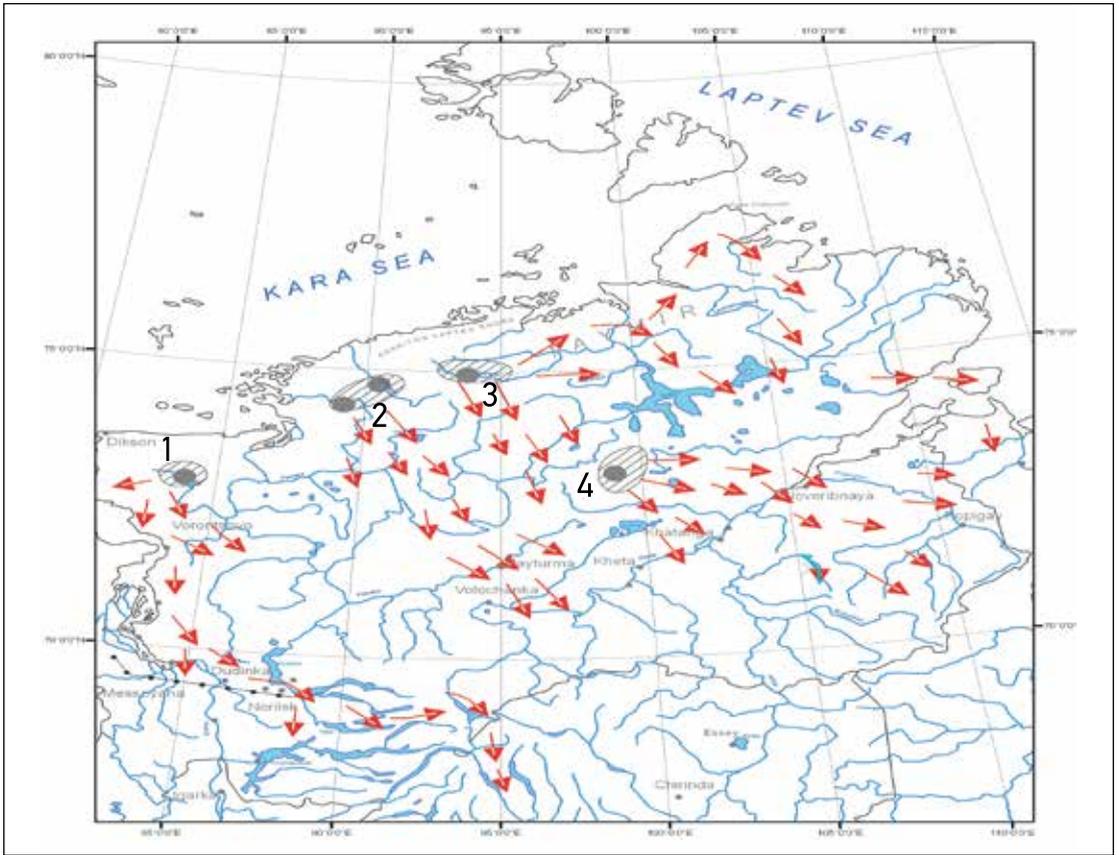


Fig. 3. Summer distribution and migration of Taimyr wild reindeer in 2009.

- (1 - Yenisei, 2 – Tareya, 3 – Upper-Taimyra, 4 – Logata),
- High density wild reindeer concentrations in late July of 2009,
- ◐ Lower density wild reindeer concentrations in late July of 2009,
- Migration,
- Pipeline.

reindeer (Yenisei, Tareya, Logata, and Upper-Taimyra Herds) located roughly in the same areas as in the early 2000s. There is also an apparent existence of two major migration flows in the fall: eastern (most reindeer) and western. The eastern flow brings reindeer from Tareya, Logata, and Upper-Taimyra groups to winter in the Anabar Plateau, northern Evenkiya, and western Yakutia. The western flow follows the Yenisei River and continues to the Putorana Plateau. These reindeer experience a noticeable influence of the Messoyakha-Noril'sk pipeline (Fig. 3) that blocks the migration route and shifts the flow to the east.

Summarizing spatial changes in the summer habitat, we can point out three overarching trends. The first is the separation of western and eastern migration flows (with the summering grounds located in

western and central-eastern Taimyr respectively). The second trend is the spatial expansion of the summer habitat due to the population increase. The third (and related) tendency is the shift of the summer habitat to the east and south, generally following south- and eastward dynamics of the calving areas. (Note however, that the historical record that predates aerial surveys suggests that the summer habitat shifted west between the 1960s and 1970s. This shift indicates a possibility of periodical changes in reindeer spatial (Syroechkovskii & Klein, 1995)).

Winter

Historical data from the 1960s suggest that at that time the TRH inhabited two main areas: the Putorana Plateau in the west and the Kotuy River

basin in the east (south of winter grounds used in the 1930s (Michurin, 1965)). During the period of regular observations, despite considerable variability we detect further southward (and eastward) movement. If in the 1970s (although the data for the 1970s is limited) most reindeer wintered in Putorana and Anabar Plateaus and in along the Yenisei's left bank, in the 1980s the population started to penetrate as far south as Tura hamlet and as far east as Viluy and Olenek basins in western Yakutia. Simultaneously, the size of the habitat increased to over 1000 km² reflecting the growth in reindeer population. At present, most reindeer winter in the eastern part of the areal (Anabar Plateau and northern Evenkiya), as well as on the Putorana Plateau and the left bank of Yenisei in the west (Fig. 2).

The main factors of reindeer concentration in winter are snow cover and forage availability. During mild winters more reindeer stay in northern locations, sometime even in the tundra of the Taimyr Peninsular. Wintering of isolated reindeer herds in tundra became more prevalent in the last few decades (Kolpashchikov, 2000). During winters with intensive precipitation, reindeer tend to spend the winter season in the uplands of Putorana and Anabar Plateaus. In addition, to accommodate a growing number of reindeer, the winter habitat has substantially expanded. Our estimates based on GIS analysis of the aerial survey data indicate a 38.7% increase in winter habitat between 1980 and 2000. With that increase, as mentioned before, areas of reindeer concentration in winter shifted south and east.

Spring migration and calving

Calving is a critical period in the reindeer annual cycle and *Rangifer* exhibits considerable spatial fidelity in choosing calving grounds, although periodic shifts are also possible (Gunn & Miller, 1986). Such a considerable change has been happening since the 1980s in Taimyr. The eastward and southward drift of the wintering regions caused reindeer to move farther away from traditional calving grounds (Fig. 2). As a result, reindeer (while starting the migration in March as usual) arrive to the tundra later than in the past (in May, not in April as before) and are not able to advance as far north as before. Laishev *et al.* (2002) reported that there was no significant change in forage availability or other conditions in the calving areas used in the previous decades. Thus, the main reason for shifting calving grounds to the south (see Fig. 3) is the longer migration route (now 1400-1500 km) from the wintering regions. In the recent years mass calving took place in Central Taimyr (Dudypta, Yangoda, Luktakha and Gorbitya River basins).

The southward shift of calving areas is a worrisome tendency for several reasons: (1) it is more difficult for pregnant cows to cover longer distances, and (2) later migration coincides with impassable rivers that lead to crowding of reindeer on the banks. This leads to calving in high density conditions that could be detrimental for forage availability. Reportedly, the cow density since the 1980s has been 7-15 times higher than in 1972 (Laishev *et al.*, 2002). In addition, being born farther south from the summer habitat, calves have to cover longer distances and cross rivers on their way to the north (Figs. 1 and 2), a process that considerably increases infant mortality. In the 1970-90s the estimated newborn calf death rate was about 10%, whereas in 2000-2009 it jumped to 14% (Mikhailov & Kolpashchikov, 2011).

Summary

Since the 1960s we observe the shift of the TRH's summer, winter, and calving areas eastwards and southwards with a simultaneous expansion of the habitat (Fig. 2). During the 1960s, reindeer were concentrated in western Taimyr and summering to the south of the Byrranga Mountains. In the early 1980s, the reindeer population increased in Central and later in Eastern parts of Taimyr and declined in western Taimyr. Nowadays most of the reindeer concentrate in Central and Eastern Taimyr, shifting the wintering and calving areas eastwards and southwards. Winter habitat moved noticeably to the east and south. Since the 1980s, the TRH started to penetrate as far south as Tura hamlet and as far east as Viluy and Olenek basins in western Yakutia. As a result, calving grounds also shifted south, a trend that for several reasons might endanger the survival of the reindeer population (e.g., due to higher pressures on cows and calves). At the same time the TRH habitat expanded, especially in winter. This, of course, partially reflected the increase in TRH population, the decline in domestic reindeer in central and eastern parts of Taimyr, and coincided with the east-south geographical shift in wild reindeer migration.

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