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# Geographical variability and cultural diversity of reindeer pastoralism in northern Russia: delimitation of areas with different types of reindeer husbandry

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## Abstract

Traditional reindeer husbandry in Russia is a fascinating phenomenon of northern pastoralism and nomadism. Russia is home to over two-thirds of the world's total domesticated reindeer herd. Reindeer husbandry in Russia is practised by 15 indigenous peoples, some of whom still pursue a nomadic lifestyle. The purpose of this article is to visualise reindeer husbandry, together with its hosting biophysical and social environment, as a socio-ecological system or a reindeer pastoralist landscape, and to present its diversity as a geographical system of landscape zones and regions. Such a holistic landscape approach is rooted in the landscape ecology and reflects the basic patterns of reindeer husbandry's connections with its surroundings. The research includes 3 stages. We started by dividing the entire reindeer husbandry area of the Russian North into several landscape zones focusing on the predominant migration patterns of reindeer herders, as such patterns reflect the interaction of reindeer husbandry with the geographical environment as a whole. The next stage was zoning by cultural types of reindeer husbandry. In the final stage, we divided the particular reindeer husbandry areas into smaller regions according to the local features of reindeer pastoralism. The research has resulted in a map of traditional reindeer husbandry landscape zoning. This map embraces the whole territory of Russia where traditional reindeer husbandry still exists and comprises 35 units (reindeer pastoralist landscapes) related to four taxonomic levels. The present zoning scheme of Russian reindeer husbandry is, on the one hand, a result but, on the other hand, a tool for further research on reindeer pastoralism within a holistic landscape ecology approach.

**Keywords** Pastoralist landscape zoning, Types of reindeer herding, Pastoralist socio-ecological system, Migration patterns, Holistic landscape approach, Northern indigenous peoples

Traditional reindeer husbandry in Russia is a *fascinating* phenomenon of Eurasian pastoralism and nomadism. Russia is home to over two-thirds of the world's total domesticated reindeer herd. The reindeer pastoralism area in Russia extends over a range of more than 2000 km from north to south, from the polar tundra to

the southern taiga, and about 5000 km from west to east. Fifteen indigenous peoples are engaged in reindeer husbandry, and some of them still keep their nomadic way of life. Reindeer herders have managed to adapt to a variety of natural landscapes, from the flat waterlogged plains of Western Siberia to the Saian Mountains.

During the late Soviet period, reindeer husbandry in Russia remained relatively stable, and the number of reindeer fluctuated around the same level. Since the beginning of the market reforms in 1990, the reindeer numbers in all regions of Russia have been changing dramatically. In most areas, reindeer pastoralism declined greatly;

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in a number of regions, it disappeared completely, but in some districts, on the contrary, the number of reindeer increased. In recent decades, numerous publications (Baskin 2016; Istomin et al. 2017; Khakhovskaia 2007, 2019; Klokov 2012, 2020a, b; Konstantinov 2015; Mathiesen et al. 2023, etc.) have shown that the situation in reindeer husbandry varies greatly across different reindeer herding areas. In some districts, there is a lack of pasture forage, but reindeer husbandry has nevertheless turned into a successful business. In others, reindeer husbandry is decreasing, as herding families have gone to live in settlements no longer wishing to be nomadic. In many regions, the authorities pay great attention to the support of reindeer pastoralism, but in different ways: by supporting either only municipal or private reindeer herding businesses as well. The effect of diverse factors is manifested differently on local, regional and federal levels (Antonov et al. 2019).

In examining the diverse and sometimes even oppositely directed trends in reindeer pastoralism, we are confronted with questions such as “Why do some local communities develop strategies that allow them to solve problems successfully, while others repeatedly fail?” and “Why do reindeer husbandries in some regions prospered economically, while in others, they flounder and repeatedly fail in their attempts to make reindeer husbandry commercial?” These questions have not yet been answered, and if the unsuccessful attempts to answer them prove something at all, it is that the answer cannot be discovered in the study of institutions or economic only but should take into account the whole sphere of interaction between human communities, (semi) domesticated reindeer populations and environment. One way to do that is through the study of the resilience and vulnerability of northern social-ecological systems (SES) (Kofinas et al. 2005, p 8). Such studies have been conducted also in Russia, primarily in the area of Nenets reindeer husbandry in the Iamal Nenets Autonomous Okrug (Forbes et al. 2006, 2009; Forbes 2013). However, while they have demonstrated the high resilience of Nenets reindeer pastoralism in tundra, this has not in any way brought us closer to answering the central question of why reindeer husbandry in most other parts of Russia remains unsustainable. Although there has been a number of publications on reindeer pastoralism in the Kola Peninsula, Western and Eastern Siberia, Iakutia and Far East of Russia, there are very few studies that have compared its status across several regions of Russia (Golovnev et al. 2018; Klokov 2020a, b).

Hence, it may be relevant to approach these issues from a human geographical perspective by taking a view of reindeer pastoralism in its conjunction with the biophysical and social environment, e.g. reindeer pastoralist

cultural landscape and reindeer pastoralist socio-ecological system (RPSES).

Although the concept of SES (Berkes and Folke 1994; Berkes et al. 2003) has emerged independently of the concept of cultural landscape, both approaches address human activities and natural processes as a united whole. The history of the concept of cultural landscape is rather complicated (Martin 2005). Various understandings of this concept have been and continue to be formed by different geographical schools (Cosgrove 2009). In this case, we use one of the classical interpretations proposed by C.O. Sauer (Sauer 1963 [1925], 343): “The cultural landscape is fashioned from a natural landscape by a cultural group. Culture is the agent, the natural area the medium, the cultural landscape is the result”. According to C. O. Sauer, the cultural landscape is the geographic area in the final meaning. Its forms are all the works of man that characterise the landscape, including forms of population, housing, forms of production and types of land utilisation (Sauer 1963 [1925], 342–343). This holistic approach is shared by a number of Russian geographers (Frolova 2019), to whose work we further refer in this paper.

The concept of landscape is also used in anthropology. The basic ideas (positions) for this were developed in the famous article by Ingold (1993). Later, they were deployed mainly in historical ecology (Balée 2006) and narrative ecology (Tsing 2015). An overview of these approaches is provided in the paper by Kirill Istomin (2023) in this issue. Despite significant methodological distinctiveness in each of these approaches (we will return to some of them below), all works based on the concept of landscape have in common a very broad holistic vision, which constitutes their strong and, at the same time, weak side.

William Balée (2006, 75) noted the landscape is “a central term used in historical ecology to situate human behaviour and agency in the environment” as it is “derived from historical geography, instead of the ecosystem, which is from systems ecology. Historical ecology is similar to non-equilibrium dynamic theory, but differs in its postulate of human-mediated disturbance as a principle of landscape transformation”

When studying reindeer pastoralism, the landscape approach can often be reduced to a minimalist model that considers a system of three basic components—pasture, reindeer and herders (Krupnik 1993; Holand et al. 2022; Istomin 2023). From the reindeer pastoralists’ perspective, the landscape is characterised by the dynamic relationship between the pasture resources, the herd, other pastoralists and themselves (Holand et al. 2022, 10). A holistic landscape approach is rooted as well in the landscape ecology reflecting the basic patterns of reindeer husbandry’s connections with its surroundings.

Having started with the study of biophysical systems, landscape ecology is evolving towards a more holistic approach (Bastian 2001; Angelstam et al. 2019; Frolova 2019). The holistic landscape approach emerged to fill the gap in understanding how the interactions between ecosystems and human well-being influence, and are influenced by, landscape patterns. According to this point of view, landscapes are quintessential examples of *human–environment systems* or *social-ecological systems* that are place-based, hierarchical patch mosaic systems in which humans and ecosystems mingle (Wu 2021, 3).

Pearson and Gorman (2010, 1176) proposed a conceptual model that incorporated the ideology of “human ecological holism” and placed “landscape ecology centrally as the discipline able to incorporate societal values and knowledge (which contribute to sustainable livelihoods) along with the biophysical pattern and process...”. This gave the possibility for trans-disciplinary and an integrated approach to planning, design of management strategies and for recognising the important role indigenous people play in landscape management. Li et al. (2021) as well state that landscape ecology thinking can provide an important spatial perspective to understanding SES complexities and not to neglect the landscape spatial heterogeneity.

Landscape ecology provided a holistic concept for grassland systems and pastoralism studies in various areas (Pearson and Gorman 2010; Wu et al. 2015; Li et al. 2021; Gillin 2021, etc.). However, studies on reindeer pastoralism that use the holistic landscape-ecological paradigm are still rare. Only the most recent works (Skarin et al. 2020; Reindeer husbandry and global environmental change pastoralism in Fennoscandia 2022; Seitsonen and Fjellström 2022) broadly use the concept of landscape referring to Tim Ingold’s statement that the environment is not only a bio-physical but as well a cultural landscape shaped by herders and their herds (Ingold 1980).

Landscape approach may give the possibility to present an overall picture of the diversity of RPSES and their environment. It certainly does not replace an in-depth study of reindeer pastoralism in different regions of Russia but can add well to it. Thus, it would help to:

- a) Identify the gaps in knowledge of the regional aspects of reindeer pastoralism
- b) Assess the diversity of conditions, both natural, economic, cultural and socio-political, in which herding communities manage their livelihood
- c) Find out what are the common traits of reindeer pastoralism in different regions and what are the unique characteristics of each region
- d) Better justify the selection of model areas for future studies
- e) Understand which models of pastoralism have a better chance of surviving in certain setting
- f) Produce more specific recommendations for regional authorities, taking into account the specificities of reindeer husbandry and its environment in concrete areas

At the same time, it should be stressed that the cultural landscape approach also has certain limitations. Thus, since this approach focuses on the relation between natural and cultural, it is relatively poorly suited for studying natural phenomena. Therefore, one hardly can expect that the cultural landscape approach would provide any new information on reindeer biology and/or ecology, although it can provide some insights into reindeer behaviour as much as it is shaped by interaction with the human masters (Istomin 2023).

In reindeer pastoralism, routine, economy and culture are woven together and rooted in the enclosing landscape. The configuration and composition of the landscape allows, facilitates or complicates the presence and movement of herders, reindeer and other living beings, both human and non-human, depending on their perception of obstacles and areas of interest (Courault et al. 2018). The first aim of our research is therefore to provide an overview of the reindeer husbandry across all regions of Russia with its local variants and differences in relation to natural and/or historical regions, which may be interpreted (treated) as reindeer pastoralist landscape (RPL).

The second task is to define the principles of geographical systematisation of RPL/RPSES and to present their diversity by a zonal-regional system, reflecting the main regularities of their location and connections with the geographical environment. Such a system is presented as a small-scale overview map, and it is a groundwork for developing and further comparative analysis of the RPL/RPSES (Fig. 1).

Reducing a description to a system is an important step in landscape studies. “Once this happened the geographer is responsible within the limits of the system for any areal study he undertakes; otherwise he is free to roam, to choose, and to leave” (Sauer 1963 [1925], 331).

The proper environmental and ethnological issues as well as cultural markers (place names, sacred sites, etc.) and the perpetuation of local knowledge constitute the intangible side of landscapes crucial in the understanding of socio-political territorial issues of reindeer husbandry (Cogos et al. 2017), and these have not been considered in this study. However, we believe that the proposed map might be a useable tool to ongoing researches on such areas.

### Methodological remarks

The close connection of reindeer husbandry to the regional bio-physical and cultural environment has been noted in many local and regional studies in Russia. These include analyses of the subsistence systems of Chukotka whale hunting and of reindeer husbandry among Nenets and Chukchi by Krupnik (1993), studies of the economic complexes of the Western Siberian peoples (Golovnev 1993), of the cultural landscapes of the Evenks, Tofalars and Tuvianian Toju (Ragulina 2000), of the ethno-economic areas of the peoples of Taimyr (Klokov 1997). A comparative analysis of the concept of landscape among the Izhma Komi and the Nenets was carried out by Istomin and Dwyer (2009, 2010, 2021). At the same time, there have been no survey works of this kind on traditional reindeer husbandry in the whole of Russia.

A number of studies have differentiated between types of reindeer husbandry in the Russian North on a geographical basis. Thus, Bogoraz (1932, 27) divided reindeer herding into the type where reindeer are harnessed and used in sledges, that is spread in tundra, and the type where riding reindeer is common, which is spread in taiga; these types were further divided into the eastern subtypes, where herding dogs were not used, and the western subtypes, where herding was performed with a help of dogs (Ienisei being the geographic border between them). Vasilevich and Levin (1951) identified five types of reindeer husbandry each based on a set of ethnographic features (we will hereafter refer to them as cultural types of reindeer husbandry).

Our methodology is based on the works of Russian geographers committed to the holistic landscape concept (see the overview of Frolova 2019), in particular, the cultural landscape concept suggested by Kalutskov (2008), and the principles of cultural–geographical zoning suggested by Manakov (2012) and Andreev (2012). The basic principle of this approach is the holistic view of the landscape as a socio-ecological system that integrates a specific human community with a specific part of the geographical environment.

Developing ideas of Sauer (1963 [1925]) and Kalutskov (2008), we believe that an individual reindeer herding cultural landscape (RPL/RPSES) is an area that is populated and developed by the local reindeer herding community. The landscape is developed by herders' community not only in economic, but also in cultural, semantic and other aspects, but in this paper, we limit ourselves to considering the aspect of traditional economy. Reindeer husbandry can be either a primary or a secondary economic activity, and its role in the landscape varies accordingly.

The plan for our research was as follows. First, we divided the entire reindeer husbandry area of the Russian North into several landscape zones focusing on the

predominant migration patterns of reindeer herders, as such patterns reflect the interaction of reindeer husbandry with the geographical environment as a whole. The next step was zoning by cultural types of reindeer husbandry. In the final third stage, we delineated the particular reindeer husbandry areas into smaller regions according to local reindeer husbandry characteristics.

This sequence was proposed by the well-known Russian economic geographer Smirniagin (2011) whose research was focused on zoning and delimiting various forms of economic activity. Although he did not study reindeer husbandry but other spheres of economy, his methodological advices were quite universal. He suggested starting by identifying the main drivers that create territorial differences in the economy, then identifying the main “kernels” of typicality (the most typical areas) on this basis and, only at the last stage, drawing boundaries between units (zones, districts, etc.).

In order to do this, we used our own empiric materials accumulated over many years of fieldwork research into reindeer husbandry in various areas of Russia, as well as literature sources and information by the Russian Statistics Agency reflecting reindeer numbers at the district level (Basa dannykh...). We also requested (and were granted) the data of the All-Russian Population Census 2010 on the number of the members of indigenous groups per municipal districts/city districts.

The results of the zoning and delimitation of areas with different types of reindeer husbandry are shown on the map (Fig. 1) and in Table 1, which contains the map legend.

#### Level 1: Zoning the reindeer husbandry area according to the seasonal migration patterns as connected to the natural environment

The natural environment determines the ecological conditions for reindeer and the natural context of the livelihood for herders. This is first of all climate and vegetation. On most of the flatland territory of Russia, climate and vegetation generally change in a regular pattern from north to south according to the latitudinal zonal concept. The exception is mountain regions where the law of latitudinal change of vegetation gives way to the vertical zonation, as well as an area close to the Pacific Ocean in the north-east of Russia. However, reindeer forage plant stocks do not always follow the zonal concept. In the tundra, the forage productivity of the vegetation cover increases towards the south. In the taiga, there is no such regularity as the distribution of reindeer lichen beds is significantly related to the nature of soil-forming materials.

In general, grazing conditions for reindeer in the tundra and taiga differ dramatically in terms of climate

conditions (wind, temperature and humidity conditions) and the accessibility of forage plants in winter (e.g. snow depth). This differentiation is also confirmed by the presence of two distinct ecological forms of both wild and domesticated reindeer in tundra and taiga. Herders' living conditions are strongly influenced by the availability of firewood, and it is difficult to winter in the tundra, where there is no wood.

Since the seasonal environmental requirements of reindeer are highly diversified, herders tend to use pasturelands in different landscape zones in different seasons. In the plains, this is possible due to many hundred kilometres long migrations; in the mountains, shorter seasonal relocations up and down the slopes were sufficient. In the case reindeer husbandry plays a leading role in a traditional economy, seasonal moving is completely subordinated to its interests. Not only pastures are taken into account in the nomadic migrations pattern. Many other conditions such as the possibility of river crossing, the need to pass by the village for shopping before moving long distances and to drive the reindeer to the slaughterhouse in the autumn are given consideration as well. Herders generally strive to be able to choose different ecological grazing areas and that is why pasture areas are most often associated with natural-landscape boundaries. The natural landscape borderland is therefore often seen as a coherent territorial unit in terms of the concept of the RPL. "Finally, it is important to note that no feature of the landscape is, of itself, a boundary. It can only become a boundary, or the indicator of a boundary, in relation to the activities of the people (or animals) for whom it is recognised or experienced as such" (Ingold 1993, 156).

In a similar way that three forms of modern reindeer pastoralism depending on the biogeography of the pastures, as well as on historical roots and traditions, can be distinguished in Fennoscandia (Holand et al. 2022, 16–17), the four most characteristic patterns of seasonal migrations can be identified in Russia (Klokov and Mikhailov 2017):

- 1) *Meridional (interzonal) pattern*: It is characteristic of large-scale tundra reindeer herding on the plains, where the latitudinal zonality of the landscapes is well-defined. Summer grazing areas are located in the tundra, while winter grazing areas are in the forest tundra and northern taiga. Seasonal migrations are often many hundreds of kilometres long.
- 2) *Mountain pattern*: Reindeer herders use the vertical zonality of mountainous landscapes, reindeer graze in the mountain tundra in summer and in the river valleys and at the foot of the mountains in winter.

The distance between summer and winter pastures is significantly shorter than in the previous pattern.

- 3) *Circular (within-zonal) pattern*: Seasonal grazing areas are relatively compact, tens of kilometres apart, and situated within the same landscape zone. Over the course of the year, the herd makes one or more circles to distribute the grazing load evenly over the pastures. This pattern is typical for forest tundra and northern taiga as well as for northern tundra if southward migration is difficult or impossible (e.g. on islands).
- 4) *Local pattern* is characteristic of transport reindeer husbandry in the taiga, where herds are small and continuously kept in approximately one area. Fencing is frequently used.

According to Paine (1972), migrations of the first and second pattern can be regarded as resource migrations and the third as distributing ones.

Based on these patterns, we first delimited the landscape zones with large-herd tundra and small-herd taiga reindeer husbandry. These two eco-economic patterns differ in many ways. The main differences can be summarised as follows (Klokov 2007, 2011).

The features of typical of taiga reindeer husbandry are small herds; the use of reindeer mostly for transportation, short migrations, free grazing in the summer; the use of special means of attracting and taming reindeer (smoke chimneys, tethering, fencing, salt feeding); and a number of others.

Tundra reindeer husbandry represents the pastoralism proper, characterised by large herds, the focus of the economy on meat and antler production, long interzonal migrations, permanent herd control, a low degree of domestication of most reindeer (except sledding animals) and a number of other features. It should be noted, that despite being designated as "tundra herders", these reindeer herders also use pastures located further south in the forest tundra and northern taiga for wintering.

With the exception of the long seasonal migrations, measured in hundreds of kilometres, the features highlighted above for tundra reindeer husbandry are also characteristic of large-scale reindeer husbandry in the mountains.

Therefore, at the first level of delimitation, we have divided the tundra and taiga reindeer husbandry zones, and separately the mountainous reindeer husbandry zone.

To determine the zones boundaries, we used the most recent biome map developed at Moscow State University (Biomy Rossii [Biomes of Russia] (map) 2018) and reindeer husbandry land management records obtained from regional agencies in Murmansk Oblast', Nenets and Iamal-Nenets Autonomous Okrugs, Taimyr and Chukotka and maps from the

**Table 1** The spatial geographical system of landscape zones and regions, reflecting basic patterns of reindeer husbandry

Unit index and names	1	2	3
<b>I. Tundra reindeer husbandry zone</b>	<b>1488.5</b>	<b>+0.473</b>	<b>0.10</b>
<b>I. S. Area of Samoyedic tundra reindeer husbandry</b>	<b>1218.1</b>	<b>+1.550</b>	<b>0.47</b>
I.S1. Kola province	53.7	+0.321	0.15
I.S2. Province of east European tundra reindeer husbandry	259.4	+0.352	0.14
I.S3. Province of West Siberian tundra reindeer husbandry	905.0	+1.968	0.45
I.S3.1. Ural-Iamal region	144.3	+2.037	0.25
I.S3.2. Iamal region	315.3	+1.502	0.29
I.S3.3. Gyda region	271.9	+2.583	0.31
I.S3.4. Near-Enisey region	104.8	+5.164	0.82
I.S3.5. Nadym-Purovsky region	68.7	-1.653	0.52
<b>I.T. Tungus tundra reindeer husbandry area</b>	<b>41.7</b>	<b>+3.282</b>	<b>0.84</b>
I.T.1. Dolgan reindeer husbandry region of eastern Taimyr and western Iakutia	20.5	+2.246	0.42
I.T.2. Northern Iakutia Even, Evenk and Iukaghir reindeer husbandry region	21.2	+4.284	0.97
<b>I.Ch. Area of Chukotka-Koriak tundra reindeer husbandry</b>	<b>228.7</b>	<b>-5.969</b>	<b>0.95</b>
I.Ch.1. Central Chukotka tundra region (Chukchi reindeer husbandry with participation of Chuvans and Evenks)	187.5	-6.524	0.93
I.Ch.2. Tundra region of northeast Chukotka (Chukchi reindeer husbandry)	13.2	-6.762	0.79
I.Ch.3. Tundra region of South-Eastern Chukotka (Chukchi reindeer husbandry)	6.46	-2.213	0.27
I.Ch.4. Koriak-Chukotka region (Koriak, Chukchi, and Even reindeer husbandry)	21.61	-1.840	0.08
<b>II. Zone of taiga reindeer husbandry</b>	<b>113.9</b>	<b>-0.521</b>	<b>0.19</b>
<b>II.WE. The area of east European taiga reindeer husbandry: the Kola province</b>	<b>1.4</b>	<b>-1.677</b>	<b>0.48</b>
<b>II.WS. Western Siberian taiga reindeer husbandry area</b>	<b>61.1</b>	<b>-4.409</b>	<b>0.01</b>
II.WS.1. Region of Western Siberian taiga reindeer husbandry of the Khanty and forest Nenets	58.8	-1.876	0.41
II.WS.2. Selkup and Evenk reindeer husbandry region	2.3	-0.045	0.00
<b>II.T. Tungus taiga reindeer husbandry area</b>	<b>51.4</b>	<b>-13.558</b>	<b>0.36</b>
II.T1. Western Evenk reindeer husbandry province	0.70	+0.747	0.10
II.T2. Province of Evenki-Iakut reindeer husbandry	44.2	+1.144	0.18
II.T3. Far East province of Evenk and Uilta reindeer husbandry	6.5	-9.667	0.26
<b>III. Mountain reindeer husbandry zone</b>	<b>106.8</b>	<b>-6.087</b>	<b>0.78</b>
<b>III.1 Ural area of Samoyedic reindeer husbandry</b>	<b>12.2</b>	<b>+4.190</b>	<b>0.07</b>
<b>III.2 East-Iakutsk area of Tungus (Even) reindeer husbandry</b>	<b>72.5</b>	<b>-6.940</b>	<b>0.92</b>
<b>III.3 Magadan-Kamchatka area of Tungus (Even) reindeer husbandry</b>	<b>24.9</b>	<b>-8.696</b>	<b>0.87</b>
<b>III. 4. South Siberian Saian reindeer husbandry area</b>	<b>2.6</b>	<b>+3.028</b>	<b>0.06</b>
III. 4.1. Tofalar reindeer husbandry region	0.35	+2.179	0.18
III. 4.2. Tuvinian reindeer husbandry region	2.3	+2.755	0.08
III. 4.3. Soiot reindeer husbandry region	0.05	+4.590	0.30

The table presents the legend on the map (Fig. 1)

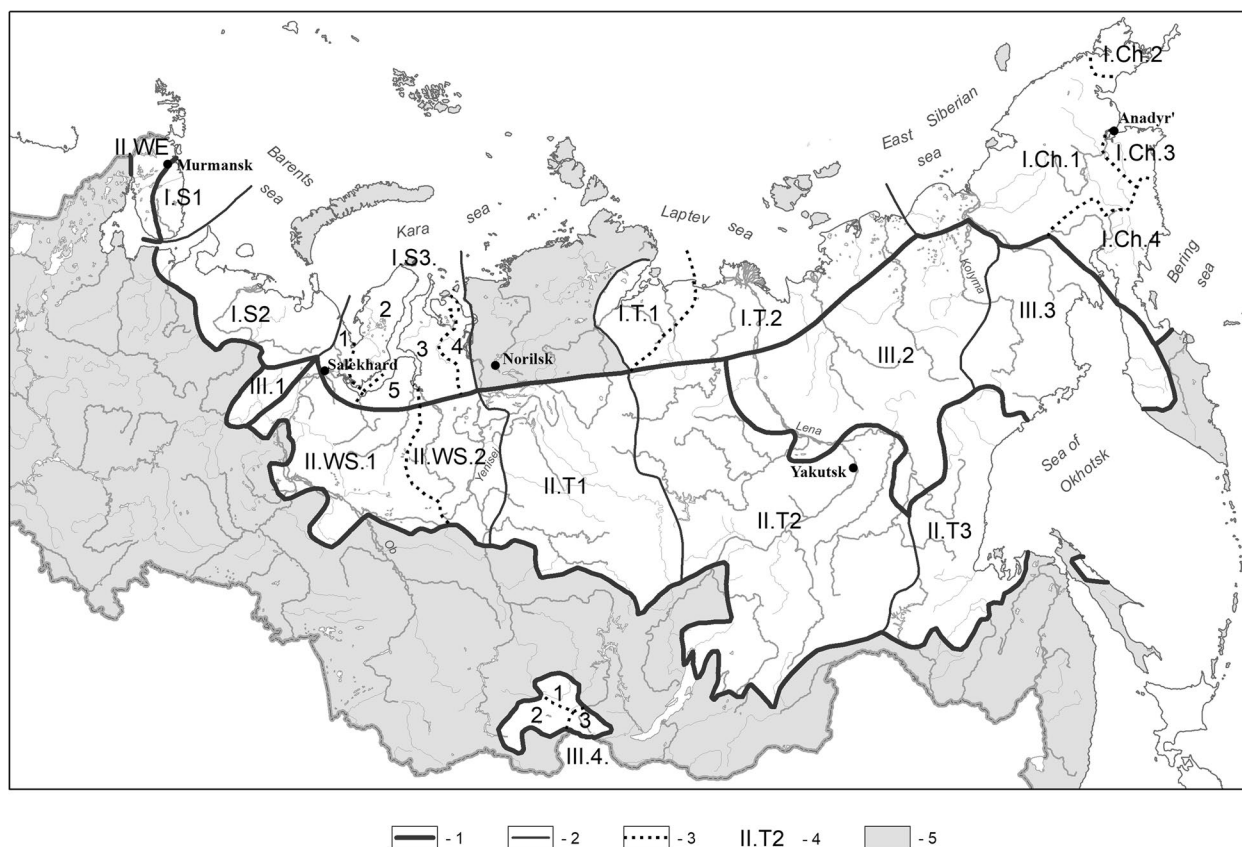
Key symbols: 1—number of domesticated reindeer, average 2010–2019, thousand; 2—reindeer number regression coefficient, 2010–2010 (calculated using Microsoft Excel's SLOPE function; prior to calculation the data have been normalised to the period average); 3—Pearson determination coefficient (calculated using Microsoft Excel's RSQ function)

Iakutia Agricultural Atlas (Atlas selskogo khoziaistva Iakutskoi ASSR [Atlas of agriculture of the Iakutia Republic] 1989).

#### Level 2: Delimitation of reindeer husbandry areas according to their cultural diversity

Every community runs reindeer husbandry in its own way, slightly different from others, according to its own

traditions. A great number of well-known ethnographic facts provide evidence of this. For example, mobile dwellings and sledges are made quite differently by the Nenets, Chukchi and Iakuts. The Izhma Komi and Nenets constantly control their herds, while other peoples more often let reindeer graze freely. The Nenets and Komi make permanent use of herding dogs, sit on the left side of their sledges when travelling and use their



**Fig. 1** Delimitation of areas and regions with different types of reindeer pastoralism in northern Russia. Legend: 1—borders of reindeer husbandry zones; 2—borders of reindeer husbandry areas and provinces; 3—borders of reindeer husbandry regions; 4—index of areas, provinces and regions (see Table 1); and 5—territory, without reindeer husbandry

sledges not only in winter, but also in summer. The Chukchi do the opposite in all this. Historically, different peoples have different ways of breeding reindeer. That is why reindeer bred by different northern peoples differ significantly in their size and appearance. In Russia, it is customary to differentiate between four main reindeer breeds: Nenets, Chukchi, Even and Evenki. In addition, some breed groups are also distinguished, such as Tofalar reindeer.

These features provide grounds to divide the reindeer herding areas not only according to the natural environment but also according to the cultural characteristics and traditions of herders' communities. We based this division on the already mentioned division of reindeer husbandry into five cultural types (Vasilevich and Levin 1951). Two of them, Samoyed and Chukotka-Koriak, historically developed in the tundra and possessed all the characteristic features of tundra reindeer husbandry. The Samoyed type includes Nenets and Izhma Komi reindeer husbandry. However, many of its features (e.g. sledge construction, the use of a herding dog, the Nenets reindeer breed) are also found in the reindeer husbandry of

Khanty and Selkups in the Western Siberian taiga. The currently extinct reindeer husbandry of Nganasans, Mansi and Kets also used to belong to this type.

The Chukchi, Koriak and Chuvan reindeer husbandries make up the Chukchi-Koriak type, and the Tofalar, Todzhin-Tuvinian and Sioit make up the Saian type. The Tungus type was created and developed in Eastern Siberia by the Evenks and Evenks as a typical pattern of taiga reindeer husbandry. Later, it was extended to the northern Yakutia tundra as well. This type also includes reindeer herding of Dolgans, Iukaghirs, Yakuts and Uiltas (in Sakhalin).

The Sámi type of reindeer husbandry has not survived in Russia. Some of its features (especially the free pasturing in summer) can be found in the modern reindeer husbandry of the Kola Peninsula. In this respect, the tundra and forest tundra of the Kola Peninsula have been identified as a separate ethno-cultural province with a peculiar pattern of seasonal reindeer grazing.

In the recent past, reindeer husbandry was also practised by the Pomors in the taiga part of the Kola Peninsula. The Pomors is a particular ethnographic group of

Russians. Their reindeer herding cannot be included in any of the types mentioned above (Kozmin 2003). At present, there is only one two-person Pomor reindeer herding brigade left on the Kola Peninsula (Kirill Istomin, personal communication).

In line with these differences, we have delimited the regions and provinces using data population census in Russia 2010 and maps from (Turaev et al. 2011). These sources enable us to trace the boundaries of each indigenous people's area of settlement. With a few exceptions, these boundaries followed the administrative-territorial division into municipal districts.

The most important exception has been the Taimyr municipal district, the largest one. Its western part, on the left bank of the Yenisei, is occupied by the Nenets people, who herd over 100,000 reindeer there. There is also a small area of Dolgan reindeer husbandry with about 3000 reindeer on the eastern edge of the Taimyr district. Nganasans used to herd reindeer in the central Taimyr, but their reindeer husbandry disappeared after the increase in wild reindeer population in the 1980s. Currently, there is no reindeer husbandry in the central part of Taimyr. For these reasons, we divided the Taimyr into three parts: the western part with Nenets reindeer husbandry (I.S3.4), the eastern part with Dolgan reindeer husbandry (I.T.1) and the central part, which has been marked as an area with no reindeer husbandry.

### Level 3: Delimitation of reindeer husbandry areas according to the local particularity

At the third level of our zoning, we applied the methodological technique of “floating” feature (Smirniagin 2011; Manakov 2012). This technique implies the use of different delineation criteria in different territories in accordance with the characteristic features of spatial differentiation historically evolved in a given place. We have employed this technique only in some cases, as there is not yet enough material to carry out detailed zoning for the whole of Russia.

1. Two landscape regions (I.Ch.2 and I.Ch.3) have been separated in the Chukotka Autonomous Okrug as areas of so-called “risky reindeer breeding” (Mironenko 2000). There is a high risk of ice crust formation there. After the market reforms of the 1990s, reindeer herding declined very dramatically in that region. In the southern region (I.Ch.3), it disappeared altogether, and then it was restored on a small scale. At the same time in the central Chukchi landscape area (I.Ch.1), the decline in reindeer husbandry was not so dramatic.

2. In the West Siberian sub-region of tundra Nenets reindeer husbandry (I.C.3), four landscape areas have been identified. A number of features were used to distinguish them, including the direction of seasonal migrations, the extent of industrial impact on pastureland, relations with industrial companies, the balance of different forms of reindeer ownership and trends in the number of reindeer.
3. In the West Siberian taiga reindeer husbandry area, the regions are delineated in accordance with the ethnic variability of the indigenous population.

The resulting zoning pattern reflects significant characteristics of reindeer pastoralism and its connections to the natural, socio-economic and cultural context in the RPSES framework. Previous publications (Klokov 2011, 2012, 2020a, b) have already summarised the main differences between tundra and taiga reindeer husbandry, which corresponds to the first level (step) of delimitation and between Nenets, Chukchi and Evenk reindeer husbandry, which corresponds to its second level. On the map (Fig. 1), these distinctions, presented earlier in the comprehensive text, got geographical localisation. The main features of reindeer husbandry, categorised by cultural type, are shown in Table 2.

### Discussion

The reindeer herding area zoning pattern we have proposed takes into account both the natural and socio-cultural aspects of reindeer pastoralism. In addition, each unit delineated on the basis of these aspects constitutes a kind of geographical identity—RPL/RPSES. According to Sauer, the identity of a landscape is based on “constitution, limits and generic relation to other landscapes, which constitute a general system”, while the landscape is considered in a sense as having an “organic quality” (Sauer 1963 [1925], 321–322). It cannot be said that the attributes of reindeer husbandry in each unit are formed by simply combining the natural, socio-economic and cultural characteristics. In each unit, RPL/RPSES has its own unique (special, individual) features and its own historic background.

Thus, reindeer herders' migration patterns cannot be predicted on the basis of knowledge of the structure of the natural landscape only, or on the basis of cultural traditions alone. Such patterns form as a result of a sophisticated and prolonged interaction between the former and the latter. On the one hand, many features of the traditional reindeer pastoralism were historically shaped by the surrounding natural landscape. This resulted in a convergence of economic forms, which was similar to the convergence phenomenon in the evolution of species. We can see this in the large number of common features



**Table 2** The main features of reindeer husbandry (RH) by main cultural types

Criteria	Samoyed type	Chukotka-Koriak type	Tungus type
Location	Kola Peninsula	North-East of Russia	Iakutia
Main reindeer herding peoples	Izhma Komi, Nenets and Samiés	Chukchies and Koriaks	Evenks
Natural environment	Lowland tundra and northern taiga	Mountains and plains in tundra and forest-tundra	Mountains in northern taiga and forest-tundra
Reindeer pastures	Shortage of pasture in some plots	Winter ice crusts in the Pacific Ocean coastal area. Deficit of pastures during the Soviet time and an abundance of free pastures now	Caring capacity of pastures has always been and remains much larger than reindeer stock number
Main traditional activities in the past	Two main types of traditional activities—management of large reindeer herds (Komi and Nenets) and a combination of fishing, reindeer herding and hunting (Samiés)	Management of large reindeer herds focused on meat and skins production	Using reindeer as transport during winter trapping expeditions. Rich herders usually leased their reindeer for transport use. Vagrant life without regular migration ways used to be a characteristic feature
Trends of reindeer numbers as the result of market reforms (1990s–2000s)	A modest reduction of reindeer number (of about 10%)	Significant increase in reindeer number in the private sector and a small reduction in municipal enterprises	Graduate decrease in reindeer number since the 1960s when mechanical transport started to replace transport animals in taiga. In several districts, RH was lost
Trends of reindeer numbers since 2010	Slight negative trend	Negative trend	Fluctuation with a general negative trend
Methods of nomadic migrations (between summer and winter areas)	The summer (in the tundra) and winter (in the taiga) grazing areas are partially separated by fences. In spring, herders let reindeer graze freely in the tundra. In late autumn, they gather them, drive them in a corral and divide them into herds	Very long seasonal migrations (many hundred kilometres each). All loads including mobile dwellings are moved mainly by reindeer sledges	Short seasonal migrations. Loads are usually moved on pack reindeer or by reindeer sledges (in winter)
Way of life nowadays	Herders live mainly in houses or cabins built in the tundra and taiga (so-called temporary bases). Most parts of women stay in settlements	High percentage of fully nomadic families with very long migration ways (up to 1000 km)	Herders live partly in permanent camps in taiga and partly in villages. Distance between summer and winter pastures is measured by tens of kilometres

**Table 2** (continued)

Criteria	Samoyed type	Chukotka-Koriak type	Tungus type
Herd control	Free grazing of reindeer in summer combined with some monitoring of the herd in winter	Permanent (round-the-clock) herd control using reindeer sledges in summer, sledges and snow-scooters in snow time. The widespread use of herding dogs	Permanent (round-the-clock) herd control on foot in summer, using snow-scooters during snow time
Structure of reindeer herd	High percentage of productive females	Complex herd composition. Significant percentage of castrated bulls used for transportations. Non-productive females are also in demand as transport force	High percentage of productive females
Main sources of income nowadays	Meat production	Meat and velvet antlers production	State (regional) support, meat production, subsistence use of reindeer meat and skins
Balance between family-based reindeer husbandry (with privately owned) and reindeer husbandry in enterprises	The proportion of private reindeer is small (about 10%)	During the Soviet period, the percentage of privately owned reindeer had never sunk below 28%. Now, 70% of reindeer are private. The number of private reindeer is still increasing	No reliable data
Priorities and adaptive strategies nowadays	Herders work for reindeer herding enterprises for a wage. The Sami occasionally attempt to keep small herds of reindeer for a tourism business	The main aim of herders is to enlarge the family-owned herd and to keep the nomadic way of life. Private reindeer herders are in the opposition to the regional administration	Herders combine herding with hunting and fishing
External negative impacts and challenges	Severe disturbance of reindeer by outsiders, including poaching (illegal shooting of domestic reindeer)	Gas and oil industry encroachment, fragmentation by infrastructure	Local small-scale impact of different kinds of industrial development
			Free pasturing is typical, smoking fires, and fences are often used during the snowless time
			Significant percentage of castrated bulls used for transportations
			Cash income derived mostly from hunting fur animals (sable) with reindeer used as transport. Subsistence use of reindeer meat and skins to a small extend
			Combining of herding with other activities. Easy transition from herding to non-traditional activities. Mostly, individual patterns of adaptation to changing social environment
			Wild reindeer impact, local small-scale industrial impact

present in all forms of tundra as well as of taiga reindeer husbandry. However, the neighbourhood factor is also important, as neighbouring groups often share herding practices with each other. As detailed studies of reindeer herding practices among the Nenets and Izhma Komi (Istomin et al. 2017, 120–122) have shown, a number of places have developed their own regional herding system, in which representatives of different ethnic communities are involved. However, in other cases, it has been noted that within even one municipal district, embedded traditions of different ethnic reindeer herding communities play a prominent role. Such examples are provided by Khakhovskaia (2007, 83) for the North-Even district of the Magadan region, where the Even and Koriak reindeer herding communities are located side by side.

According to Tim Ingold, the landscape is never complete: neither “built” nor “unbuilt”, it is perpetually under construction. It is made by humans, and it makes humans (Ingold 1993, 162). Thus, the study of the cultural landscape is always associated with its history and retrospective analysis. Although the temporal aspect is not considered in this paper, the zoning proposed here is based also on a detailed study of the temporal changes in reindeer husbandry over the past decades, the results of which have been outlined in previous works (Klokov 2011, 2012, 2020a, b). Each of the identified on the map (Fig. 1) landscape area has its own specificity, both in terms of the history of reindeer herding communities and in terms of reindeer population dynamics. Thus, the map reflects both the synchronicity and diachronicity of the RPL.

The proposed zoning system makes it possible to present the regional dynamics of the reindeer population in Russia in all its diversity in a compact form (Table 3). This table relates to the current situation; a retrospective analysis over the last few decades could be a subject of a separate paper.

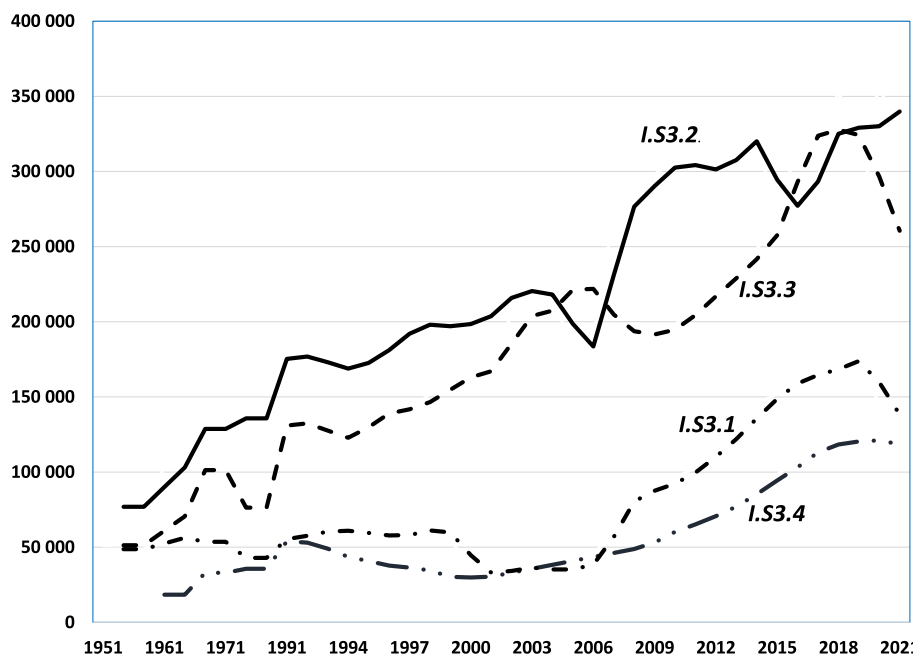
Thus, the interesting spatial and temporal phenome is the rapid growth of the domesticated reindeer population in the tundra between the Ural Mountains and the Ienisei River (I.S3). It is difficult to correlate it with a certain set of environmental factors. However, it is clearly localised in the geographical space and driven by institutional changes (e.g. by the transition of reindeer from public ownership to private property, etc.), which for some historically specific reasons have occurred in this area only. This growth began in the Iamal district in the 1960s and accelerated after the market reforms of the 1990s. Later, the area of this growth extended to the neighbouring Tazovsky district to the east, in the middle of the 2000s to the neighbouring Priuralsky district to the west, and then expanded to the right bank of the Ienisei in the Taimyr district (Fig. 2).

The phenomenon of the rapid increase in the number of reindeer in this province can be explained neither by any single natural or socio-economic factor nor by their combination. The key to this phenomenon probably lies in the ethnocultural characteristics of the mentality of this regional group of reindeer herders (Klokov 2020a, b). Studies by ethnographers and sociologists have indicated that the size of a reindeer herd is the main criterion of social status and material well-being for the group. In other indigenous groups in the area, such as Nenents fishermen, money is the main criterion of material well-being (Martynova 2014). Combined with the socio-economic environment and the political history of the Iamal-Nenets Autonomous Okrug, this focus on increasing the private herd of reindeer, often even at the expense of an economic gain, resulted in the transition of most reindeer from public to private ownership and the escape of reindeer husbandry from the control of the local authorities. The result of this growth, exacerbated by the withdrawal of pastures for industrial development, has been a looming ecological crisis of pasture resource

**Table 3** Distribution of zoning units (areas and provinces) and reindeer number by landscape zones and cultural type of reindeer husbandry

Landscape zones	Cultural types of reindeer herding														
	Samoyed			Tungus			Chukchi-Koriaks			Saian			Others		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Tundra	1.S1	3.5	≈	1.T	3.3	+	1.Ch	9.8	-	x					x
	1.S2	16.2	+												
	1.S3	55.6	+												
Taiga	I.WS	3.3	≈	II.T	3.1	-	x			x			II.WE	0.0	-
Mountains	III.1	0.9	+	III.2	3.4	-	x			III.4	0.1	-	x		
				III.3	0.9	-									

1—index of units on the map (Fig. 1); 2—number of reindeer (% from the total reindeer number in Russia); 3—trends: growth, +; reduction, -; about the same level, ≈



**Fig. 2** Increase in the reindeer number in the province of West Siberian tundra reindeer husbandry. For the index of regions, see Table 1

depletion, much the same pattern as the classical case of “the tragedy of the commons”. (Hardin 1968; Ostrom 1990).

Another “mysterious” case of the evolution and transformation of the cultural landscape we see in north-eastern Russia in the ongoing depression of Chukotka-Koriak reindeer husbandry, which was the most successful type of reindeer husbandry in Soviet times (1970–1980). Equally “enigmatic” is the diversity of trends in taiga and mountain reindeer husbandry in Eastern Siberia (Klokov 2020a, b). It is hoped that an analysis based on a holistic approach that synthesises natural, socio-economic and cultural interrelationships will help to clarify and provide guidance for supporting reindeer husbandry in these areas.

### Conclusion

The research has resulted in a map of traditional reindeer husbandry landscape zoning. This map comprises 35 units (RPL/RPSES) related to four taxonomic levels including the whole territory of Russia where traditional reindeer husbandry still exists. This zoning makes it possible to develop a holistic landscape concept in at least three aspects.

Firstly, it can contribute a better understanding of the dependence of reindeer husbandry on environmental factors, e.g. pasture degradation, climate change, increase/decrease in the number of competitors (wild reindeer), predators and diseases, which is important for assessing

the sustainability of reindeer husbandry and to compare the role of socio-economic and bio-physical drivers in terms of landscape sustainability science.

Secondly, it can lead to a better understanding and explanation of the diversity of RPSES responses to external influences (such as the transition from planned to market economy in the 1990s), the modification of political environment (including Russian federal legislation) and global changes (such as the spread of technological innovations, etc.). This is important in terms of regional landscape governance and state protectionism for reindeer husbandry.

Thirdly, the map provides a kind of “inventory” of different forms of traditional reindeer husbandry what is important for historical ecology studies (Balée 2006) in terms of safeguarding herders traditions as intangible cultural heritage and a resource for tourist business (Kuleshova 2013).

The landscape approach not only makes it possible to trace the reindeer husbandry’s dependence on the local natural and socio-cultural environment but also reveals how pastoralism shapes the landscape, primarily influencing its vegetation. In this case, a study of the modern landscape is then combined with field paleoecological, palaeographic, historical and archaeological methods (Anderson et al. 2014; Seitsonen and Fjellström 2022). The former is a classic example of an integrated approach for studying the landscape agency in Evenki-Iakut reindeer husbandry along the Zhuia River in Eastern

Siberian taiga (this site is located in II.T2, Fig. 1). This study pointed how the landscape might “offer itself” for vastly different types of human and/or animal actions. The role of landscape agency was to attract both people and animals (reindeer), each of whom could be recognised by each other to a greater and lesser extent when sharing a common space.

The landscape and SES research is also being carried out in Iamal tundra focusing on the interaction between pastoralism and pasture plants, as in this area reindeer grazing has a strong influence on vegetation succession, especially shrub growth (Forbes et al. 2009; Skarin et al. 2020; Spiegel et al. 2022). The most recent paper of Istomin (2023) attempts to analyse diverse forms of reindeer pastoralism in the European part of Russia from the viewpoint of the landscape approach. He comes to the conclusion that reindeer pastoralism, with its particular techniques of herding and modes of interaction between humans and reindeer, transforms the natural environment making the natural landscape domesticated in the sense that it turns into an integral part of the pastoralist system just as wild reindeer had previously become such a part (Istomin 2023, 8).

The identification of individual landscapes also provides an opportunity to use the methodological approach of Tsing (2015, 167–176) according to which landscape is a cumulative result of occasional encounters. It cannot be explained away by a reference to general principles only, but its understanding is possible only in the form of history, that is a narrative about the succession of encounters that give rise to it (Istomin 2023, 2). Thus, the distinctive reindeer herding system in northern Russia on the Kola Peninsula (see I.S1 on Fig. 1) cannot be explained without taking into account the history of relations between the autochthonous Sami reindeer herders and the Izhma Komi and Nenets who moved there with their reindeer herds in the late nineteenth century.

Hence, the results of reindeer pastoralism studies often need to be linked to specific locations (landscapes). In other words, they need to be put on the map. The above zoning scheme of Russian reindeer husbandry is, on the one hand, a result, but on the other hand, a tool for further research.

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#### References

- Anderson, D.G., E.M. Ineshin, N.V. Kulagina, et al. 2014. Landscape agency and Evenki-lakut reindeer husbandry along the Zhuia River, Eastern Siberia. *Human Ecology* 42: 249–266. <https://doi.org/10.1007/s10745-013-9632-6>.
- Andreev, A.A. 2012. Opyt kulturno-landshaftnogo raionirovaniia Rossii [The experience of cultural and landscape zoning of Russia]. *Pskovskii Regionological Journal* 13: 12–25 (In Russian).
- Angelstam, Per, Jose´ Munoz-Rojas, and Teresa Pinto-Correia. 2019. Landscape concepts and approaches foster learning about ecosystem services. *Landscape Ecology* 34: 1445–1460. [https://doi.org/10.1007/s10980-019-00866-z\(0123456789\),-volV\(0123456789\),-volV](https://doi.org/10.1007/s10980-019-00866-z(0123456789),-volV(0123456789),-volV). Accessed 18 Nov 2022.
- Antonov, E.V., T.V. Litvinenko, and V.N. Nuvano. 2019. Multiscale analysis of the dynamics in reindeer herding in arctic regions: Geographical shifts and intraregional and local differences. *Regional Research of Russia* 9 (1): 53–65.
- Atlas selskogo khoziaistva lakutskoi ASSR [Atlas of agriculture of the lakutia Republic]. 1989. Moskva: GUGiK SM SSSR [In Russian].
- Balée, W. 2006. The research program of historical ecology. *Annual Review of Anthropology* 35: 75–98. <https://doi.org/10.1146/annurev.anthro.35.081705.123231>.
- Baskin. 2016. Sovremennoe olenevodstvo v Rossii: Sostoianii, mobilnost, prava sobstvennosti, paternalism gosudarstva. *Etnograficheskoe Obozrenie* 2: 28–43 (In Russian).
- Bastian, Olaf. 2001. Landscape ecology – Towards a unified discipline? *Landscape Ecology* 16: 757–766.
- Baza dannykh pokazatelei munitsipalnykh obrazovanii Federalnoi sluzhby gosudarstvennoi statistiki Rossii [Database of indicators of municipalities of the Federal State Statistics Service of the Russian Federation]. <https://www.gks.ru/dbscripts/munst/munst.htm>. Accessed 4 Mar 2022 [In Russian].
- Berkes, F., J. Colding, and C. Folke. 2003. *Navigating social-ecological systems*. Cambridge: Univ. Press.
- Berkes, Fikret and Carl Folke. 1994. Linking social and ecological systems for resilience and sustainability. *Beijer Discussion Paper Series* 52. [https://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/4352/Berkes-linking\\_social\\_and\\_ecological\\_systems\\_for\\_resilience\\_and\\_sustainability.pdf?sequence=1](https://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/4352/Berkes-linking_social_and_ecological_systems_for_resilience_and_sustainability.pdf?sequence=1).
- Biomy Rossii [Biomes of Russia] (map). 2018. Scale 1:7 500 000. Moskva: Department of Geography, Moscow State University. <https://wwf.ru/what-we-do/bio/biomy-rossii/>. Accessed 17 May 2022.
- Bogoraz-Tan, Vladimir G. 1932. Severnoe olenevodstvo po dannym Khoziaistvennoi perepisi 1926–1927 gg. [Reindeer husbandry, data of the Economic Census 1926–1927]. *Sovetskaia Etnografiia* 4: 26–62.
- Cogos, S., M.M. Roue, and S. Roturier. 2017. Saami place names and maps: Transmitting knowledge of a cultural landscape in contemporary contexts. *Arctic, Antarctic and Alpine Research* 49 (1): 43–51.

- Cosgrove, D.E. 2009. Cultural landscape. In *The Dictionary of Human Geography*, 5th ed., 133–134. Blackwell Publishing Ltd.: Chichester.
- Courault, Romain, Gregory Duval et Marianne Cohen. 2018. La fragmentation des paysages de l'élevage des rennes. Une étude de cas en Laponie suédoise. *Géocarrefour*, 92/3. <https://doi.org/10.4000/geocarrefour.11035>
- Forbes, B.C. 2013. Cultural resilience of social-ecological systems in the Nenets and Yamal-Nenets Autonomous Okrugs, Russia: A focus on reindeer nomads of the tundra. *Ecology and Society* 18 (4): 36. <https://doi.org/10.5751/ES-05791-180436>.
- Forbes, B.C., M. Bolter, L. Muller-Wille, J. Hukkinen, F. Muller, N. Gunsley, and Y. Konstantinov, eds. 2006. *Reindeer management in northernmost Europe linking practical and scientific knowledge in social-ecological systems*. Berlin Heidelberg: Springer-Verlag.
- Forbes, B.C., F. Stammler, T. Kumpula, N. Meschtyb, A. Pajunen, and E. Kaarlejärvi. 2009. High resilience in the Yamal-Nenets social-ecological system, West Siberian Arctic, Russia. *Proceedings of the National Academy of Sciences* 106 (52): 22041–22048. <https://doi.org/10.1073/pnas.0908286106>.
- Frolova, Marina. 2019. From the Russian/Soviet landscape concept to the geo-system approach to integrative environmental studies in an international context. *Landscape Ecology* 34: 1485–1502.
- Gillin, Kramer. 2021. Variability is not uncertainty; mobility is not flexibility: Clarifying concepts in pastoralism studies with evidence from Tajikistan. *Pastoralism: Research, Policy and Practice* 11: 13. <https://doi.org/10.1186/s13570-021-00203-7>.
- Golovnev, A.V. 1993. *Istoricheskaia tipologija xoziaistva narodov Severa Zapadnoi Sibiri [Historical typology of the economy of the peoples of the North of Western Siberia]*. Novosibirsk: Nauka [In Russian].
- Golovnev, A.V., D.A. Kukanov, and E.V. Perevalova. 2018. *Arktika: atlas kochevykh tekhnologii*. Saint-Petersburg: MAE RAN [In Russian].
- Hardin, Garrett. 1968. The tragedy of the commons. *Science* 162: 1243–1248. <https://doi.org/10.1126/science.162.3859.1243>.
- Holand, Oystein, Horstkotte Tim, Kumpula Jouko, and Moen Jon. 2022. Reindeer pastoralism in Fennoscandia. In *Reindeer husbandry and global environmental change*, ed. T. Horstkotte, O. Holand, J. Kumpula, and J. Moen, 7–47. London: Routledge. <https://doi.org/10.4324/9781003118565-3>.
- Ingold, Tim. 1980. *Hunters, pastoralists and ranchers: Reindeer economics and their transformations*. New York: Cambridge University Press.
- Ingold, Tim. 1993. The temporality of the landscape. *World Archaeology* 25 (2): 152–174. <https://doi.org/10.1080/00438243.1993.9980235>.
- Istomin, Kirill V. 2023. Cultured reindeer, domesticated land, and (self)-cultivated herders: Histories and structures of reindeer herding landscapes in the European part of Russia. *Pastoralism* 13: 11. <https://doi.org/10.1186/s13570-023-00273-9>.
- Istomin, K.V., and M.J. Dwyer. 2009. Finding the way: A critical discussion of anthropological theories of human spatial orientation with reference to reindeer herders of Northeastern Europe and Western Siberia. *Current Anthropology* 50 (1): 29–49.
- Istomin, Kirill V., and Mark J. Dwyer. 2010. Dynamic mutual adaptation: Human-animal interaction in reindeer herding pastoralism. *Human Ecology* 38 (5): 613–623. <https://doi.org/10.1007/s10745-010-9341-3>.
- Istomin, K.V., K.V. Liskevich, and O.I. Ulyashev. 2017. Komi-Izhma reindeer herding husbandry: Ethnic invariants and local variations. *Bulletin of Archeology, Anthropology and Ethnography* 4 (39): 114–125. <https://doi.org/10.20874/2071-0437-2017-39-4-114-125>.
- Istomin, K.V., and M.J. Dwyer. 2021. *Reindeer herder's thinking: A comparative research of relations between economy, cognition and way of life*. Fürstenberg/Havel: Kulturstiftung Sibirien.
- Kalutskov, V.N. 2008. *Landshaft v kulturnoi geografii [Landscape in cultural geography]*. Moskva: Novyi xronograf [In Russian].
- Khakhovskaia, L.N. 2007. Magadaniskoie olenevodstvo v usloviakh rynochnoi ekonomiki [Magadan reindeer husbandry in a market economy]. *Vestnik DVO RAN* 3: 77–86 [In Russian].
- Khakhovskaya, L.N. 2019. Vzaimodeistviie liudei i zhivotnykh v chukotskom olenevodstve noveishego vremeni (antropologicheskii aspekt). *Vestnik Arkheologii. Antropologii i Etnografii* 1 (44): 98–107 [In Russian].
- Klokov, K.B. 1997. Northern reindeer of Taymyr Okrug as the focus of economic activity: Contemporary problems of reindeer husbandry and the wild reindeer hunt. *Polar Geography* 21 (4): 233–271. <https://doi.org/10.1080/10889379709377629>.
- Klokov, K.B. 2007. Reindeer husbandry in Russia. *International Journal of Entrepreneurship and Small Business* 4 (6): 726–784.
- Klokov, Konstantin B. 2011. National fluctuations and regional variation in domesticated reindeer numbers in the Russian North: Possible explanations. *Sibirica* 10 (1): 23–47. <https://doi.org/10.3167/sib.2011.100102>.
- Klokov, Konstantin B. 2012. Changes in reindeer population numbers in Russia: An effect of the political context or of climate? *Rangifer* 32 (1): 19–33. <https://doi.org/10.7557/2.32.1.2234>.
- Klokov, Konstantin B. 2020b. Raznonapravlennost trendov v traditsionnom olenevodstve narodov Sibiri i Arktiki [Divergence of trends in traditional reindeer herding of the peoples of Siberia and the Arctic]. In *Energiia Arktiki i Sibiri: Ispolzovanie resursov v kontekste sotsialno-ekonomicheskikh izmenenii*, ed. V.N. Davydov, 49–86. Moscow: Izdatelstvo vostochnoi literatury [In Russian].
- Klokov, K.B. 2020a. Diversity of regional trends in traditional reindeer husbandry in the Russian Arctic. In *IOP Conference Series: Earth and Environmental Science* 539:012180. <https://doi.org/10.1088/1755-1315/539/1/012180>.
- Klokov, K.B. and V.V. Mikhailov. 2017. Mekhanizmy vozdeistviia prirodnykh i socialnykh faktorov na zhizneobespechenie lokalnykh soobshchestv olenevodov v taezhnykh i tundrovnykh landshaftakh [Mechanisms of the impact of natural and social factors on the livelihoods of local communities of reindeer herders in taiga and tundra landscapes]. *Etnos i sreda obitaniia* 5:108–136. Moskva: IEA RAN [In Russian].
- Kofinas, Gary P. 2005. Research plan for the study of rapid change, resilience and vulnerability in social-ecological systems of the Arctic. *The Common Property Resource Digest* 5: 1–9. <https://hdl.handle.net/10535/2965>.
- Konstantinov, Yulian. 2015. Conversations with power: Soviet and post-Soviet developments in the reindeer husbandry part of the Kola Peninsula. In *Uppsala Studies in Cultural Anthropology*. Uppsala: Uppsala Universitet.
- Kozmin, V.A. 2003. *Olenevodcheskaia kultura narodov Zapadnoi Sibiri [Reindeer herding culture of the peoples of Western Siberia]*. Sankt-Peterburg: Izdatelstvo SPbGU [In Russian].
- Krupnik, Igor. 1993. *Arctic adaptations: Native whalers and reindeer herders of Northern Eurasia (Arctic Visions)*. Dartmouth College Press: Hanover.
- Kuleshova, M.E. 2013. Cultural landscapes and prospects for extending Russia's representation on the World Heritage List. *Regional Research of Russia* 3 (3): 301–307.
- Li, Li., Fabian Ewald Fassnacht, and Matthias Burgi. 2021. Using a landscape ecological perspective to analyze regime shifts in social-ecological systems: A case study on grassland degradation of the Tibetan Plateau. *Landscape Ecology* 36: 2277–2293. <https://doi.org/10.1007/s10980-021-01191-0>.
- Manakov, A.G. 2012. Struktura geokulturnogo prostranstva Rossii: Podkhody k delimitatsii [The structure of the geocultural space of Russia: Approaches to delimitation]. *Pskovskii Regionologicheskii Zhurnal* 14: 22–35 [In Russian].
- Martin, Geoffrey J. 2005. *All possible worlds: A history of geographical ideas*. 4th ed. Oxford University Press: New York–Oxford.
- Martynova, E. P. 2014. Predstavleniia o bogatstve u nentsev lamala [Ideas of wealth among the Nenets of lamala]. In *Sibirskii sbornik* 4, 161–170. Saint-Petersburg: MAE RAN [In Russian].
- Mathiesen, Svein Disch, Inger Marie Gaup Eira Ellen Inga Turi, Anders Oskal, Mikhail Pogodaev, Marina Tonkopyeva. 2013. *Reindeer husbandry adaptation to the changing Arctic. V.1*. Springer: Cham. <https://doi.org/10.1007/978-3-031-17625-8>
- Mironenko, O. 2000. Puti optimizatsii sistema zemlepolzovaniia i zemleustroistva olenevodchesko-promyslovnykh xoziaistv [Ways to optimize the system of land use and land management of reindeer herding and commercial farms]. *Novosti olenevodstva* 4, 70–79. Magadan: Zonalnyi NIISX Severo-Vostoka [In Russian].
- Ostrom, E. 1990. *Governing the commons*. Cambridge: Cambridge University Press.
- Paine, Robert. 1972. The herd management of Lapp reindeer pastoralists. In *Perspectives on Nomadism*, ed. W. Irons and N. Dyson-Hudson, 76–87. Leiden: E. J. Brill.
- Pearson, Diane M., and Julian T. Gorman. 2010. Exploring the relevance of a landscape ecological paradigm for sustainable landscapes and livelihoods: A case application from the Northern Territory Australia. *Landscape Ecology* 25: 1169–1183. <https://doi.org/10.1007/s10980-010-9498-6>.
- Ragulina M.V. 2000. *Korennye etnosy sibirskoi taigi: motivatsiia i struktura prirodopolzovaniia (na primere tofalarov i evenkov Irkutskoi oblasti)*. [Indigenous ethnic groups of the Siberian taiga: motivation and structure of nature

- management (on the example of the Tofalars and Evenks of the Irkutsk region)] Novosibirsk: Izd-vo SO RAN [In Russian].
- Reindeer husbandry and global environmental change pastoralism in Fennoscandia. 2022. Eds. Tim Horstkotte, Oystein Holand, Jouko Kumpula and Jon Moen. London and New York: Routledge. <https://www.taylorfrancis.com/books/oa-edit/https://doi.org/10.4324/9781003118565/reindeerhusbandry-global-environmental-change-jon-moen-oystein-holand-jouko-kumpula-timhorstkotte?context=ubx>. Accessed 18 Nov 2022.
- Sauer, C.O. 1963 [1925]. The morphology of landscape. Reprinted in J. Leighly ed., *Land and life: Selections from the writings of Carl Ortwin Sauer*, 315–350. Berkeley: University of California Press.
- Seitsonen, Oula and Markus Fjellström. 2022. Habitation sites and herding landscapes. In *Domestication in action: Past and present human-reindeer interaction in Northern Fennoscandia*, ed. A.-K. Salmi, 153–186. Palgrave Macmillan: Cham. <https://doi.org/10.1007/978-3-030-98643-8>.
- Skarin, Anna, Mariana Verdonen, Timo Kumpula, Marc Macias-Fauria, Moudud Alam, Jeffrey Kerby, and Bruce C Forbes. 2020. Reindeer use of low Arctic tundra correlates with landscape structure. *Environmental Research Letters* 15:115012. <https://doi.org/10.1088/1748-9326/abbf15>.
- Smirniagin, L.V. 2011. Metodicheskiye podkhody k raionirovaniyu v obshchestvennoy geografii. [Methodological approaches to zoning in public geography]. *Vestnik Moskovskogo Universiteta. Seriya 5 Geografiya* 6: 13–19 ([In Russian]).
- Spiegel, M.P., A. Volkovitskiy, A. Terekhina, B.C. Forbes, T. Park, and M. Macias-Fauria. 2022. Top-down regulation by a reindeer herding system limits climate-driven Arctic vegetation change at a regional scale: Data. *Oxford University Research Archive*. <https://doi.org/10.5287/bodleian:E2x6bnggk>.
- Tsing, Anna Lowenhaupt. 2015. *The mushroom at the end of the world: On the possibility of life in capitalist ruins*. Princeton: Princeton University Press.
- Turaev, Vadim, Rodion Sulyandziga, Pavel Sulyandziga, and Vladimir Bocharnikov. 2011. *Encyclopedia of Indigenous Peoples of the North, Siberia and the Far East of the Russian Federation*. Moscow: Centre for Support of Indigenous Peoples of the North (CSIPN). <https://www.iwgia.org/en/resources/publications/305-books/4302-encyclopedia-of-indigenous-peoples-of-the-north-siberia-and-the-far-east-of-the-russian-federation.html>. Accessed 18 May 2022.
- Vasilevich, G.M., and M.G. Levin. 1951. Tipy olenevodstva i ikh proiskhozhdenie [Types of reindeer husbandry and their origin]. *Sovetskaya Etnografiya* 1: 63–87 ([In Russian]).
- Wu, Jianguo. 2021. Landscape sustainability science (II): Core questions and key approaches. *Online Landscape Ecology*. <https://doi.org/10.1007/s10980-021-01245-3>.
- Wu, Jianguo, Qing Zhang, and Ang Li Cunzhu. Liang. 2015. Historical landscape dynamics of Inner Mongolia: Patterns, drivers, and impacts. *Online Landscape Ecology*. <https://doi.org/10.1007/s10980-015-0209-1>.

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