REVIEW

Striking the balance: Challenges and perspectives for the protected areas network in northeastern European Russia

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Abstract Increasing anthropogenic pressure on the largest remaining tracts of old-growth boreal forest in Europe necessitates additional conservation of ecosystems and biodiversity in northeastern European Russia. In a regional network comprising 8 % of the Nenets Autonomous District and 13.5 % of the Komi Republic, 248 areas have varying protected statuses as state nature reserves (zapovedniks), national parks, reserves/sanctuaries (zakazniks), or natural monuments. Due to increased natural resource extraction in this relatively pristine area, designation of additional protected areas is critical for the protection of key ecological sites. The history of ecological preservation in these regions is herein described, and recent recommendations for incorporating additional ecologically representative areas into the regional network are presented. If the protected area network can be expanded, the overall environmental stability in these globally significant ecosystems may remain intact, and can help Russia meet the 2020 Aichi conservation targets, as set forth by the Convention of Biological Diversity.

Keywords Ecosystem conservation · Komi Republic · National park · Pechora River · Zapovednik · Zakaznik

INTRODUCTION

There is an urgent need for establishing an ecological framework in northern Russia to ensure sustainable development and resource conservation (Evseev and Kravovskaya 2013). A coherent network consisting of multiple protected area categories is a key element of such a framework. The northeast portion of European Russia includes the mainland and adjacent island territories of the Nenets Autonomous District and the Komi Republic, and

contains important watersheds for both the Barents Sea and the Kara Sea, including the Pechora River basin (Fig. 1). The overall environmental stability in this region is greatly determined by the ecosystem status of natural complexes in the Pechora River basin, which is the largest river in Northern Europe. The river is 1809 km long, of which 1596 km are within Komi Republic, while the rest flows across the Nenets Autonomous District. The total area of the Pechora basin is 252 000 km². Starting in the mid-1950s, logging rates steadily increased and in recent decades, this natural resource-rich area has seen rapid development of the industrial extraction of coal, oil, gas, gold, bauxite, and other minerals (Ministry of Culture and National Policies of the Komi Republic 2006). The rate of anthropogenic transformation of the region's ecosystems is steadily growing; however, vast areas of forest still survive and disturbances to the landscape remain localized (Walker et al. 2009; Sieber et al. 2013).

Ecosystems in the far northern reaches of Europe are often quite vulnerable, many having a very thin layer of top soil that can be easily degraded. Following disturbance, the natural recovery rate of these ecosystems is extremely slow, and thriftless resource management may lead to unpredictable changes in the environment (Archegova 1992; Voronin et al. 1994; Archegova et al. 1996). This is evident in some of the taiga environments of the Pechora basin, where the percentages of mature and over-mature softwood stands have noticeably decreased, while significant stands of birch and aspen have developed as a result of timber clearing and fire (Larin 1987; Degteva et al. 1997; Pruchkin 1998; Degteva 2001). An increase in vegetation cover in forest ecosystems has been observed in some parts of the Komi Republic. This increase in productivity is statistically correlated with sites experiencing increases in temperature and decreased precipitation, with these

Fig. 1 The Komi Republic and Nenets Autonomous District (detailed map to the right) are part of the Russian Federation and are adjacent to the Barents and Kara Seas. The Pechora River is the largest river in northeastern Europe and is an important watershed in this region

impacts being most pronounced in the southern and middle subzones of taiga (Lopatin et al. 2006).

In the tundra areas, vast territories covered by reindeer pastures have become a zone of environmental conflict due to habitual overgrazing and the growing exploitation of oil, gas, and mineral resources. Anthropogenic transformation of tundra wetlands and shallow coastal waters of the Barents Sea have resulted in significant ecosystem change. In particular, disturbances to avian breeding grounds and shedding areas have had negative impacts on the abundance of aquatic and semiaquatic birds (Mineev 2000).

ENVIRONMENTAL IMPACT OF THE FOREST PRODUCTS INDUSTRY

In the mid-twentieth century, mechanization within the logging industry increased dramatically, and resulted in the highest level of anthropogenic impact on forest ecosystems in the Komi Republic. The impact was compounded by an increased demand for forestry products and raw materials associated with a growing pulp and paper industry, and increased shipments of lumber to the central and southern parts of Russia (Chuprov and Zabortseva 1998).

The volume of harvested timber totaled about 22 million cubic meters per year in the period from the mid-1960s until

the end of the 1980s. Consequently, the percentages of immature and mature stands within forest areas decreased, and quality of the forest stand structure deteriorated. The share of deciduous trees significantly increased, with about 20 % of the forested area converted from conifers to deciduous species.

In addition to an increase in the volume of timber harvested, changes in forest cover and species composition were associated with changes in silviculture methodologies. In place of shelterwood and seed tree harvest management systems, clear-cut harvesting, using large modular machines weighing up to 20–22 tons, was adopted. These larger machines sharply increased the negative impact of logging equipment on soil and vegetation. Areas with little-disturbed forest and areas of indigenous old-growth forests were significantly reduced. In this regard, the conservation of primarily undisturbed forest ecosystems has gained greater importance, and has become more urgent.

In the early 1990s, a general deterioration of Russia's economic situation impacted the region and the forest products industry. During this period, the production and consumption of wood dramatically reduced, and the lumber industry of the Komi Republic was noted as suffering the greatest rate of production decline in the logging industry (Pruchkin et al. 1999). By 1997, decreased demand for pulp and timber resulted in a decline of industrial wood harvest to 4.1 million m³ year⁻¹. In the last decade, forestry production

levels in the region rose slightly, averaging around 7 million $\text{m}^3 \text{year}^{-1}$. The percentage of young and middle-aged hardwood forests significantly increased by the end of the twentieth century and has not changed substantially in recent decades, which indicates continuing, large-scale impacts on forest ecosystems. To date, only two of the eleven large tracts of little-disturbed forest landscapes, identified in the Komi Republic, are within the regional system of protection (Yaroshenko et al. 2008). In particular, significant areas of coniferous forest, located in the northern, middle, and southern taiga ecotones, are not fully protected.

ENVIRONMENTAL IMPACT OF GAS AND OIL EXPLORATION ON THE ENVIRONMENT

The initiation of a market economy in modern Russia led to intensive economic development in the northern regions of the country. In recent decades, land located within the oil-rich Timan-Pechora Basin Province has been widely used for construction and operation of oil and gas production facilities, and transport, primarily by pipeline infrastructure. The majority of the northern oil fields have not yet been put into operation, but the amount of land involved in industrial use is increasing every year. Thus, in the Nenets Autonomous District, oil production started in 1984 at the Kharyaga field located at the border with the Republic of Komi. To date, 90 hydrocarbon fields are identified in the District, 39 fields producing oil, the rest being at various stages of preparation for the operation. The total oil production reached 200 million tons by October 2014 (Administration NAD 2014). Over the next few years, the planned commissioning of new fields will enable the volume of oil production to rise to 20 million tons per year.

Between 1995 and 2012, the number of producing oil fields has more than doubled (from 36 to 82) in the Komi Republic, with a total of 137 oil fields discovered in the region. Conversely, by 2012, only eight of the 138 natural gas fields identified were in production. While oil production increased, the volume of annual gas production fell by almost two times from the peak at beginning of the 1990s, and in 2012 was only 2.4 billion cubic meters. During this period, coal production also declined from 24.4 to 12.7 million tons per year as well. Peat extraction is currently underway on a limited scale.

A significant portion of hydrocarbon deposits in the northeast of European Russia is located in the permafrost zone, an ecosystem which is fragile and vulnerable to external influences (Olsen et al. 2011). Human activity is expanding, and in some cases, it is the only cause of changes in the permafrost. Buildings, roads, pipelines, facilities for open pit mining, unregulated traffic, and surface contamination have a strong impact on these areas.

For this reason, the permafrost is considered the most vulnerable ecosystem in the northern regions. Existing areas of permafrost in the far northern taiga are the most vulnerable permafrost wetlands of the boreal zone, where melting is very likely to occur. The peat layer, which protects the permafrost, is being degraded due to contamination by dust, sand, and oil. Any disturbance of the peat surface layers in the tundra leads to irreversible changes, transforming a carbon-sink ecosystem into a carbon-emitting system, either directly through emissions of greenhouse gases or, through hydrological flows subsequently becoming a source of emissions.

Habitat protection and rapid restoration of disturbed landscapes are essential for sustainable exploitation of hydrocarbon deposits in the permafrost zone. This is particularly important given the fact that the stability and functionality of ecosystems within the Bolshezemelskaya tundra support the traditional lifestyle of indigenous peoples of the North (Krasouskaya 2008).

Landscape transformation associated with exploitation of forests, active bog reclamation (Alexeeva 2009), and mining industry expansion stimulated scientists in the Komi Republic to conduct research for the purpose of documenting the need for the organization of protected areas. This research was actively supported by the regional government.

In this region, conservation has become a critical issue, especially in its tundra zone, where hunting and fishing limits are not strictly enforced and poaching pressure is high. Due to the increasing anthropogenic pressures on environmentally sensitive landscapes, such as old-growth boreal forests and wetlands, the development of a systematic monitoring plan is critical for establishing a baseline understanding of these biologically and ecologically important ecosystems. This paper outlines the history and the present status of protected areas in northeastern European Russia, and discusses the importance of identifying and preserving other important areas.

PROTECTED AREA CATEGORIES

In 1995, Russia ratified the Convention on Biological Diversity, taking on the shared global responsibility for conservation and sustainable use of biological diversity, agreed to by signing members of the international community. The period from the second half of the 1990s through the early 2000s was the time when environmental problems commanded significant attention, and a majority of regulations dealing with environmental protection were enacted in the Russian Federation during that period. It is important to note that law provisions are often amended to address changes in modern Russia. For example, since

2011, use of nature reserves has been expanded beyond the original allowances of solely conducting environmental education, to include permission for the organization of tourism.

The development of an integrated system of protected areas has been a core part of the national strategy aimed at preserving the structure of natural ecosystems and landscapes, species composition of particular areas, and biological diversity. On October 2, 1992, the President of Russia passed decree No. 1155 stating that the development and preservation of protected areas is a priority of the State Environmental Policy of the Russian Federation in order to ensure environmental safety and preservation of the national natural heritage of the peoples of Russia. This position was continued in the 2002 Environmental Doctrine of the Russian Federation (Decree of the Russian Federation Government, 31.08.2002 N 1225).

The main document regulating the organization, protection, and use of protected areas in the Russian Federation is the federal law No. 33-FZ: “On Specially Protected Territories,” originally passed on March 14, 1995, and most recently revised on October 14, 2014 with numerous amendments. Other regulations regarding the function of protected areas are covered by federal law No. 7-FZ: “On Environmental Protection,” which was originally adopted on January 10, 2002 and most recently amended on July 07, 2014. Other relevant regulations are contained in Russian Federal laws No. 136-FZ: “The Land Code of the Russian Federation” (adopted October 25, 2001 and amended July 21, 2014); N 200-FZ: “Forest Code of the Russian Federation” (adopted December 4, 2006 and amended July 7, 2014); and law No. 74-FZ: “Water Code of the Russian Federation” (adopted June 3, 2006 and amended July 28, 2014).

A variety of protected area designations, including both federal and local categories, were developed and implemented across Russia. The main protected areas managed by the federal government are classified as strict nature reserves (zapovedniks, IUCN category Ia), national parks (IUCN category II), zakazniks (sanctuary, IUCN category IV), and natural monuments (IUCN category III).

Zapovednik (Strict Nature Reserve, IUCN category Ia)—This designation ensures that the highest level of protection and the use of zapovedniks are restricted solely to the endeavors of environmental and scientific researchers and environmental education institutions. These groups work toward the study and preservation of both floral and faunal germplasms, as well as the study of associated natural processes and phenomena occurring within plant and animal communities. These reserves contain typical and unique ecological systems, as well as specially protected natural complexes and objects (including land, bodies of water, minerals, flora, and fauna) that are

completely withdrawn from economic use but have significant environmental, scientific, ecological, and educational values. These may be examples of typical or rare landscapes, and also may serve as places for genetic diversity conservation of both plant and animal species. Protection of zapovedniks is the responsibility of the federal government.

National (and Nature) Park (IUCN category II)—These designations are applied to areas that contain natural complexes and objects of special ecological, historical/cultural, and aesthetic values and that are intended for environmental, educational, scientific, and cultural purposes, as well as controlled tourism. Unlike the zapovedniks, conservation responsibilities fall under the jurisdiction of regional authorities. National parks include areas open for recreation and tourism, as well areas under strict protection that are not open to the public. National parks differ slightly from nature parks in that environmental protection is prioritized in National parks, while protection of the environment and public use activities are given equal priority in nature parks.

Zakaznik (sanctuary, IUCN category IV)—This class of protected area is of particular importance for the preservation or restoration of natural systems or their components and the maintenance of ecological balance. Federal and local zakazniks (wildlife sanctuaries) may have a specific species or feature that is of particular significance (landscape, biological (botanical and zoological), paleontological, hydrological, or geological). Proclaiming an area as a zakaznik allows for the withdrawal of the territory from private land owners. The zakaznik designation permanently or temporarily prohibits or restricts any activity inconsistent with the objectives of the sanctuary or that harms natural complexes and their components.

Natural monument (IUCN category III)—These areas are managed for conservation of a unique and irreplaceable ecological, scientific, cultural, or aesthetic feature of natural or man-made origin. The main aim of declaring natural monuments is to preserve objects in their natural state. The owners and users of land in natural monuments are obligated to ensure the conditions of the monuments’ special protection.

KOMI REPUBLIC PROTECTED AREAS

Regulations enacted for the protection of some forested areas in Europe (Switzerland and England) are known from as early as the fourteenth century (Ritter 2011). Reasons for enacting regulations ranged from fear of avalanches and landslides in mountainous areas, to a lack of timber and firewood. Around the same time period, reforestation projects were conducted in Germany. The first measures to conserve forests in Komi were taken in

the eighteenth century, when Peter I (Tsar of Russia, 1672–1725) proceeded to build the Russian Navy. In Peter's time, forests became the property of the state. In the vast forested areas of the Pechora, Vychegda, and Mezen River basins, about 30 zakazniks were established, which lasted until the end of the reign of Peter I (Gladkova and Gladkov 1974). Protection of forest resources, particularly against unauthorized felling, was assigned to the Waldmeister Office of the Admiralty Board. The Waldmeisters were in charge of the forests adjacent to rivers (Shutikov and Popova 1997). During the reign of Catherine II, in the 1780s–1790s, general land surveys were carried out in Komi. Subsequently, the forest territories were subdivided into peasant, governmental peasant, and governmental allotments (dachas). In addition, wood plots were allotted to the Nyuvchim, Nyuchpass, and Kazhim iron factories.

In the late eighteenth and the early nineteenth centuries, the Forestry Department was established and a reform of local forest management was implemented (Shutikov and Popova 1997; Shutikov 1999). The Forestry Department was in charge of all woodlands except those owned by private individuals. The department's responsibilities included forest management and forest reclamation work, as well as protection of the forest against unauthorized felling and fires. The forests in provinces were subdivided into forestlands, wood plots, ranges, and inspection rounds. A Corp of Foresters was established, and freeholder peasants, who were appointed as forest keepers and fire foremen, played an important role in governmental forest conservation for almost a century. In 1869, recruiting of hired forest guards, foresters, and rangers began.

The immense woodlands of Komi, which is rather distant from the center of Russia, remained poorly studied for a long time. By 1917, only 4 % of the forests had been recorded as managed, and 38 % as surveyed. In the basins of the Vychegda and Mezen Rivers, governmental peasant wood plots, which comprised 5–10 % of the woodland area in each forest, were absolutely unexplored; the same was true for vast watershed areas in the Pechora basin located more than 10 km away from the rivers (Shutikov and Popova 1997). There was a sharp contrast between the vast areas of established forestlands (exceeding 2 million acres per forest) and the low number (<300) of foresters and rangers for the whole region. This noticeably reduced the efficiency of forest conservation. Local residents could not satisfy their needs for wood materials, primarily timber, out of their allotted peasant and governmental peasant plots, and often conducted illegal logging and clearing in governmental forests (Shutikov and Popova 1997; Shutikov 1999).

The first records on forest conservation in the Komi Republic, following the 1917 October Revolution, date

from 1922, when shelterbelts were allocated along the Luza River in the Noshul Forestland. As early as 1912, game warden S.G. Nat pointed to the importance of foothill and mountainous areas between the Ilych and Pechora Rivers for the protection of sable (*Martes zibellina*). However, the initiation of more extensive protection measures was delayed for more than 15 years. In 1926, the provincial government issued a decree that prohibited the felling of Siberian pine (*Pinus sibirica*), and in the late 1920s, research was launched to determine territories suitable for protected areas. In 1929 a research expedition headed by F.F. Schillinger was sent to the region and a feasibility study for a nature reserve was prepared (Schillinger 1929). The Russian Federation Government official decree establishing the reserve (it was called Pechora Zapovednik at that time) was issued on May 4, 1930. Initially, the primary goal of the strict reserve was to recover the number of valuable game animals, but by 1932 the reserve was granted the status of Research Institution. After the establishment of the Pechora-Ilych Zapovednik, no new protected areas appeared in the region for nearly 30 years. Only since 1959, when the Environmental Commission of the Presidium of the Komi Branch, USSR Academy of Sciences (currently the Komi Science Center of the Ural Branch, Russian Academy of Sciences) was created, has some systematic research been conducted in order to lay a foundation for the development of an extensive protected area system in Komi (Nepomilueva 1981; Nepomilueva and Laschenkova 1993; Degteva 1997; Degteva and Taskaev 1997; Taskaev and Degteva 1999; Degteva 2000; Ponomarev 2011).

The fundamental principles of the protected area network organization are preservation of unique natural complexes and objects that have suffered reduction in area due to anthropogenic stress; preservation of natural complexes and objects typical for different geographical subzones and threatened with destruction and degradation; conservation of gene pools for endangered species; and promotion of recreation, ecotourism, and education.

By the mid-1970s, a significant number of protected area designations occurred based on recommendations of the Environmental Commission. Four zakazniks dedicated to landscape preservation and 14 zakazniks dedicated to Siberian pine conservation were established, and more than 20 unique natural formations were declared natural monuments (Alexeeva et al. 1993, 1995). The most intense expansion of the protected area system occurred between the late-1970s and the mid-1990s. During that period, about 15 resolutions related to the establishment of zakazniks and natural monuments were passed by the Komi Republic regional government. These pieces of legislation were specifically based on the proposals produced by specialists of the Komi Research Center and local

government authorities. Several resolutions were also issued to approve local protected area regulations specifically related to Protected Natural Objects and Areas.

In addition to federal laws, legal status and management of protected areas in the Komi Republic also fall under the laws passed by the Komi Republic government. The most important Decrees of the Komi Republic Council of Ministers are listed in Table 1.

In 2002, restructuring of the protected areas network in the Komi Republic began, with the purpose of bringing it in line with the provisions of Federal Law No. 33-FZ. The protected areas which were fully or partially superimposed on other reserves (mainly reserves and natural monuments located within the current boundaries of national parks) were abolished. As a result, the number of protected areas decreased significantly (from 302 to 240). However, the overall protected territory remained the same. Starting 2014, the regions must coordinate with the Ministry of Natural Resources all changes made to the provisions on regional protected areas.

Currently, the Komi Republic has protected areas in all the categories defined by the Federal Law on protected areas: the Pechora-Ilych Biosphere Zapovednik, a national natural park (Yugyd Va), zakazniks, and natural monuments of various profiles: landscape, biological, hydrological, geological, etc. (Table 2). In all, 240 protected areas are functioning, covering an area of 5 615 945 hectares in total (13.5 % of the republic's territory), with the largest portion located in the Pechora basin.

The indigenous taiga phytocenoses that occur in the Komi Republic are dominated by Siberian polydominant taiga species, primarily Siberian spruce (*Picea obovata*), as well as Siberian fir (*Abies sibirica*) and Siberian larch (*Larix sibirica*). Despite intense forest exploitation, the region has retained the largest arrays of old-growth forests of the European North. Almost all of them are located in the Pechora basin. The primary coniferous forests display not only a rich gene pool of tree species, but also rare and endangered herbaceous plants, bryophytes, and lichens, as well as medicinal herbs. Forests are the predominant type of vegetation in the areas of the largest protected areas in the Pechora basin, i.e., the Pechora-Ilych Zapovednik and the Yugyd Va National Park. In 1995, by decision of the UNESCO international committee, these protected areas were entered on the World Nature Heritage list under the common title “Virgin Komi Forests.”

Although described as “virgin,” the forests of Komi have a long history of human presence. In fact, many of the so called “virgin” forests of the world have actually experienced anthropogenic influences for millennia. Research has shown that many forested regions previously described as “pristine” or “virgin” actually exhibit evidence of human utilization and that indigenous peoples

have played a significant role in shaping forest structure. This has been shown in tropical forests around the world (Heckenberger et al. 2003; Willis et al. 2004), as well as in boreal regions in Scandinavia and Canada (Josefsson et al. 2010; Johnson and Miyanishi 2012). These studies have found that long-term, low-intensity human activity has had distinct influence on forest structure and composition (Josefsson et al. 2009).

According to current archeological data, it is hypothesized that the first humans arrived to the northeastern region of European Russia during the Middle Pleistocene (Lower Paleolithic, about 70 000 years ago). Prehistoric settlements on the Upper Pechora and its major tributary, the Unya River, are dated to the period of the last (Valdai) Glaciation. The Pechora basin in the upper and middle reaches has been continuously inhabited starting from the Mesolithic and early Neolithic (8th–4th millennia BCE); however, the population density was and remains extremely low. Hunting, fishing, and gathering remained the main occupations of the tribes inhabiting the region until the first millennium CE.

Archeological findings dated to the Vanvzdinskaya culture (1st millennium CE) indicate the presence of cattle in the south-western part of the region. Rudimentary slash-and-burn agriculture may have been present during this period; however, no direct evidence has yet been found. Hunter-gatherer communities dominated the ancient Komi up to the Middle Ages (eleventh to fourteenth centuries), and ranching became an important part of the economy in the Middle Ages. Archeological excavations of settlements along the rivers Vychegda (up to Kotlas), Sysola, Luza, Vashka, Mezen, Vym found various types of tools associated with agriculture, which are unknown from the earlier periods. Iron and bronze casting production played a prominent role in the economy of the medieval period.

The development of agriculture was the beginning of anthropogenic transformation of forest ecosystems in the river valleys. Slash-and-burn agriculture dominated and often resulted in extensive wildfires. This type of farming existed in the agricultural economy until the beginning of the twentieth century and was mostly present in the south-western part of the region. Many of the secondary forests, which are common landscape features in the Luza, Vym, Sysola, Vychegda, and Vashka rivers basins originated during the late nineteenth to the early twentieth centuries. The start of the industrial use of forests marked the accession of the Komi region to Russian state (fifteenth century). In the sixteenth to eighteenth centuries significant proportion of forests in the Sysola, middle Vychegda, and Vym basins were felled for the needs of the production of salt, iron and cast iron, and mast wood blanks. Despite considerable amount of forest management, logging

Table 1 The Komi Republic Council of Ministers decrees governing the protected areas

No.	Title of the decree	Adoption date	Amended decree and date
408	On the preservation of cedar at logging sites and establishing cedar reserves and natural monuments in the Komi Republic	October 16, 1967	October 08, 2010, No. 339
91	On the establishing of unique natural formations in the Komi Republic as natural monuments	March 5, 1973	December 20, 2004, No. 241
484	On the establishing of zakazniks and natural monuments in the Komi Republic	November 30, 1978	September 09, 2009, No. 256
90	On the implementation of the Komi Republic Council of Ministers resolutions on the protection of rare plants and animals and establishing additional zakazniks and nature monuments	March 29, 1984	June 17, 2011, No. 270
222	On establishing the reserves and natural monuments of republican significance	October 31, 1988	June 17, 2011, No. 270
193	On the establishment of new protected areas and natural monuments in the Komi Republic	September 26, 1989	October 08, 2010, No. 339
110	On establishing of the reserves and natural monuments of the republican significance and the establishment of new zakazniks	March 1, 1993	November 24, 2010 No. 406
241	On the abolition of some protected natural areas of republican significance and amending the Komi Republic regulations on protected areas	December 20, 2004	June 03, 2006, No. 32
268	On the abolition of certain protected areas of republican significance and amending the regulations of the Republic of Komi in the domain of republican significance protected areas	October 6, 2008	September 09, 2009, No. 275

Table 2 Protected Areas in the Pechora basin within the Komi Republic and Nenets Autonomous District

Category	Republic of Komi	Nenets Autonomous District
State nature reserve (zapovednik)	1	1
National park	1	
Zakaznik	164	4
Landscape	32	
Biological	1	
Forest (including Siberian pine)	11	
Botanical	12	
Ichthyological	12	
Hydrological (Mire)	95	
Geological	1	
Natural monument	73	2
Forest (including Siberian pine)	15	
Botanical	16	
Hydrological (Mire)	15	
Aquatic	9	
Geological	18	
Protected natural landscape	1	
Integrated historic and natural museum		1
Total protected areas	240	8

operations until the nineteenth century were quite localized. The greatest anthropogenic impact occurred in the forests located in the south-western part of the modern

Komi Republic, and was concentrated around the major human settlements.

The Pechora-Ilych State biosphere zapovednik

The Pechora-Ilych State Biosphere Zapovednik was established more than 80 years ago (Fig. 2a) and is now the republic's second largest PA. When including the designated buffer zone, its overall area is more than 1 million hectares. The area consists of two sectors: the smaller portion lying within the Pechora Lowland, in the vicinity of Yaksha Village; and the main sector, which consists of the Ilych and Upper Pechora interstream area. Natural complexes in this sector are virtually undisturbed in the lowland, foothill, and mountainous zones, each zone being very specific in geomorphology, soils, and vegetation (Zhitenev and Serebryany 1988). Timber plantations are widespread in the Yaksha sector. Further to the east of the lowland part of the reserve, coniferous stands become predominant in the forest landscapes, consisting mainly of Siberian spruce with lesser amounts of Siberian fir and Siberian pine.

Inventory of the reserve's vegetation produced interesting floristic finds (Lavrenko et al. 1995; Degteva and Zheleznova 1997). One-fifth of the vascular plants in the reserve's flora is considered rare and requires continuous population-size monitoring. Rarities include species protected at the federal level such as lady's-slipper orchid (*Cypripedium calceolus*, category 3), fairy slipper (*Calypso bulbosa*, category 3—rare), narrow-leaved marsh orchid (*Dactylorhiza traunsteineri*, category 2—decreasing

Fig. 2 Protected areas in the Komi Republic. **a** The Manpupuner Plateau and the stone pillars known as “the Seven Strong Men” are considered one of the “Seven Wonders of Russia” and are located in the Pechora-Ilych State Biosphere Zapovednik. **b** Steep cliffs known as the “Lower Gate” along the lower portion of the Shchugor River in Yugyd Va National Park

numbers), and the Urals’ endemics and sub-endemics: *Anemonastrum biarmiense*, *Gagea samojedorum*, and *Scorzonera glabra*. In the lichen flora, interesting discoveries have included an Asian species, *Sticta nylanderiana*, found in Europe for the first time, as well as the identification of five species new to Russia: *Cheiromicina flabelliformis*, *Leptogium rivulare*, *Pannaria confusa*, *Phaeophyscia constipata*, and *Ph. hirsuta*.

Today, the Pechora-Ilych State Biosphere Zapovednik territory is inhabited by numerous and stable populations of valuable game animals including sable (*Martes zibellina*),

European pine marten (*Martes martes*), otter (*Lutra lutra*), American mink (*Neovison vison*), Eurasian beaver (*Castor fiber*), brown bear (*Ursus arctos*), Eurasian elk (*Alces alces*), and grouse birds. Colonies of northern pika (*Ochotona hyperborea*) are present in the reserve, and rare birds of prey protected at the regional and local levels, osprey (*Pandion haliaetus*, category 3—rare), golden eagle (*Aquila chrysaetos*, category 3), white-tailed sea eagle (*Haliaeetus albicilla*, category 3), peregrine falcon (*Falco peregrinus*, category 2), and gyrfalcon (*F. rusticolus*, category 2) have their nests there (Taskaev 1998; Danilov-Danilyan 2008).

The limestone parma area is a unique natural monument in the Zapovednik that documents the natural history of the region's fauna and its settling by humans. The gem of this area is Iordansky's Ravine located on the Pechora's right bank 17 km upstream to the southeast of the Shezhim mark. There are several large caves there. In the largest, known as "the Bear Cave," geologists and archeologists discovered Northern Europe's largest collection of Pleistocene fauna artifacts and one of the northernmost upper Paleolithic settlements of early man (Spiridonov 2001).

The Pechora-Ilych State Biosphere Zapovednik is also the Republic's oldest research institution. Scientists have conducted systematic integrated research of the natural complexes occurring on the plains, foothills, and mountains (Spiridonov 2001). The numbers of valuable game animals, e.g., beaver, sable, elk, and wild reindeer, have been restored (Bobretsov et al. 2004). The world's first elk farm was established in the reserve, and elk has become the most studied valuable animal in this area.

The Yugyd Va National Park

The Yugyd Va National Park (1 891 701 ha) is located in the Vuktyl, Pechora, and Inta Districts of the Komi Republic, in the basins of the Kosyu, Bolshaya Synya, Schugor, and Podcherem Rivers, and on the western hill-sides of the North Urals and Subarctic Urals (Zhitenev and Serebryany 1988; Alexeeva et al. 1995; Spiridonov 2001). As of today, it is the largest protected area in the Komi Republic (Fig. 2b). The national park was established in 1993 and was granted federal status in 1994. Significant changes to the boundary of Yugyd Va National Park were recently proposed to allow mining projects to proceed. These proposals are currently being contested in the courts. In light of the potential exclusion of some of the northern portions from the Park, the UNDP/GEF project has funded research aimed at identifying other promising areas for potential inclusion in Yugyd Va.

The park area is partitioned into four zones designated for (1) strict nature protection, with a subzone of river headwaters; (2) visitor service; (3) traditional trades; and (4) regulated business and recreation uses. The park is a unique corner of Europe where intact expanses of nature remain virtually undisturbed. A rich geological history has formed more than 60 natural monuments, such as strato-typical sections and markers, reef formations, monuments of tectonic events, weathering outliers, and caves, as well as the southernmost glaciers located within the Telposky massif (Spiridonov 2001).

More than half the area of the national park (56 %) is forested. The mountainous forest stands consist of Siberian spruce, Siberian larch, Siberian fir, and Siberian pine. Of the hardwood species, birch is the most common

component of the forest stand. Downy birch (*Betula pubescens*) is widespread in flatter areas, while tortuous birch (*Betula pubescens* subsp. *tortuosa*) is more abundant in the mountains. Siberian spruce is the predominant species in most forest landscapes. The foothill forests of the park's southern portion (Schugor River basin) are associated with the transition belt between the middle and northern taiga subzones, and where fir and Siberian pine are dominant species. Further to the north, the proportion of these species gradually decreases, until they completely disappear. They are replaced by Siberian larch (Nepomilueva 1978; Degteva 1994; Voronin et al. 1994; Degteva and Martynenko 2000). The forest serves as a valuable bank of genetic diversity for the main forest-forming species.

The park area hosts rare plant species, many of which are included in the "Red Data Book of the Russian Federation" (Nepomilueva and Laschenkova 1993; Degteva 1994; Voronin et al. 1994; Taskaev 1998; Degteva and Martynenko 2000; Trutnev 2008). Several plant species have their only European populations there (*Neotorularia humilis*, *Primula pallasii*). The park's rivers originate in the Urals and ensure clear water in the Pechora's main bed. Rare fish species inhabit the waterways and spawn, including glacial relics such as Atlantic salmon (*Salmo salar*), Arctic grayling (*Thymallus arcticus*), peled (*Coregonus peled*), and Arctic char (*Salvelinus alpinus*). A diverse vertebrate fauna includes more than 40 mammal species and more than 190 species of birds, including white-tailed eagle, gyrfalcon, osprey, and peregrine falcon.

Zakazniks

In addition to the Pechora-Ilych Biosphere Zapovednik and the Yugyd Va National Park, protected areas of particular value have been established to protect Siberian pine at the northwestern border of its natural distribution. Over most parts of the region, the Siberian pine locations are insular, and pure stands are rarely found. Excessive harvesting of Siberian pine has seriously damaged the size of its population in European Russia and significant areas of Siberian pine have decreased dramatically due to very large fires in the foothills of the Urals by the Ilych River. Therefore, conservation and reclamation of Siberian pine in the Komi Republic is regarded as the most important task. Siberian pine became the first protected plant species of the Komi Republic (Nepomilueva 1974). Currently, 6 zakazniks and 14 natural monuments are functioning in the republic to protect Siberian pine (Alexeeva et al. 1995). Almost all of these protected areas are concentrated in the Pechora basin and have well-developed conservation plans to restore Siberian pine populations and to increase its proportion in the stands (thinning and salvage felling, re-seeding, and seedling planting). All the zakazniks have been surveyed,

and regular monitoring has been established in many of them. A network of genetic reserves for primary forest-forming species has been launched; the first stage, comprising 38 refuges on an area of 28 000 ha, has been approved. In the basin of the Schugor River, a large tributary of the Pechora River, six reserves have been established to preserve the Siberian pine gene pool (Nepomilueva and Laschenkova 1993), with forest zakazniks that include large areas of primary forest (Fig. 3).

In total, the Red List of the Komi Republic contains 236 species of vascular plants, 71 species of bryophytes, 82 species of lichens, and 42 species of fungi (Taskaev 2006). The principal locations of rare and relic vegetation species, and species complexes, are in the Pechora basin, i.e., in the Cis-Urals, Urals, and Timan. (Laschenkova 1972; Laschenkova and Nepomilueva 1977, 1982; Ulle and Laschenkova 1985; Lavrenko 1988; Voronin et al. 1994; Lavrenko et al. 1995). Species preserved in protected areas include such rare species of vascular plants as *Anemonastrum biarmiense*, *Cypripedium calceolus*, *Elytrigia reflexiaristata*, *Gypsophila uralensis*, *Linum boreale*, *Paeonia anomala*, *Pentaphylloides (Dasiphora) fruticosa*, *Primula pallasii*, *Rhodiola rosea*, and others. Stable populations of rare, relic, and endemic species are preserved in 18 forests, and 28 botanical zakazniks and natural monuments. Representative habitats for rare fauna are preserved mostly in landscape zakazniks, the reserve, and the national park. The total number of animal species that are protected in the republic is 100, including five species of mammals, 33 birds, 2 amphibians, 6 fish, and 54 species of invertebrates (mostly insects) (Taskaev 2006).

Apart from the forest, the region's most important environment-stabilizing agents are wetlands. In the Komi Republic there are 113 protected marshes, of which 17 are of scientific value, the rest being berry marshes that are important for conservation of cranberry resources (Alexeeva 1984; Alexeeva et al. 1993, 1995). The largest wetland ecosystems in the Pechora basin include Martyushevskoye, Usinsky, and Okean (Botch 1999) (Fig. 4).

Rivers with special importance for fisheries are classified as ichthyologic or landscape zakazniks. Among these are two areas of the Pechora River and its larger tributaries (the Unya, Ilych, Podcherem, Kozhim, Synya, and Pizhma). The Pechora's tributaries maintain a hydrochemical balance in its main bed and provide habitats and breeding ground for valuable populations of Atlantic salmon, Arctic grayling, nelma (*Stenodus leucichthys nelma*), char (*Salvelinus alpinus*), and bullhead (*Cottus gobio*) (Degteva 1994; Sidorov 1995). Riparian protection zones, where felling is prohibited, have been established along the watercourses and around wetlands. Forest ecosystems within the riparian protection zones serve as environmental corridors integrating protected areas into a single network.

Among the region's 19 geological monuments are unique weathering outliers and stratotypical sections, which border the Ural river. The data on the protected areas is summarized in a monograph titled "Cadastre of Nature Protected Areas of the Komi Republic" (Alexeeva et al. 1995) and in the map form, scale 1:1 200 000 (Taskaev et al. 1996a, b). The electronic databases "Conservation Areas of the Republic of Komi" (<http://gis.rkomi.ru/oopt>) and "Red Data Book of the Republic of Komi" (<http://ib.komisc.ru/add/rb/>) have been created in the Komi Republic for efficient management of information on endangered species and ecosystems.

NENETS AUTONOMOUS DISTRICT PROTECTED AREAS

In the Nenets Autonomous District, the development of a protected area network has been under way since the mid-1980s (Zolotoy 1999). The Vaigachsky Reserve was the first place designated as an area of special conservation at the regional level. It was established in 1983 on Vaigach Island to conserve the natural ecotopes and the habitats required for the reproduction and population size maintenance of eider duck (*Somateria* sp.), swans (*Cygnus bewickii*, *C. cygnus*), barnacle goose (*Branta leucopsis*), and polar bear (*Ursus maritimus*). During 1985–1987, three more protected areas were instituted within the district. The largest of these is the Republic-level Nenetsky State Zoological Reserve (area of 320 000 ha) established to protect wetlands that are important gathering places for waterfowl during their molting, nesting, and migration (Glotov 1999; Zolotoy 1999). The Great Gate Canyon Natural Monument, located 40 km southeast of Indiga Village, was established to conserve the picturesque basalt steepes in the valley of the Belaya River, a salmon spawning waterway. The Pustozorsky Natural Monument is of great historic value and is part of an integrated historic and natural museum of Pustozorsk. Pustozorsk was founded in that area at the end of the fifteenth century. The town was a business and cultural center of the Pechora land, which played an important role in the development of the Russian Far North (Yeliseeva 1999).

The designation of additional protected areas for inclusion in the network was resumed in the second half of the 1990s. In November 1996, the Bolshezemelsky zakaznik was established in the western part of the Yugra Peninsula, in order to protect ecological habitats and breeding grounds of many rare animal and bird species. In 1997, the Russian Federation Government instituted the Nenetsky State Zapovednik. The reserve's wetlands, i.e., sea shoals, islands, and tundra and estuary wetlands, are very important for preservation of the diversity and numbers of

Fig. 3 Current (a) and projected (b) boundaries of forest zakazniks in the western part of the Komi Republic (marked with red in c). Forest zakazniks include large areas of primary forest. The Komi Republic government adopted the 2030 Strategic Development Plan for protected areas network development. The total territory of protected areas in the Komi will increase by more than 11 000 km²

Fig. 4 The largest wetland protected areas in the Komi Republic

waterfowl, and have been recommended for inclusion on the list of wetlands protected by the Ramsar Convention on Wetlands (Zeng et al. 2014), of which the Russian Federation is a contracting party. To conserve the White Sea wetlands, the regional Shoinisky zakaznik was established in 1997, and to save and recover the salmon fish populations and waterfowl ecotopes in the Pechora River estuary, the Nizhnepechorsky zakaznik was established. This protected area, as well as the Nenetsky Zapovednik, protects migration routes of salmon through the coastal areas of Pechora Sea and in the Pechora River estuary. The Belaya River, included in the Great Gate Canyon Natural

Monument, is also an important spawning place for Atlantic salmon. A new zakaznik (named More-Yu) has been proposed to conserve an insulated plot of sparse-growing spruce forest in the tundra zone, and a natural monument (Pym-Va-Shor), is being planned for the conservation of important sites containing significant geological formations, thermal mineral springs, and rare plant communities (Zolotoy 1999; Lavrinenko and Lavrinenko 2006). The total area of protected areas in the Nenets Autonomous District today is 1 418 648 hectares, or slightly more than 8 % of the District's territory (Lavrinenko and Lavrinenko 2006).

CHALLENGES AND PERSPECTIVES

The Komi Republic has a territory comparable to Sweden but, with approximately 2.7 inhabitants per square kilometer, has a population density that is nearly ten times lower (Ministry of Culture and National Policies of the Komi Republic 2006). With the current percentage of territory designated as protected areas, the Nenets Autonomous District and the Komi Republic (8 and 13.5 %, respectively), fall within the range that is currently found in Sweden (~10 %) and Norway (~17 %) (Norwegian Environment Agency 2013; Swedish Forest Agency 2014). The proportion of area occupied by protected areas is an important indicator for conservation efforts; however, it is also necessary to consider other factors such as ecosystem representation, functional connectivity, and management categories of the protected areas (Elbakidze et al. 2013).

The primary tool for implementing integrated environmental protection measures is expansion of the protected areas network. The existing protected area system of northeastern European Russia requires improvement. One of the fundamental necessities for the building of a conservation network is the identification and preservation of ecosystems typical of different geographical zones and subzones. Reference plots allotted as reserves must conserve the gene pool of the flora and fauna and also play a central role in maintaining the environmental balance in the upcoming anthropogenic changes in the environment. Forests and wetlands function as the most important environment-stabilizing agents in the region. However, distribution of protected areas over the region is not sufficiently uniform. As a result, many ecosystems representative of the typical tundra biome and which support rich avifaunal habitats (molting places, nesting grounds, migration stop-over sites, etc.) are left outside the conservation areas (Mineev 2000). The tundra and mountain tundra ecoregions in the arctic areas of northeastern European Russian remain under represented in the protected areas system. Tundra zonal communities are only protected in the protected areas network of the Nenets Autonomous District. Only some frost large mound bogs and, to a lesser extent, frost flat mound bogs have the status of protected areas in the southern subzones of hypoarctic tundra, and northern and southern tundra within the territory of the Komi Republic. Gap analysis established that the following landscapes are not well represented in the protected areas network: undulating tundra plains of the Ural foothills, undulating forest-tundra plains of Ural foothills and the Chernishov Ridge, lowland forest-tundra plains moraine, and outwash and lacustrine-alluvial sandy forest-tundra plains. Polar Ural Mountain landscapes are not fully represented in the regional system of protected areas and preservation is significantly weaker compared to

the prevalence of the Northern Urals and Polar Urals landscapes. The Polar Urals in the borders of the Komi Republic are represented in only one landscape zakaznik, two botanical zakazniks, and three natural monuments at regional level. These protected areas have recently experienced increased anthropogenic pressure, and there is no Federal Protected area in the region. Special attention must be given to development of the protected area system in the southern districts of the Komi Republic and in the tundra zone, where few protected areas currently exist.

Many wetlands in the Nenets Autonomous District and the Komi Republic (Fig. 5) meet the criteria for recognition as ‘Wetlands of International Importance’ as specified by the Ramsar Convention (Zeng et al. 2014). In the Nenets Autonomous District, this includes the coastal areas of the Sengeysky Strait and Sengeysky Island, Pakhanch Bay and Pesyakov Island, the coastal areas of Yugorsky Strait and tiny islets located in the strait, interstream areas of the Lymbadayakha–Sedyakha, Tabyu–Saayakha–Sopchayu, and Belkovskaya–Vasyakha rivers, and Belkovsky Bay. In the Komi Republic, this category covers the wetlands of the middle Pechora basin (from the Kolva River estuary to the Zverinets River), the lower course of the Lemva River, and interstream areas of the Usa and the Yun’yakha. In the lower Pechora basin, the most valuable wetlands of this category include the Tobysh, Putino, and Maer marshes; and Keldar, Komino, and Motino lake systems. The extensive, well-preserved wetlands of the Komi Republic and the Nenets Autonomous District are critical for bird migration (Fig. 5). Despite this importance, only a few wetlands have legal protected area status. In the Komi Republic, these are the Martyushevskoye, Usinsky Kompleksny, and Okean wetlands. In the Nenets National District, key wetlands landscapes are protected in the “Nenets” State Natural Reserve and state zoological “Nenets” zakaznik. Recognition of these wetlands as Ramsar Sites would help toward ensuring their conservation (Zeng et al. 2014).

Future research should also include surveys for evidence of ancient cultural remains. These legacies of early human influence should be considered as valuable resources which enrich the overall significance and the cultural values of the current and future protected areas. Protecting these ancient cultural remains can serve an important living repository of human history and ecological influence and, along with endangered flora and fauna and unique landscapes and geological formations, should be considered an important components of protected areas (Östlund et al. 2006). Expanding the protected areas network will contribute to the conservation of landscapes, biotic communities, and species diversity, including populations of rare species, the maintenance of ecological balance, and the traditional way of life of indigenous peoples.

Fig. 5 Wetlands in the Nenets Autonomous District and the Komi Republic that meet the criteria of ‘Wetlands of International Importance’ as specified by the Ramsar Convention. 1 The Shoina–Torna interstream area; 2 The Nes–Chizha interstream area; 3 The Snopa–Oma–Vizhas–Perepusk interstream areas; 4 The lower reaches of the Velt River and Torovey Lake; 5 The Sengeiskiy Strait and Sengeiskiy Island; 6 Kolokolkova Bay; 7 The Russkiy Zavorot Peninsula; 8 Korovinskaya Bay; 9 The delta of the Pechora; 10 Bolvanskaya Bay; 11 The Chyornaya River basin; 12 Pakhanchesckaya Bay and Pesyakov Island; 13 The Medynskiy Zavorot Peninsula; 14 The waters of Khaipudyrskaya Bay with Dolgiy Island, Golets Island, Matveev Island and Zelenets Island; 15 The Lymbadayakha–Sirtiyakha interstream area; 16 The Bolshaya Oyu River basin; 17 The Vasjakha–Belkovskaya interstream area; 18. The Belkovskiy Gulf; 19 The Tabju–Sopchaju–Saayakha interstream areas; 20 The middle reaches of the More–Yu River; 21 The system of Vashutkiny Lakes; 22 Kharbeiskie Lakes; 23 Padimeiskie Lakes; 24 The basin of the middle reaches of the Bolshaya Rogovaya River; 25 The Usa–Lemva–Yunjakha interstream areas; 26 The Usvanyur swamp system; 27 The Pechora River valley between the mouths of the Kolva River, the Lyzha River and the Zverinets River; 28 Marsh “Okean”; 29 Urdyuzhskoe Lake; 30 Marsh “Maerskoe”; 31 Tobyshskie swamps; 32 Kosminskie and Motinskie lake systems; 33 Putinskie swamps

CONCLUSIONS

Monitoring of biodiversity and ecosystems is not occurring in the majority of protected areas. For many designated areas of

the protected area network, including such large protected areas as the Yugyd Va National Park and the Nenetsky Zapovednik, the data collection on various components of their natural complexes is not complete. Some progress has been

made, and regular field surveys of the protected areas have been implemented in recent years. Additional protections have been achieved via improvements of regulations on zakazniks and natural monuments, as well. The results of the scientific surveys will be used for further development and improvement of the protected area system in northeastern European Russia, with the Pechora River basin as an integral part.

Compared with many other regions of the world, the landscapes of northeastern European Russia have had relatively low disturbance from anthropogenic activities. The region's forests, marshlands, and tundra ecosystems serve as key ecotopes for many species of plants, animals, lichens, and fungi, many of which have become endangered in other European countries. These regions are of considerable environmental value not only for Russia, but also for the global community. Therefore, significant effort should be made to designate additional protected areas in the Barents Euro Arctic Region.

Assessment of the ecological landscapes contained within the protected areas network of the northwestern part of the Barents Euro Arctic Region indicates a relatively satisfactory representation of the middle and northern taiga subzones (except for the Timan Ridge with its scarcity of protected areas), and in the foothills and mountains of the North and Subarctic Urals. At the same time, it must be stated that representation is absolutely insufficient for both the typical and unique land and water ecosystems of the tundra zone in its vast plains (Bolshezemelskaya Tundra) and mountainous areas (Polar Urals). Compared with the taiga subzones, these ecologically important regions are quite poorly represented in the protected area network. Other areas that require additional representation and protection are the coastal environments and estuaries of rivers flowing directly into the Barents Sea and its bays.

An extensive, national study to assess the representativeness of current protected areas and to determine what expansion is necessary to improve its representativeness was recently orchestrated by the World Wildlife Federation (Krever et al. 2009). In association with this assessment, scientists at the Institute of Biology and Institute of Geology, Komi Science Center conducted an inventory of protected areas in the Komi Republic, with an additional field research group targeting areas of old-growth forest, as well as other objects and natural complexes suitable for inclusion in the system of protected areas. The focus of this gap analysis research was to identify landscapes and ecosystems that are not represented, or are underrepresented, in the existing network of protected areas. WWF-Russia experts recommended the organization of eight new federal protected areas in the Komi Republic: two zapovedniks and six zakazniks. Some of the proposed areas are now protected at the regional level.

Experts of Komi regional nonprofit foundation “Silver Taiga” prepared proposals on the extension of the existing

protected areas to preserve old-growth forests in areas of Udorski region in the Komi Republic. Based on continued analysis, Komi scientists in the framework of the UNDP/GEF project have also proposed extension of the protected areas network. This includes the organization of four new biological zakazniks (three in the Polar Urals and one in the forest-tundra zone), two ornithological zakazniks (in the tundra zone and middle taiga subzone), two landscape zakazniks (in the pre-tundra forests band and Far North taiga subzone), two hydrological zakazniks for wetland conservation (in key ecotone subzones of the middle and southern taiga), and four additional protected areas to preserve unique geological objects. The Nenets Autonomous District program of protected areas network development calls for establishing of three new zapovedniks and two national parks with a total area of 2500.09 hectares, which will be an additional 1.4 % of the district's area.

Historically, anthropogenic-induced ecological impacts have been relatively limited in this vast and wild region of the world. This is not likely to be the case in the twenty-first century, as it is quite evident that the northeastern part of Barents Euro-Arctic Region (BEAR) is being, or will be, developed as a primary fuel and natural resource base for Russia and Europe. The potential for extensive ecological degradation in this region, and adjacent seas, is now greater than ever before and warrants increased governmental efforts at the regional, national, and international levels in order to establish a well-balanced protected area network. Increasing data-collection efforts, and strategically designating protected areas that contain underrepresented ecological complexes, will be essential for the conservation of the unique and diverse biota and habitats found in the Barents Euro Arctic Region. This will also help Russia meet the Convention on Biological Diversity's 2020 Aichi Biodiversity targets, which were developed at the Nagoya summit in 2010. Target 11 of this strategic plan is to ensure the effective conservation of ecologically representative areas covering at least 17 % of terrestrial and inland water areas and 10 % of coastal and marine areas. If the protected area network can be expanded, the overall environmental stability in these globally significant ecosystems may remain intact.

While there are tangible benefits resulting from the current network of protected areas in the Komi Republic, there are also socioeconomic, judicial, political, and ecological threats that may jeopardize the network's functionality (Watson et al. 2014). The predominance of the mining industry in the region's economy, and a conflict of interest between social and economic growths in the Komi Republic, and the protection of high-quality areas of indigenous and unique ecosystems, is a major concern. Other related issues, including low technological level in mining industry, and the potential disturbance associated with accessing mineral resources within the confines of the protected areas pose

significant threats. In addition, low living standards in rural areas results in high levels of poaching, and there insufficient resources to provide security for the protected areas network. Legislative difficulties at the federal level impact the timely formation of improved regulations for ensuring functionality and managing the network. At the regional level, excessive bureaucracy, poor enforcement of current laws, and a generally low ecological awareness among the majority of the Komi citizens and lawmakers have potential to threaten the stability of the protected areas system. Finally, there is currently a lack of financial support from large companies and private stakeholders to ensure the network's proper functionality and management.

These threats could lead to a number of negative outcomes. A reduction in the overall geographic area of the network could result from abandonment of protected areas in order to further the region's economic plans. The aesthetic value of the landscape could deteriorate, and the ecosystems' inherent ability to maintain ecological balance in the region could be impeded. Biological diversity could suffer at the genetic, population, and ecosystem levels. A large loss of primary forest areas, worsening habitat conditions, and fragmentation could subsequently impact rare plant species, causing population reduction and destabilization, ultimately impacting their ability adequately independently to reproduce.

The urgency for a response to the threats listed above has been reduced by the Komi Republic's large size, low population density, and the lack of infrastructure. Precisely because the majority of protected areas are located in hard to reach regions, these complex ecosystems are protected despite the absence of holistic, sustainable protection measures. It is evident, however, that with the increasing anthropogenic pressure, threats to protected areas will inherently grow. Therefore, effective measures aimed at improving the protection and management of protected areas at both the regional and federal levels are urgently needed. The elimination of gaps in the existing network of protected areas through the establishment of new sites would be a significant step toward the conservation of these magnificent and ecologically important biological communities and landscapes.

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