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Research Article

Forest fires as a factor in the spread of alien plant species in protected areas

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Abstract

In the context of contemporary climate and weather changes, protected areas are increasingly vulnerable to catastrophic wildfires. This study examines the impact of the 2010 and 2021 fires on the spread of alien vascular plant species within the Mordovia State Nature Reserve. Floristic research has revealed a consistent annual increase in both the number of species and occurrences of alien vascular plants in pyrogenic communities, with notable colonization by invasive species such as *Juncus tenuis*, *Epilobium pseudorubescens*, *Erigeron canadensis*, *Erigeron strigosus*, *Bidens frondosa*, and *Solidago canadensis*. Over the period from 2011 to 2024, the dispersal of alien vascular plants has been observed not only in pyrogenic communities but also along roadsides within the not-unburned forested areas of the reserve. This spread has been facilitated by post-fire management activities, including fire suppression, vehicle patrolling of the protected area, clearing and plowing of firebreaks and service roads, and the creation of mineralized strips using a disc harrow. It is recommended to revert to using a plow for firebreak construction and the establishment of mineralized strips within the protected area. In the future, further colonization of pyrogenic communities of the Mordovia State Nature Reserve by invasive species such as *Amelanchier spicata* (Lam.) K.Koch, *Acer negundo* L., and *Sorbaronia* × *fallax* (C.K.Schneid.) C.K. Schneid. from adjacent areas is anticipated.

Keywords: fire-damaged forests, invasive plants, protected area, Republic of Mordovia, vascular plants

Introduction

Protected areas are relatively undisturbed natural sites with a designated conservation regime. These areas are typically characterized by high biodiversity levels (The Emerald Book…, 2011–2013; Shmiedel et al., 2013; LeRoux et al., 2019; Matten et al., 2023; Duco et al., 2024; Viciani & Alberti, 2024), yet they are increasingly susceptible to invasions by alien species under contemporary environmental conditions (Foxcroft et al., 2013; Starodubtseva et al., 2017; Shackleton et al., 2020; Esina & Khapugin, 2022; Gamova, 2022; Shovkun & Zernov, 2022; Shrestha et al., 2025). In recent decades, climate change (Lipka & Krylenko, 2021) and extreme weather fluctuations (Roslin et al.,

2021) have led to a rise in wildfire occurrences, including within nature reserves and national parks (Khapugin et al., 2012, 2015, 2016a,b; Kadetov et al., 2022, 2024; Gafurova, 2024). In 2011, we observed the first appearance of certain alien vascular plant species in burned areas of the Mordovia State Nature Reserve (Khapugin et al., 2012, 2015, 2016a,b). The reserve experienced severe wildfires in 2010 and 2021, which affected more than one-third of its territory (Fire Book…, 1976–2024). As a result, we initiated research on the impact of wildfires on forest ecosystems (Khapugin et al., 2012, 2015, 2016a,b; Grishutkin, 2012; Makarkin & Ruchin, 2022). The primary objective of this study is to assess the effects of wildfires on the spread of alien plant species within the Mordovia State Nature Reserve. The research tasks include identifying the species composition of alien plants found in burned areas, mapping their occurrences within the 2010 and 2021 fire sites as well as in natural forest communities, and analyzing the correlation between the spread of alien plants and fire disturbance. From 2011 to 2024, we surveyed both pyrogenic and natural habitats of the reserve to document the presence of alien species (Khapugin et al., 2012, 2015, 2016a,b; Esina et al., 2022, 2024; Verhozina et al., 2022, 2024; Ershkova et al., 2023).

Material and methods

Study Area

The Mordovia State Nature Reserve was established on March 5, 1936, covering an area of 321.62 km². It is located in the northwestern part of the Republic of Mordovia (54.700°–54.933° N, 43.067°–43.60° E), within the interfluve of the Moksha and Satis rivers (Fig. 1), encompassing the Moksha River floodplain, its terrace formations, and the glaciofluvial plain (Vargot et al., 2016). The floodplain of the Moksha River is characterized by chernozem-like alluvial soils, which transition to humic-gley soils in depressions of the mesorelief, particularly in black alder (Alnus glutinosa) forests. The Moksha River terraces are dominated by sod-podzolic sandy soils (Remezov, 1960). The reserve is situated in the central part of the East European Plain, along the southern boundary of the mixed and broadleaf forest zone (Milkov, 1953; Ershkova & Esina, 2024). Forest ecosystems cover 89.3% of the reserve's territory. The area is divided by clearings into 294 forest quarters, each predominantly measuring 1 × 1 km. The main forest-forming tree species include *Betula pendula* Roth (35.8% of the reserve's total area), *Pinus sylvestris* L. (25.3%), *Tilia cordata* Mill. (5.1%), and *Populus tremula* L. (4.9%). The floodplain of the Moksha River features oak forests dominated by *Quercus robur* L. (1.6%). Additionally, black alder (*Alnus glutinosa* (L.) Gaertn.) forests (6.1%) and spruce (*Picea abies* L.) stands (0.4%) occur in the Moksha floodplain, as well as along the valleys of smaller rivers and streams, including the Pushta, Vyaz-Pushta, Vorsklyai, and Arga rivers (Forest Management…, 2014).

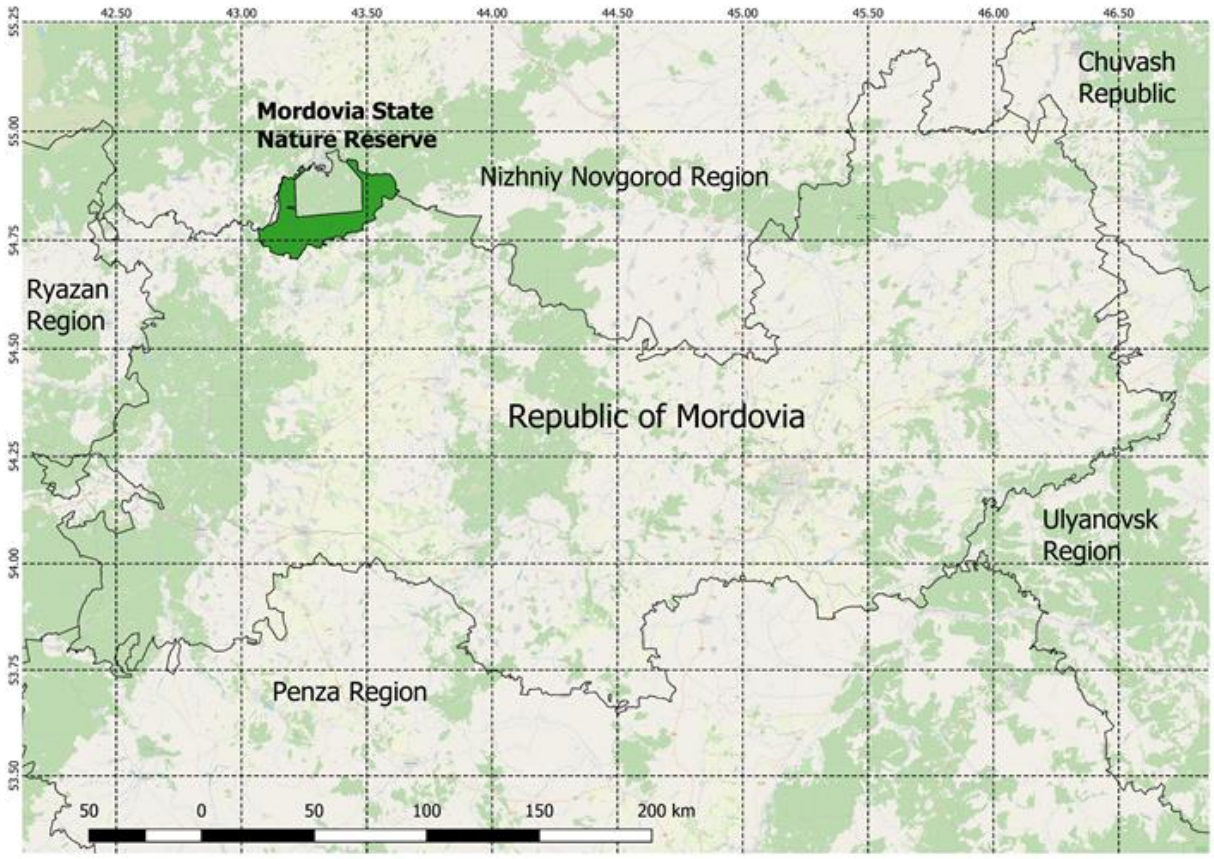

Figure 1. Geographical Location of the Mordovia State Nature Reserve.

The central administrative settlement of the Mordovia State Nature Reserve is located in the Pushta settlement, which consists of approximately two dozen residential houses, along with small front gardens, vegetable plots, and old orchards. The reserve has a network of forest clearings and service dirt roads that extend across its territory, with paved roads present in the central and northeastern parts. A railway also runs through the northeastern part of the reserve. Along its borders and within the reserve, there are 10 cordons in operation (Vargot et al., 2016).

A large territory of the reserve has been affected by two catastrophic wildfires in the past 15 years. In 2010, fires spread across 12,213.03 hectares in the northwestern, southwestern, and northeastern parts of the reserve. Another major fire occurred in 2021, affecting 11,928.03 hectares, primarily burning the same area that had already been affected by the 2010 fire (Fig. 2). The total area of burned forests from the 2010 and 2021 wildfires amounts to 15,723.4 hectares (Fire Book, 1976–2024).

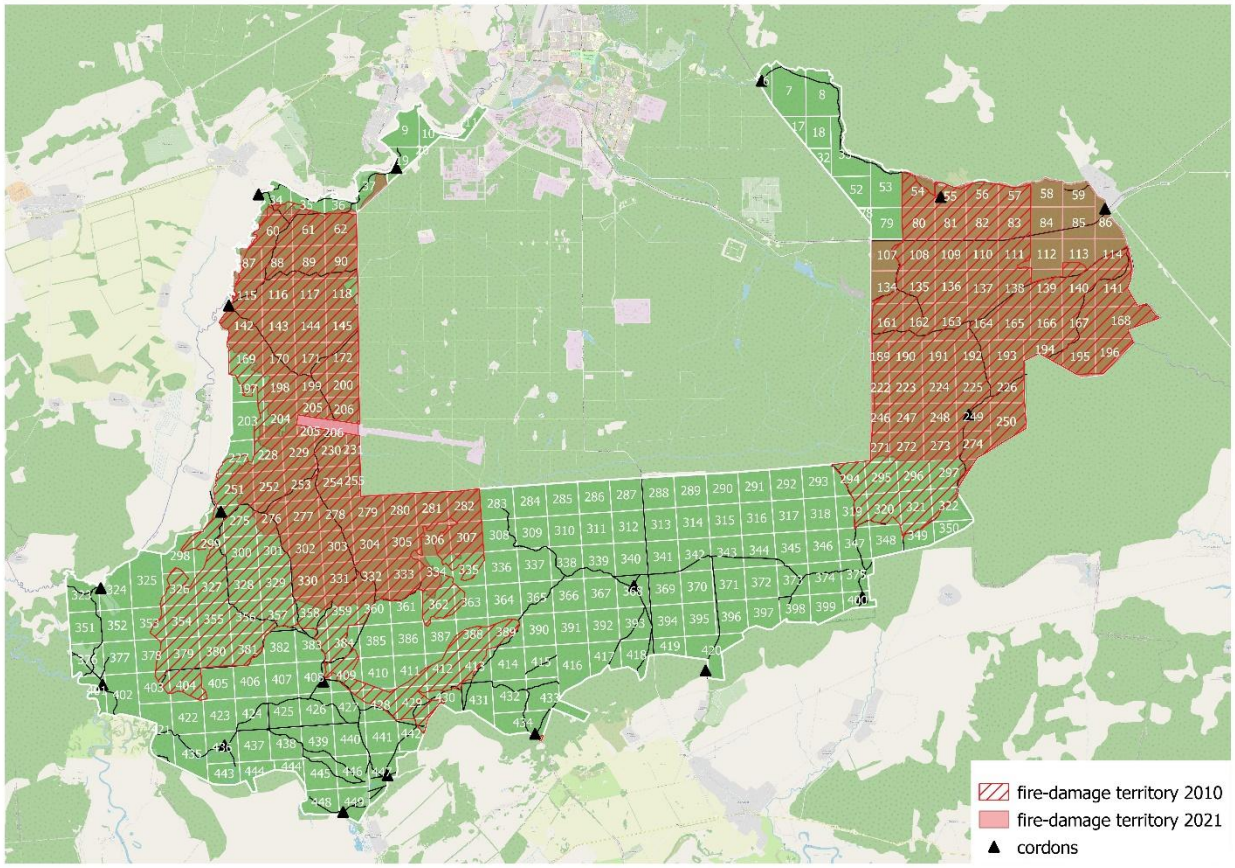

Figure 2. Fire-damaged territories in the territory of the Mordovia State Nature Reserve: orange – in 2010, green – in 2021; red – both 2010 and 2021.

Data collection and analysis

This study is based on a dataset of georeferenced occurrences of alien vascular plant species collected by the authors from 2021 to 2024 across the entire territory of the Mordovia State Nature Reserve (Esina et al., 2022, 2024 https://www.inaturalist.org/projects/vascular-plants-in-the-mordovia-state-nature-reserve). Over this period, more than 3,000 observations of alien vascular plants were recorded throughout the reserve, including in pyrogenic communities. Most of these records were documented through photographic evidence on the iNaturalist platform (https://www.inaturalist.org/projects/vascular-plants-in-the-mordovia-state-nature-reserve). Some records were further validated by herbarium specimens incorporated into the HMNR collection.

Additionally, the authors used previously published data on the flora of the Mordovia State Nature Reserve (Kuznetsov, 1960; Borodina et al., 1987; Vargot et al., 2016; Esina et al., 2022; Ershkova et al., 2023; Verkhozina et al., 2022, 2024), studies on pyrogenic successions from 2011–2014 (Khapugin et al., 2012, 2015, 2016a,b), and photographic records uploaded by other researchers to the iNaturalist platform (https://www.inaturalist.org/).

During fieldwork, the authors surveyed forest quarters of the Mordovia State Nature Reserve, including both natural and pyrogenic vegetation. Detailed attention was given to habitats potentially preferred by

alien species for colonization, such as the edges of dirt roads and highways, firebreaks, forest clearings, areas near settlements and codrons, and tourist sites.

Data from photographic observations and herbarium collections of alien vascular plants in the Mordovia State Nature Reserve, including those found in pyrogenic communities, were compiled into a Microsoft Excel database (Microsoft Office 2016, v. 14.0.6023.1000) (Esina et al., 2024) and published in the project "Flora of the Mordovia State Nature Reserve" based from iNaturalist platform Field data processing and visualization were performed using Microsoft Excel (Microsoft Office 2016, v. 14.0.6023.1000) and QGIS 3.36.00. The analysis of the distribution of invasive vascular plant species (*Juncus tenuis*, *Lupinus polyphyllus*, *Epilobium pseudorubescens*, *Erigeron canadensis*, *Erigeron strigosus*, *Bidens frondosa*, *Solidago canadensis*) (Vinogradova et al., 2010) and their association with pyrogenic habitats was conducted using the Statistica 12 software package.

Results

Currently, 25 species of alien vascular plants have been identified in the 2010 and 2021 fire-damaged territories within the Mordovia State Nature Reserve (Khapugin et al., 2012, 2015, 2016a,b; Esina et al., 2024; Ershkova & Esina, 2024; https://www.inaturalist.org/observations/234477999) (Table 1), accounting for 14.4% of the total number of alien species in the protected area's flora (Esina et al., 2024).

Table 1. Alien species of vascular plants in the fire-damaged territories of the Mordovia State Nature Reserve

Species of plant	Number of locations in the fire-damage territories	Percentage of all locations	Number of locations in the all territory of the MSNR	Percentage	Year of the first registration in the MSNR	Year of the first registration in the fire-damaged territories of the MSNR
***Bidens frondosa* L.**	**100**	**44,1**	**227**	**100**	**2013**	**2013**
***Juncus tenuis* Willd.**	**87**	**66,4**	**131**	**100**	**1978**	**2012**
***Epilobium pseudorubescens* A.K.Skvortsov**	**103**	**94,5**	**109**	**100**	**2012**	**2012**
Galeopsis bifida Boenn.	85	32,3	263	100	1987	2021
G. ladanum L.	3	60,0	5	100	1952	2023
G. speciosa Mill.	11	29,7	37	100	1936	2011
Echinochloa crus-galli (L.) P.Beauv.	2	18,2	11	100	1936	2022
Erigeron annuus (L.) Desf.	26	36,6	71	100	1989	2011
***E. canadensis* L.**	**655**	**77,4**	**846**	**100**	**1978**	**2011**
***E. strigosus* Muhl. ex Willd.**	**174**	**47,2**	**369**	**100**	**2020**	**2020**
Heracleum sosnowskyi Manden.	1	9,1	11	100	2013	2024
Lactuca serriola L.	19	54,3	35	100	1950	2011
Lupinus polyphyllus Lindl.	9	9,4	96	100	1984	2021

Malus domestica (Suckow) Borkh.	14	15,2	92	100	1936	2020
Oenothera biennis L.	1	8,3	12	100	1984	2011
O. rubricaulis Klebahn.	5	13,9	36	100	1984	2021
Polygonum aviculare L.	1	11,1	9	100	1936	2023
Salix × *fragilis* L.	1	33,3	3	100	1983	2020
Sambucus racemosa L.	49	8,5	574	100	1936	2021
Setaria viridis (L.) P.Beauv.	8	62,8	78	100	1936	2023
S. pumila (Poir.) Roem. & Schult.	21	53,8	39	100	1977	2023
***Solidago canadensis* L.**	**289**	**68,0**	**425**	**100**	**2012**	**2016**
Sonchus arvensis L.	1	50,0	2	100	1979	2012
Spergula arvensis L.	5	55,6	9	100	1936	2019
Viola arvensis Murray	10	22,2	45	100	2011	2011

Table 1 shows that before the catastrophic fires of 2010 and 2021, species such as *Juncus tenuis*, *Galeopsis bifida*, *Lupinus polyphyllus*, *Oenothera biennis, O. rubricaulis*, *Sambucus racemosa*, *Erigeron annuus*, *E. canadensis, E. strigosus*, *Lactuca serriola*, *Sonchus arvensis,* and some others were known from only a few locations within the Mordovia State Nature Reserve but did not spread across the protected area (GMU; Kuznetsov, 1960; Borodina et al., 1987; Vargot et al., 2016).

Following the 2010 fires, the number of occurrences of *Juncus tenuis, Galeopsis bifida*, *Sambucus racemosa*, *Erigeron annuus*, *E. canadensis,* and *E. strigosus* began to increase in both pyrogenic and natural communities. *Juncus tenuis* was primarily found in wet wheel tracks and the edges of bogs, mostly within fire-affected areas. *Galeopsis bifida* was associated with firebreaks and disturbed soils along roads. The remaining species occurred both in fire-damaged forest communities and in disturbed sites along roads and clearings. *Oenothera biennis* and *O. rubricaulis* were sporadically found in similar habitat types (Esina et al., 2024; https://www.inaturalist.org/projects/vascular-plants-in-the-mordovia-state-nature-reserve).

Previous studies (Khapugin et al., 2012, 2015, 2016a,b) and research by other authors (Kadetov et al., 2022, 2024; Gafurova, 2024) indicated that 2–3 years after fires, *Erigeron annuus, E. canadensis, E. strigosus,* and *Lactuca serriola* reduced their activity in pyrogenic communities. However, after the 2010 burn territories were re-burned in 2021, the number of occurrences of these species (except *Lactuca serriola*) increased again, both in pyrogenic and natural communities (Esina et al., 2024). Species such as *Bidens frondosa*, *Epilobium pseudorubescens*, *Solidago canadensis*, and *Viola arvensis* were recorded in the Mordovia Nature Reserve only after the 2010 fire, occurring in burned areas, forest roads, and clearings, both in the burned forest and in unburned forested areas (Khapugin et al., 2012, 2015, 2016a,b; Esina et al., 2024). These species were likely introduced from anthropogenically disturbed areas and settlements adjacent to the reserve, possibly through vehicles involved in firefighting efforts.

Moreover, our initial assumption that *Viola arvensis* and *Sambucus racemosa* were incidental species in fire-affected areas (Khapugin et al., 2012, 2015) has proven incorrect. The number of occurrences of all these species in pyrogenic communities has been increasing year by year (Esina et al., 2024). Notably, the spread of invasive species such as *Lupinus polyphyllus* and *Heracleum sosnowskyi* is primarily associated with the natural communities of the Mordovia Nature Reserve (Vargot et al., 2016). The introduction of *Heracleum sosnowskyi* was recorded in 2013 in a deciduous forest in the northwestern part of the reserve, adjacent to areas with dense stands of this species. The invasion of *Lupinus polyphyllus* (as well as *Solidago canadensis*) into the protected area occurred from settlements located along the reserve's periphery (Khapugin et al., 2016a; Vargot et al., 2016).

Currently, the slow spread of *Heracleum sosnowskyi* and *Lupinus polyphyllus* into both pyrogenic and natural forest communities of the Mordovia Nature Reserve is being observed. Of the 96 recorded occurrences of *Lupinus polyphyllus* between 2011 and 2024, only 9 are within the boundaries of the burned areas. One of the 11 occurrences of *Heracleum sosnowskyi* during this same period was noted in 2024 in a burn area.

As a result of processing field data (Khapugin et al., 2012, 2015, 2016a,b; Esina et al., 2024; https://www.inaturalist.org/projects/vascular-plants-in-the-mordovia-state-nature-reserve), we found that the highest number of occurrences of alien vascular plant species in the burn areas is attributed to invasive species (Vinogradova et al., 2010) such as *Juncus tenuis*, *Epilobium pseudorubescens*, *Erigeron canadensis*, *Erigeron strigosus*, *Bidens frondosa*, and *Solidago canadensis* (Fig. 3).

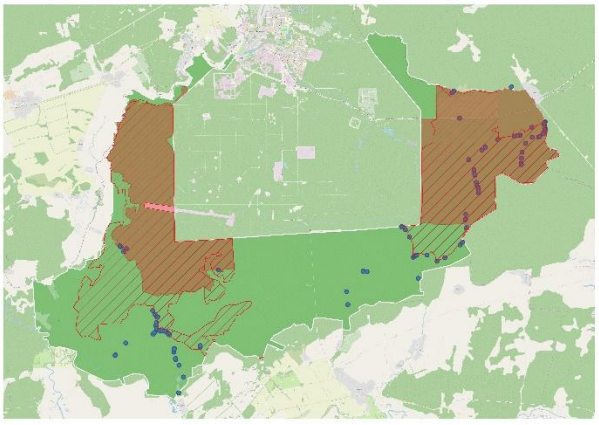

Figure 3a. *Juncus tenuis*

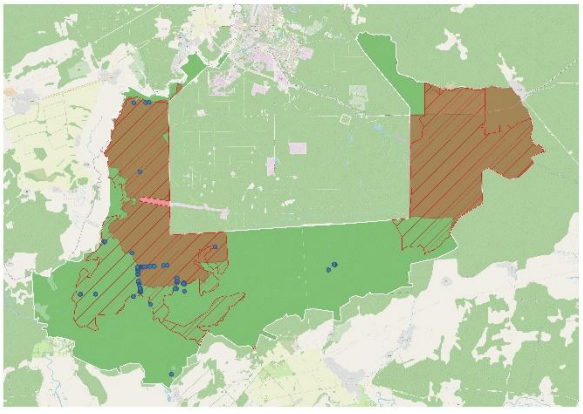

Figure 3b. *Epilobium pseudorubescens*

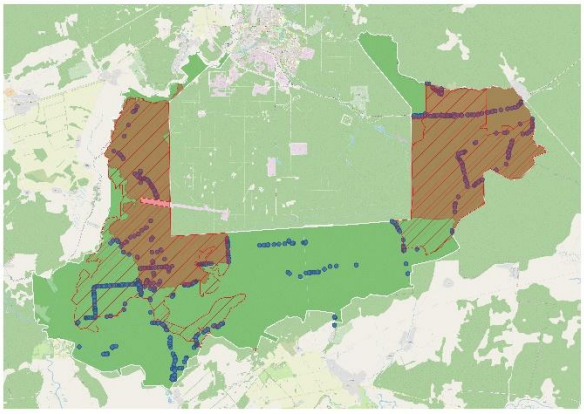

Figure 3c. *Erigeron canadensis*

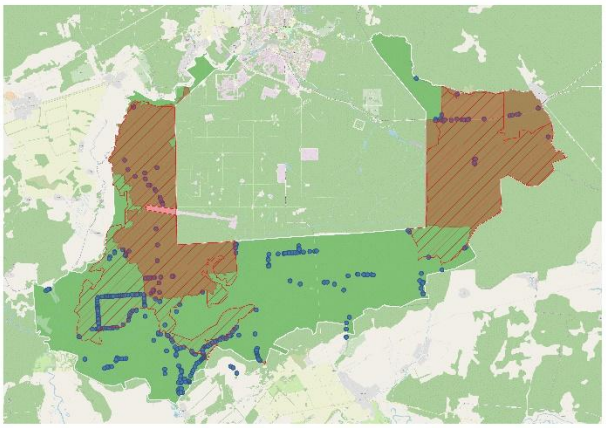

Figure 3d. *Erigeron strigosus*

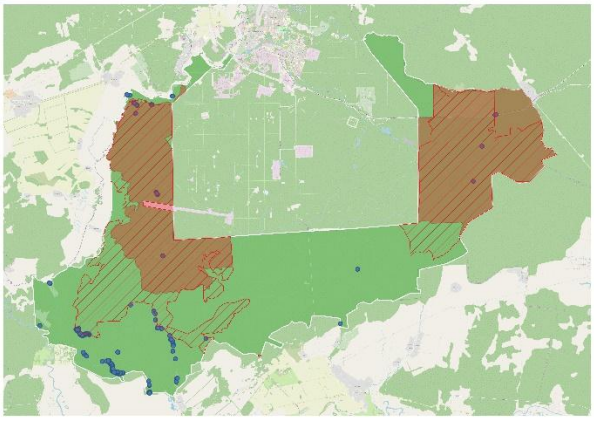

Figure 3e. *Bidens frondosa*

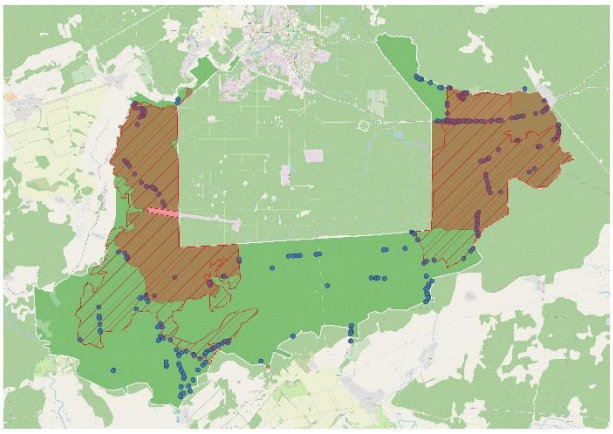

Figure 3f. *Solidago canadensis*

Figure 3. Maps of locations of fire-related invasive plants in the territory of the Mordovia State Nature Reserve.

To identify the relationship between the distribution of these species and the burn areas, we calculated a number of descriptive statistics, such as the mean number of occurrences of invasive species, as well as their breakdown into areas with fires (fire) and without fires (no fire) (Fig. 4).

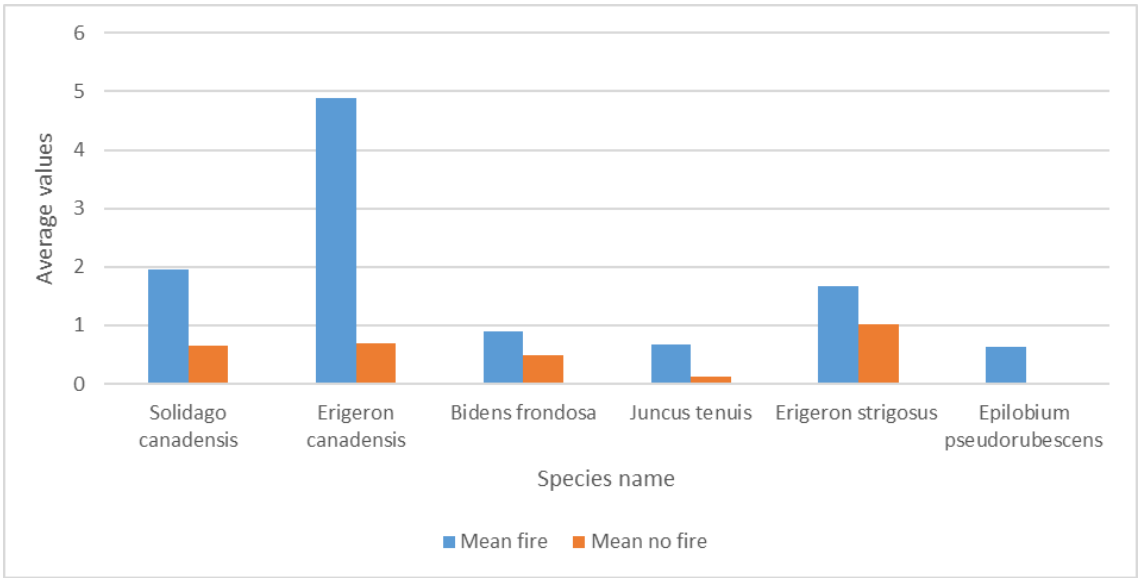

Figure 4. The mean number of occurrences of invasive species in the burn areas and natural communities of the Mordovia Nature Reserve between 2011 and 2024.

During the analysis, it was found that all studied plant species were more frequently encountered in fire-affected areas. However, for some species, the difference in the mean number of occurrences between fire-affected and non-fire areas was most pronounced. For example, for *Solidago canadensis*, the mean number of occurrences in fire-affected areas was 1.94, while in non-fire areas, it was 0.65. A similar situation was observed for *Erigeron canadensis*: in fire-affected areas, the mean number of occurrences was 4.89, while in non-fire areas it was 0.69. For *Erigeron strigosus*, the difference between occurrences in burned and unburned areas was less pronounced (1.67/1.02, respectively). *Epilobium pseudorubescens* was mainly observed in areas affected by fires and the average number of encounters in fire sites was 0.63.

To test the normality of the data distribution, the Shapiro-Wilk test (Shapiro & Wilk, 1965) was applied, which indicated a deviation from normal distribution. Therefore, non-parametric methods were used for further analysis, specifically the Kruskal-Wallis test (Kruskal & Wallis, 1952). The results of this test revealed statistically significant differences between fire-damaged and non-fire areas for most of the plant species. Statistically significant differences were found for all species except *Bidens frondosa* (Fig. 5). Specifically, for *Solidago canadensis* ($H = 20$, $p < 0.0001$), *Erigeron canadensis* ($H = 51$, $p < 0.0001$), *Juncus tenuis* ($H = 8.19$, $p = 0.0042$), and *Erigeron strigosus* ($H = 8.29$, $p = 0.0040$), *Epilobium pseudorubescens* ($H = 11{,}84$, $p = 0{,}0006$), a significant increase in the number of occurrences of these species was recorded in fire-damaged areas. This supports the hypothesis that fires contribute to the spread of some invasive species by creating conditions that facilitate their successful adaptation and spread.

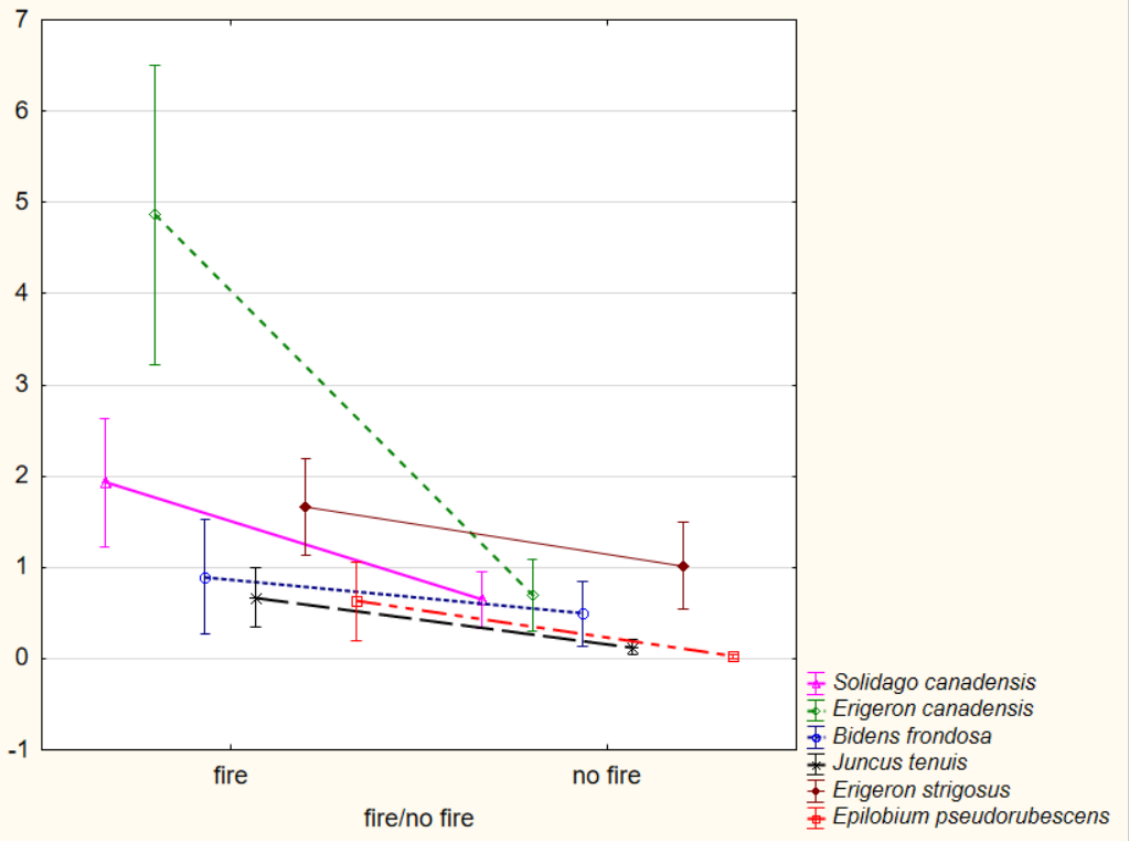

Figure 5. Results of the Kruskal-Wallis test analysis for the spread of invasive species in the Mordovia State Nature Reserve.

To assess the relationships between species, Spearman's rank correlation method was used (Table 2). The results revealed strong positive correlations between related species in the absence of fire (no fire). Specifically, strong correlations were observed between *Erigeron canadensis* and *Erigeron strigosus* (0.68), as well as *Solidago canadensis* and *Erigeron strigosus* (0.57), indicating their close ecological relationship. Additionally, on burned areas, a correlation between *Juncus tenuis* and *Erigeron strigosus* (0.51) was also observed. In contrast, in fire-affected areas, the correlation between *Erigeron canadensis* and *Erigeron strigosus* remained, though it was slightly lower (0.64), and a noticeable correlation between *Erigeron canadensis* and *Solidago canadensis* (0.62) was detected. However, the correlation between *Juncus tenuis* and *Erigeron strigosus* was relatively low (0.40).

Table 2. Spearman's correlation of invasive plant species in natural and fire-damaged areas of the Mordovia State Nature Reserve

	Solidago canadensis		*Erigeron canadensis*		*Bidens frondosa*		*Juncus tenuis*		*Erigeron strigosus*		*Epilobium pseudorubescens*	
Solidago canadensis	1.000	1.000	**0.623**	0.472	0.292	0.217	0.492	0.474	0.489	**0.579**	-0.030	0.040
Erigeron canadensis	**0.623**	0.472	1.000	1.000	0.172	0.292	0.376	**0.510**	**0.642**	**0.688**	0.235	0.358
Bidens frondosa	0.292	0.217	0.172	0.292	1.000	1.000	0.207	0.300	0.211	0.292	0.020	0.066
Juncus tenuis	0.492	0.474	0.376	**0.510**	0.207	0.300	1.000	1.000	0.158	0.407	-0.164	-0.042

Erigeron strigosus	0.489	**0.579**	**0.642**	**0.688**	0.211	0.292	0.158	0.407	1.000	1.000	0.273	0.212
Epilobium pseudorubescens	-0.030	0.040	0.235	0.358	0.020	0.066	-0.164	-0.042	0.273	0.212	1.000	1.000

Note: Significant correlation coefficients are highlighted in red, and values exceeding 0.5 are shown in bold.

Epilobium pseudorubescens does not show a strong correlation with any species, but does show a slight negative correlation with *Juncus tenuis. Bidens frondosa* also did not show any significant correlation with any of the studied species. This can be explained by the fact that *Bidens frondosa* prefers hygrophytic habitats.

Discussion

Between 2011 and 2024, the number of alien vascular plant species in the burn areas of the Mordovia Nature Reserve increased from 6 to 25 (Khapugin et al., 2015; Esina et al., 2024). All the alien species recorded in the burn areas (Table 1) are found both in the burned areas and along roads and clearings in the natural plant communities of the reserve (Esina et al., 2024; https://www.inaturalist.org/projects/vascular-plants-in-the-mordovia-state-nature-reserve).

Between 2011 and 2024, we observed the intensive spread of alien species throughout the protected area. The main reason for this is the formation of primary and secondary burn areas covering one-third of the reserve's total area. The protected area experienced two catastrophic fires during the decade (in 2010 and 2021). As a result of the fire in 2021, areas burned in 2010 were transformed into vast spaces devoid of vegetation and exposed, disturbed podzol soils, which facilitated the spread and germination of seeds from species such as *Erigeron canadensis*, *E. annuus*, *E. strigosus*, *Solidago canadensis*, *Epilobium pseudorubescens*, *Sambucus racemosa*, *Viola arvensis*, and others. Instead of a decrease in the projected cover of plant communities (Khapugin et al., 2015; Gafurova, 2024), these species caused a new surge in abundance (Esina et al., 2024).

In 2010 and 2021, a large amount of firefighting equipment was used to extinguish wildfires, including fire trucks, service vehicles, graders, and tractors with blades. This facilitated the spread of alien plant diaspores across the territory of the Mordovia Nature Reserve via vehicle wheels. During the fires, forest clearings and service dirt roads, which had previously been overgrown and impassable, were cleared. Due to the intensive use of these roads and clearings – fire suppression efforts lasted for at least a month – they became severely degraded, leading to the disruption of vegetation cover, the formation of disturbed ecotopes, and the colonization of these areas by alien species.

Between 2011 and 2024, annual large-scale clearing of roads and fire-affected clearings from fallen trees was conducted. As part of fire prevention measures, for the first time in three decades, forest clearings between unburned forest quarters were restored in the reserve. Additionally, annual plowing of firebreaks and the construction of mineralized strips were carried out. Since 2015, disc attachments

have been used instead of traditional plows for firebreak maintenance. Unlike deep and wide trenches created by plows, disc attachments cultivate shallow strips of soil about 2 meters wide, effectively creating prepared seedbeds for the germination of weeds and invasive species throughout the Mordovia Nature Reserve.

Since many of the service dirt roads and clearings pass through lowlands and wetlands on the floodplain terraces of the Moksha River, hygrophilous species such as *Bidens frondosa* and *Juncus tenuis* have begun to spread in these habitats. These species are now commonly found in wet wheel tracks both within and beyond the burn areas. Their spread, along with that of other species, is facilitated by vehicles used for daily patrols conducted by the reserve's protection department. In the 20th century, patrols were primarily conducted on foot or horseback, which limited the spread of alien and weedy species due to the absence of disturbed soil surfaces. However, given that vehicles now travel to remote cordons using both dirt service roads and paved roads in the central and northeastern parts of the reserve, the future establishment of invasive species in pyrogenic communities is expected. These species include *Amelanchier spicata* (Lam.) K.Koch, *Acer negundo* L., and *Sorbaronia* × *fallax* (C.K.Schneid.) C.K. Schneid., which have already been widely recorded along public roadways (Khapugin et al., 2013; Esina et al., 2024).

Conclusion

Thus, the number of alien vascular plant species and their occurrences in the burned areas of the Mordovia State Nature Reserve has been increasing annually. By 2024, the number of these species in pyrogenic communities had reached 25, accounting for 14.4% of the reserve's alien flora. The majority of invasive vascular plant species spreading in the burned areas of the reserve include *Juncus tenuis, Epilobium pseudorubescens, Erigeron canadensis, Erigeron strigosus, Bidens frondosa,* and *Solidago canadensis,* whose distribution has been driven by fire-related factors. Between 2011 and 2024, the spread of alien vascular plant species has been observed in the pyrogenic communities formed after the 2010 and 2021 wildfires, as well as in roadside habitats within the forest massif of the reserve. This expansion has been facilitated by fire events and subsequent firefighting and fire prevention measures. In particular, the use of a disc harrow for firebreak plowing within forest infrastructure has contributed to the spread of alien plant species throughout the reserve. Given these findings, it is recommended to revert to using a plow for firebreak construction and the establishment of mineralized strips within the protected area.

In the future, the colonization of pyrogenic communities by invasive species such as *Amelanchier spicata* (Lam.) K.Koch, *Acer negundo* L., and *Sorbaronia* × *fallax* (C.K.Schneid.) C.K. Schneid, from adjacent areas, is to be expected.

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