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## Geospatial Features of Historical-Geographical Formation and the Current State of the Forest Massifs of Busk Forestry (Ukraine)

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Geoprzestrzenne cechy układu historycznego i geograficznego oraz stan obecny masywów  
leśnych leśnictwa Busk (Ukraina)

**Abstract:** The purpose of this article is to investigate the species composition, age structure, and economic utilization of forest plantations in the Busk forestry. The practical importance of such research increases in the context of administrative reform and land resource management in newly created communities and announced consolidations of forestry enterprises in 2021. The research used various time-based cartographic materials, which allowed to trace the development of typical forest massifs from the end of the 18<sup>th</sup> century to the present day. The study was conducted for four time periods. The proposed study was carried out by processing statistical materials of the Busk forestry. Based on this data, cartographic schemes of species composition, age structure, and timber

stock were constructed and analyzed by forestry. It was established that the characteristic features of forestry in the region are: uneven forest cover of the studied territory; significant fragmentation of the forest fund in the southern part of the forestry territory; location of large forest massifs in the northwestern part of the forestry; dominance of such tree species as pine, oak, and alder in the forest stands; insignificant increase in forest cover in individual territories due to the creation of pine tree cultures on unproductive lands and active expansion of black alder forests in over-moistened pastures. The division of the forest fund into categories has been studied. It has been established that the largest share of the forest fund of the Busk forestry is occupied by exploitable forests. Protective forests account for 1.5% of the total forest area in the studied region. The forest supply per capita in the Krasne territorial community is on average 0.12 ha/person, while in Busk it is 0.61 ha/person.

**Keywords:** retrospective analysis; forestry; forest cover; forest categories; forest reserve; species composition; age structure of the forest

**Abstrakt:** Celem artykułu jest zbadanie składu gatunkowego, struktury wiekowej oraz gospodarczego wykorzystania plantacji leśnych Buskiego Gospodarstwa Leśnego. Praktyczne znaczenie takiego opracowania wzrasta w kontekście reformy administracyjnej oraz uporządkowania zasobów ziemi nowopowstałych gmin oraz zapowiadanej w 2021 roku konsolidacji przedsiębiorstw leśnych. W badaniach wykorzystano materiały kartograficzne z różnych okresów, co pozwoliło nam przedstawić rozwój typowych obszarów leśnych od końca XVIII wieku do dnia dzisiejszego. Badania przeprowadzono w czterech przekrojach czasowych. Proponowane badanie przeprowadzono poprzez opracowanie materiałów statystycznych Buskiego Gospodarstwa Leśnego. Na podstawie tych danych zbudowano i przeanalizowano mapy składu gatunkowego, struktury wiekowej oraz zasobów drzewnych w sekcji leśnictwo. Ustalono, że charakterystycznymi cechami funduszu leśnego w regionie są: nierównomierna lesistość badanego terenu; znaczna różnorodności formacji leśnej w południowej części terenu gospodarstwa leśnego; położenie dużych obszarów leśnych w północno-zachodniej części gospodarstwa leśnego; dominacja w drzewostanach takich gatunków jak sosna, dąb, olcha; nieznaczne zwiększenie lesistości na niektórych terenach w wyniku tworzenia borów sosnowych na nieużytkach oraz aktywnej ekspansji olsów czarnych na podmokłych pastwiskach. Przeanalizowano podział funduszu leśnego na kategorie. Ustalono, że największy udział w funduszu leśnym Buskiego Gospodarstwa Leśnego zajmują lasy eksploatacyjne. Lasy ochronne stanowią 1,5% ogólnej powierzchni leśnej badanego regionu. Podaż lasów na mieszkańca we Wspólnocie Terytorialnej Krasne wynosi średnio 0,12 ha/mieszkańca, a w leśnictwie Busk 0,61 ha/mieszkańca.

**Słowa kluczowe:** analiza retrospektywna; leśnictwo; kategorie lasów; rezerwat leśny; skład gatunkowy; struktura wiekowa lasu

## INTRODUCTION

Forests are one of the key natural factors that significantly affect all components of the environment – the hydrological and climatic regime of the area, soil formation, flora and fauna. The forest cover is an important component of the landscape that contributes to the preservation of its other components. The important ecological stabilization and economic functions of the forest highlight

the need to study processes related to the reduction of their area and deterioration of the quality of plantings.

Despite being located within the Small Polissya region, the researched area is insufficiently and extremely unevenly forested. This is a predictable result of the active anthropogenic influence on the forests of this territory over the past centuries. The forest coverage of the study region generally exceeds 20%. Studying the forests of the Busk forestry enterprise with the aim of their effective use and reproduction in the modern stage of society's development is necessary from both an ecological and economic point of view. Currently, Ukraine is unable to fully meet its own needs for timber and is one of the least forested countries in Europe. Areas of mixed forests are promising for afforestation.

The aim of the article is to investigate the historical-geographical peculiarities of the development of specific forest areas, geospatial features of species composition, age structure, and economic utilization of forest plantations within the operational zone of Busk forestry.

The relevance of the mentioned problem is increasing in the current conditions of reforming both the country's administrative system and the forestry industry. In the near future, the merging of forestry enterprises will be carried out with the aim of increasing economic efficiency. It is likely that their boundaries will be maximally brought closer to the configuration of the newly created administrative districts. At the same time, a number of programs aimed at increasing the area of forests, intensifying forest management, etc., are being implemented in Ukraine. Possibilities for transferring non-privatized land for afforestation are being studied, especially in areas with infertile, acidic, and degraded soils.

Promising areas for forest cultivation, including plantation forestry, are precisely the territories of the Small Polissya, including the newly formed Busk and Krasne territorial communities and neighboring areas. In the era of growing anthropogenic impact, overall environmental pollution, problems of forest preservation, their rational use and restoration become of paramount importance and should be addressed at the state level.

## MATERIALS AND RESEARCH METHODS

The study of forest land use and the ecological role of forests is the subject of research by many domestic and foreign scientists. The methodological foundations of research on forest land use were developed in the works of Hensiruk (1980). The publication by Havryshok and co-authors (2022) is dedicated to the historical-geographical aspect of forest research. The study by Cebrykow and Kałamucka (2021) is devoted to the study of spatiotemporal changes in forest

cover in the western part of “Roztochchia”. The researchers use the comparison of different time maps and the proposed methodology can be used for other regions, for which there are Polish topographic maps of the thirties, including for the Small Polissya within the Lviv region.

The methods of retrospective research of forest stands using different time maps are revealed in the publications of Havryshko and Potokiiy (2014). In the area of the Small Polissya, the study of the specifics of forest use was carried out by Dankevych (2019), Furdychko et al. (2021), Kucheryaviiy (2021), Lavnyi and Kravchuk (2008), Kravchuk (2010), Palyanychko and Dankevych (2019), Myklysh et al. (2021). These studies are usually limited to considering individual aspects of the problem or a part of the territory. Indeed, the studies by Lavnyi and Kravchuk (2008) and Kravchuk (2010) focuses on studying alder stands across the entire territory of the Small Polissya. In the works of Kucheryaviiy (2010), a fairly detailed analysis of pine stands on extensive areas of the region is presented. In both cases, practical forestry needs are emphasized. The study by Palyanychko and Dankevych (2019) and co-authors is aimed at refining the physiographic zoning of the Small Polissya. The publication by Dankevych (2019) provides a general characterization of the territorial peculiarities of forestry enterprises in the Small Polissya region of Ukraine. The study examines the ecological impact of forestry enterprises on achieving balanced land use in the Small Polissya forestry zone. In the work by Furdychko and co-authors (2021), the completeness, accessibility, and transparency of the environmental-economic reporting system of forestry enterprises are investigated, using the case of Small Polissya.

Publications by Petrova and Petrov (2009) are dedicated to the study of mature and uneven-aged forest stands in the Ukrainian Small Polissya region and their nature conservation value. For comparing the floristic diversity of the investigated region with the neighboring Podillia, the article by Mudrak et al. (2018) is of interest. Myklysh and co-authors (2021) have conducted research on beech forest stands and their growth and utilization characteristics in the forests of the plain territory of Ukraine.

The publication by Havryshok et al. (2016) analyzes various aspects of forest land use in the former Radivilivskyi district. Pashkovska and Perkhach (2019) conducted research on the current state of utilization and protection of forest plantations at the “Brodivske Forest Enterprise”. There are currently no publications aimed at a comprehensive geographical study of forest land use in modern administrative districts or forestry enterprises within the Small Polissya.

A complex of interdisciplinary and specialized research methods were used during the research process, including observation, systematic approach, analysis and synthesis, generalization, systemic-structural, historical-geographical,

comparative-geographical, cartographic, and mathematical methods. The use of mathematical modeling in forest and land use research enabled the identification of interrelationships between forest conditions and factors affecting them, as well as the analysis of land use issues in the studied region.

The traditional method used in forest research is the cartographic method, which involves constructing cartographic models and gaining new knowledge through their analysis and transformation. The cartographic method was employed in the study of forests and land use within the investigated region. With its help, the researchers conducted descriptions and comparisons of historical topographic maps from different time periods for several representative areas. For the retrospective-geographical study, map sheets such as von Mieg's map (1783), the Special Map of the Austro-Hungarian Monarchy (1879), the Tactical Map of the Military Geographic Institute (1923), and a satellite image from Google Earth (2022) were used. This enabled us to trace the development of specific forest areas over a period of more than 200 years (from 1783 to 2022). In addition, various types of cartographic models were created, including models depicting the age structure and species composition of forests, the sectoral structure of forestry, timber reserves, and more.

It is important to conduct a detailed analysis of available cartographic images (topographic and thematic) of the region. Which was widely used at the preliminary stage of the research for general familiarization with the studied object, research planning, determining a rational methodology, and selecting initial cartographic materials.

Detailed descriptions of the maps were also carried out in the final stage during the content interpretation of the obtained results and authorial map schemes. This ensured a balance between qualitative and quantitative methods of cartographic analysis.

## RESULTS AND DISCUSSION

### **Historical and geographical features of forest land use development in the region**

The forests that are part of the modern Busk forestry were first measured as separate areas during 1860–1880 as part of the Austro-Hungarian state cadastre. Forest management was mandatory, and in private forests, it was carried out at the owner's expense. Without forest management plans, owners did not have the right to cut down trees (Official..., 2023).

From the beginning of the 20<sup>th</sup> century and onwards, forests were named after their owner's surnames and belonged to influential magnates. Large forest areas were owned by the families of Count Potocki, Prince Czartoryski, and



less wealthy local noble families. Large forest areas belonged to the Roman Catholic and Greek Catholic churches and magistrates since the time of the Polish-Lithuanian Commonwealth. The Busk forestry was organized in 1939 by merging private and community forests. Documentation and materials on forest management from the previous period were lost during World War II.

Considering the scarcity of reliable statistical and forest management information, available cartographic sources were used to study the historical and geographical aspect of the problem. The forest cover of the research region, as well as the entire Small Polissya region, has been decreasing since the 19<sup>th</sup> century. This can be observed well by comparing cartographic depictions from different periods. In particular, the southern and western outskirts of the researched location were studied, as at present they have less forested and fragmented and separated by villages and agricultural land. One example of the gradual decrease in forest area can be observed to the north of the village of Velykosilka (Fig. 1).

The historical name of this settlement is Zhelekhiv. On Friedrich von Mieg's map dated 1783, we see an extensive forest area approaching the village's northern and northeastern boundary. Lakes and streams are visible in the forest. One



Fig. 1. Forested area between the villages of Velykosilka and Strepitv on different time maps: a) 1783; b) 1887; c) 1930; d) 2022 (fragments taken from Map of the...; Spezialkarte der...; Mapa taktyczna...; Google Planet Earth)

hundred years later, the configuration of the forest changes. The village expands due to hamlets in the north and west and is divided into two separate settlements: Velykyi and Malyi Zhelekhiv.

Large and unregulated deforestation occurred during World War I. In the 1930s, the forest took on its current configuration – a narrow strip (the length of the forest from north to south ranges from 520 to 1,280 m), stretching from west to east and divided by a road connecting the villages of Streptiv and Velykosilka. In the 1930s, a series of hamlets and small forest farms were located to the south of the forest. After World War II, they all fell into disrepair, and only overgrown neglected gardens remain to remind us of them today. Conducting cartometric studies on the background map of Mieg is complicated but entirely possible using a special map from 1887. According to our calculations, the area of the described forest has decreased by approximately 360 ha. The error is due to the adjustment of the original cartographic image with a scale of 1:75 000 to the modern cadastral map with a scale of 1:100 000. A similar situation, and

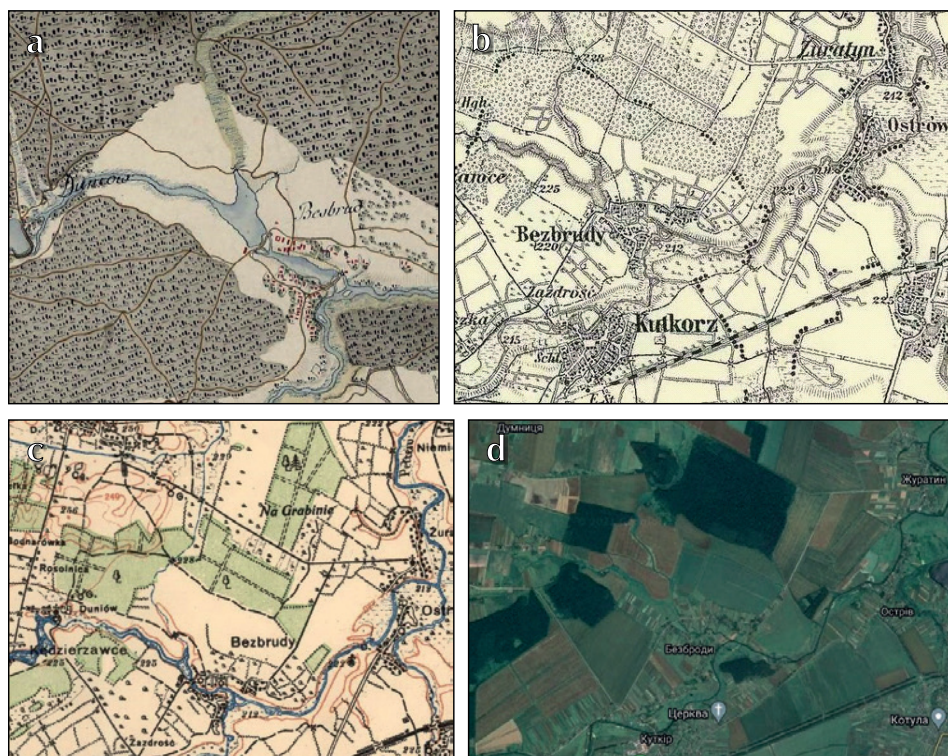


Fig. 2. Forest areas north of the village of Bezbrudy on various maps over time: a) 1783; b) 1887; c) 1930; d) 2022 (fragments taken from Map of the..., Spezialkarte der..., Mapa taktyczna..., Google Planet Earth)

perhaps a more illustrative one, can be observed to the northeast of the village of Bezbrody, which is currently located in the Kutkirske forestry area (see Fig. 2).

The village of Bezbrody is located in the valley of the Poltva River, where it meets the Dumna River. As shown on Mieg's map (Fig. 2a), at the end of the 18<sup>th</sup> century, the settlement was surrounded by forests. Deforested areas stretched along the rivers, likely serving as agricultural land for the local population.

One hundred years later, according to the Special Map of the Austro-Hungarian Empire of 1887, a railway had already been built connecting Zolochiv with Lviv and passing near the village of Kutkir, a few kilometers southeast of Bezbrody. The first thing that is clearly recorded is the absence of a forest massif on the right bank of the Poltva River and a significant reduction in the forest area on the right bank of the Dumna River. On the map, it is evident that there was logging on the watershed between the Poltva and Dumna rivers between Bezbrody and Kutkir. It is difficult to judge the decrease in forested areas on the left bank of the Dumna River towards the village of Zhuratyn due to errors in comparing maps of different scales, but the clear-cut block on the northeast of the forest massif on the 1887 map can be seen.

Further reduction of forest area can be observed in the interwar period, when the forest to the east of Ostrivets and Zhuratyn was transformed into three separate blocks. This trend continued after World War II. On a satellite image, four relatively small forest blocks can be seen in place of the former forest. Two small land plots on the banks of the Poltva River were afforested in the second half of the 20<sup>th</sup> century for soil protection purposes. A small forest block covering an area of 22.58 ha on the right bank of the Poltva River, opposite the mouth of the Dumna River, was planted during the Soviet period and has been gradually expanding ever since. This conclusion is based on a comparison of the satellite image with a 1:100 000 topographic map that reflects the situation in the 1980s. This forest block is state-owned and designated for forest management. Between it and the Poltva River, there is a 20.5-ha reserve land that can be considered as a reserve for afforestation of sloping areas.

During the analysis of the current satellite imagery as of 2021 and the Public Cadastral Map, it can be observed that the majority of lands in the basins of the Dumna and Poltva rivers have already been regulated. Each of the forest blocks also has a cadastral number. The largest of them, located to the north of the village of Bezbrody, covers an area of 200 ha. To the west of it is a forest area of 29.6 ha. Between them is a 15.4-ha reserve land on a slope that should be transferred to the forestry for afforestation. Although this is unlikely considering the active development of agribusiness. Further north, in the direction of the village of Kizliv, there are another 50.3 ha of state-owned land, which could



also be considered as a potential fund for afforestation, if not for their designated use as “for farming”.

Interesting for study is the forest area on the right bank of the Western Bug river, east of Utyszkiv village (Fig. 3). In the late 18<sup>th</sup> century, two ponds on the Western Bug river were clearly marked here. The entire right bank is covered with a forest area, either a swampy forest or a sparse forest. On the left bank of the river, east of Utyszkiv village, there is a small section of forest which then transitions to sparse forest further east. In 1887, on the map, there were already no forest areas on the left bank, while on the right bank there were two separate forest areas and extensive swampy territories with individual trees. During the Soviet period, all swampy lands were drained and converted



Fig. 3. Forest stands north of the village of Utyszkiv on different historical maps: a) 1783; b) 1887; c) 1930; d) 2020 (fragments taken from Map of the..., Spezialkarte der..., Mapa taktyczna..., Google Planet Earth)

into arable land. Currently, these are private parcels for personal or commercial agricultural production.

As for the forest areas, they have existed from 1887 to the present day. Both decreased during the interwar period, but in Soviet times, through the efforts of foresters, they acquired areas that surpassed the Austrian ones. Currently, the northern forest area is within the Verbylanske forestry zone, while the eastern one belongs to the state-owned enterprise “Halsilis” As we can see from figures 3b and 3c, the northern forest area lost its northern quarters in the 1930s and acquired a bizarre shape. Currently, it is a cadastral plot with an area of 154 ha. Thus, over the last 130 years, the mentioned territory has lost practically all its natural swampy areas, while the forest area has not only not decreased but even slightly increased.

#### The current state of land use in Busk forestry enterprise

As of 2021, the territory of Busk forestry enterprise is divided into 9 forestry units (Tab. 1). Each district includes lands covered and not covered by forest vegetation. Among the lands not covered by forest vegetation are lands used by foresters for subsidiary agricultural activities such as arable lands, meadows, pastures, and orchards. These territories provide food for wild animals that breed in the forests for hunting purposes.

Tab. 1. Distribution of forested areas in Busk forestry enterprise by forestry units as of 2021 (authors' own study based on data from Stock..., 2022)

Forestry unit name	Forest area (ha)	Forestry unit name	Forest area (ha)
Tadanyvska	3,223.7	Ozhidivske	1,571.3
Hrabivske	2,815.1	Sokolianske	2,801
Verblyanske	3,062.3	Neznaniivske	1,751.2
Polonychne	1,176	Bolozhynivske	1,701
Kutkirske	3,058		

The Busk forestry enterprise's area of activity is located on the border of Zolochiv, Chervonohrad, and Lviv districts. It fully or partially covers six territorial communities (TCs): Busk, Krasnensk, Dobrotvir, Novoyarychivsk, Kamianka-Buzka, and Hlyniansk. Within the Busk and Krasne TCs, the forest areas of the forestry enterprise “Halsillis” are located on an area of 3,714 ha. The Busk forestry enterprise oversees and controls the forestry activities of this enterprise (Fig. 4).

As seen in Fig. 4, forested lands are unevenly distributed. The average forest cover of the region is 20.9%. The highest forest cover is observed in the



Fig. 4. Cartoscheme of the research area (authors' own study based on data from Project..., 2018)

northwest of the Busk forestry district. Here, there is one large forest massif divided among five forestries. The territory to the southwest of the Busk-Bilyi Kamin line is characterized by large non-forested areas. This is the area of activity of the Kutkir forestry district, which consists of several small isolated forest masses.

The calculation of forest cover was conducted for administrative units. Analysis shows higher forest cover rates in the Busk municipality compared to the Krasnenska village. The reason for the low forest cover in the southern part of the region is discussed in the historical map's analysis above. Forest cover below 5% was found in the territory of the city of Busk, the settlement of Krasne, and the rural Starostynskyi districts of Mazurovychi (Andriivka) and Perevolochyna. Forest cover within the range of 5–10% is observed in the Starostynskyi districts of Humnys'ko, Zadvir'ia and Kutky. The region with forest cover above 20% occupies the central part of the community's territory, particularly the territories of the Starostynskyi districts of Sokolia, Pobuzhany, Yablunivka, Bolozhyniv, and Chanyzh. This is a sparsely populated region with small villages and poorly developed agriculture. The eastern and southern periphery of the Busk municipality (the villages of Toporiv, Turya, Kizliv, Novosilky, Novyi Myliatin, Ozhidiv) is characterized by forest cover of 10–20%.

The leading role in the species composition of the forest stands in the region belongs to pine plantations, which account for 46.2% of the forested area.



Its share is slightly higher in the forests of Verbylansk and Polonichny forestry (62.9% and 61.9%, respectively). The smallest proportion of pine is observed in the forests of the Neznanyiv forestry, where it accounts for only 13%. The reason for this is the specific over-humidified conditions of forest growth. Pine is capable of self-renewal on the territory of the forestry, but is mainly grown in forest plantations. Among coniferous species, European fir and larch also have a low prevalence (0.1% of the area). These species are grown on small areas in the Ozhydivsky and Tadanivsky forestries (Fig. 5).

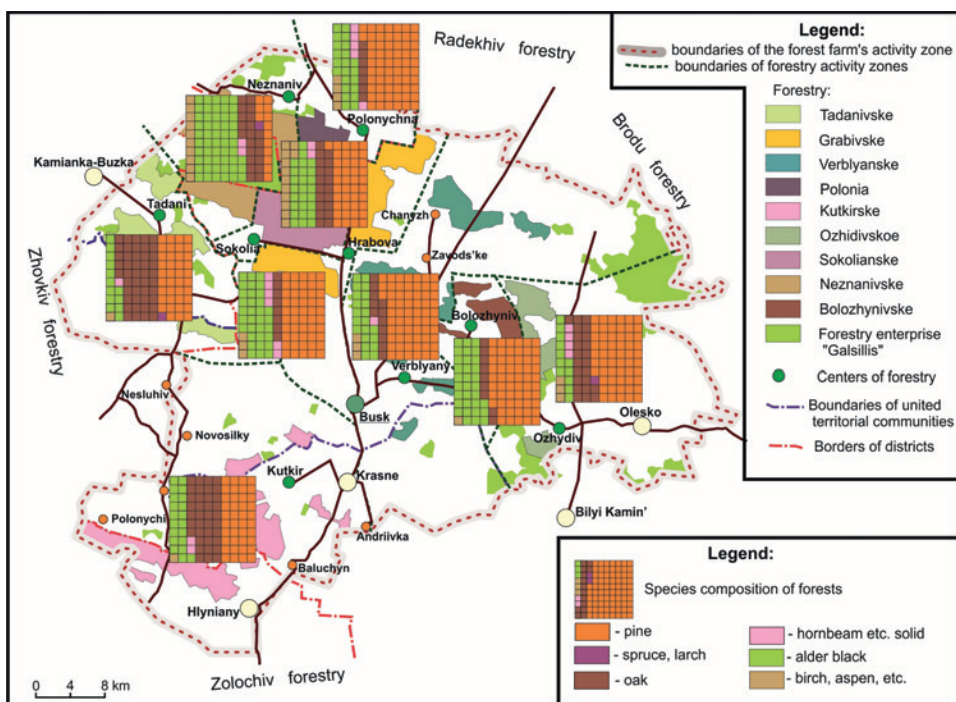


Fig. 5. The species composition of the forest stands in the Busk forestry (authors' own study based on data from Project..., 2018; Stock..., 2022)

The analysis of the forest inventory materials (Project..., 2018) indicates a gradual decrease in the proportion of coniferous species in the forests of the region and an increase in deciduous species. The main reason for this is the natural renewal of low-value deciduous species (aspen, birch) in place of coniferous clearcuts and the expansion of black alder areas in over-humidified stands. The latter occurs due to the neglected state of drainage channels and the activity of beavers in forest streams and channels.

Hard-leaved species occupy 24.5% of the forested area in the forest enterprise (Fig. 5). They are mostly represented by forest plantations and concentrated



in Kutkirske and Tadanivske forestry areas, where they occupy 39% and 47% of the area, respectively. Oak plays a leading role in this group. Hornbeam covers an average of 0.6% of the forested area in the forest enterprise. They are mostly found in Grabivske and Neznanyivske forestry areas, where they occupy 1.7% and 2% of the forested area, respectively. Most of them are medium-aged and mature. In the forest enterprise, hornbeam is a traditional companion of oak and occupies the second tier in oak forests. On the one hand, hornbeam is a low-value species that can easily replace oak and beech in forest plantations in the absence of care, and on the other hand, oak forest plantations grow slower without hornbeam, with a lower trunk and larger crown, which reduces the quality of commercial timber. The situation is significantly different in the Polissya region. The forests here are oak-pine. Hornbeam requires fertile soils, which are scarce in the region.

Deciduous species account for 29.1% of the forested area in the study area. Black alder dominates the species composition of these forests. The characteristics of these forests are described below in a separate section. Birch, aspen, and willow are much less common. Their specificity is relatively rapid maturation. Black alder forests are located in poorly drained, waterlogged areas and provide fairly high-quality commercial timber. Most of them have a vegetative origin. The highest concentration of black alder forests is observed in the Neznanyivske forestry area, where they occupy 53% of the area. In the Grabivske and Bolozhynivske forestry areas, black alder forests cover over 30% of the forested area. It occupies the smallest area in the Ozhidivske and Tadanivske forestry areas, which is related to the good drainage of local gray forest soils.

In the age structure of the forests, middle-aged stands (44.7%) and young plantations (24.5%) predominate, while saplings occupy 19.4% and only 11.4% of the forested area is covered by mature and overmature stands. Such an age structure indicates intensive forest use in the forest enterprise's territory over the last decade and active work by foresters to shape the forests species composition.

As can be seen in the map (Fig. 6), mature and overmature stands prevail in the northwestern part of the study region, with the highest proportion found in the Polonichne and Neznanyivske forest districts (25% and 21.8%, respectively). One of the reasons for this situation is the poor transport accessibility of the territory of these forest districts and land overuse. Another, no less important reason, is the significant proportion of fast-growing species in the stands. For example, a black alder stand of vegetative origin is considered mature at 50–60 years of age, whereas high-quality oak forests mature only after 100–120 years of age.

In the western part of the study area (Tadanyvskyi and Kutkirske forest districts) and in the Bolozhynivske forest district, middle-aged stands and saplings

predominate significantly. The young plantations are distributed more or less evenly, with their increased proportion being noticeable in the Polonichne and Verbylanske forest districts.

An analysis of the division of the forest fund of the Busk forestry enterprise into categories showed that the largest area is occupied by exploited forests – 22,202.1 ha (87.8%). In addition to their economic function, these forests perform a whole range of other functions, such as water protection, soil protection, and climate regulation.

Protective forests cover an area of 338.0 ha, which represents 1.5% of the total forest area in the studied region. This category includes protective forests along the strips of railway lines (271 ha) and along the strips of highways (117 ha). Recreational and health-improving forests cover an area of 2,400 ha and represent 9.5% of the forest fund structure. All of them constitute the forestry part of green zones. Nature conservation, scientific, and historical-cultural forests cover an area of 290.9 ha, which represents 1.2% of the total area of the forest enterprise. In all forestry areas of the studied region, operational forests play a leading role, while the share of other categories is insignificant. Protective forests along the strips of railway lines are only present in the Kutkirske and Ozhidivske forestry areas. The forests within the state forestry enterprise “Halsillis” belong to three categories: recreational and health-improving, protective, and operational. The characteristic feature is the decrease in the share of operational forests and the increase in the share of protective forests. Recreational and health-improving forests are a part of the territory of the national natural park “Northern Podillya”. In this case, the protective forests category includes water protection forests in the studied region, which are located along rivers, including the Poltva, the Western Bug, the Zolochivka, as well as other water bodies, such as ponds, irrigation canals, and small swampy areas.

The total wood stock in the Busk forestry is 4,576.36 thousand m<sup>3</sup>. Coniferous species account for 52.7% of the stock structure. Hard-leaved and soft-leaved species each account for 23.7% of the wood stock in the studied region. In terms of geospatial distribution, the wood stock is extremely uneven and correlates with the sizes of forest districts. The largest wood stock is in the Verbliansk forestry at 810 thousand m<sup>3</sup> (Fig. 7). The second largest in size is the Tadaniv forestry at 675 thousand m<sup>3</sup>. Half of the forest districts have wood stock that is twice as small as the maximum for the entire forestry.

The smallest wood stock (311 thousand m<sup>3</sup>) is in the Polonychna forestry. The wood stock is less than 350 thousand m<sup>3</sup>. In the wood stock structure of most forest districts (Verbliansk, Ozhidivske, Bolozhynivske, Polonychna), over 50% consists of coniferous wood. The Neznanyivske forestry has the smallest

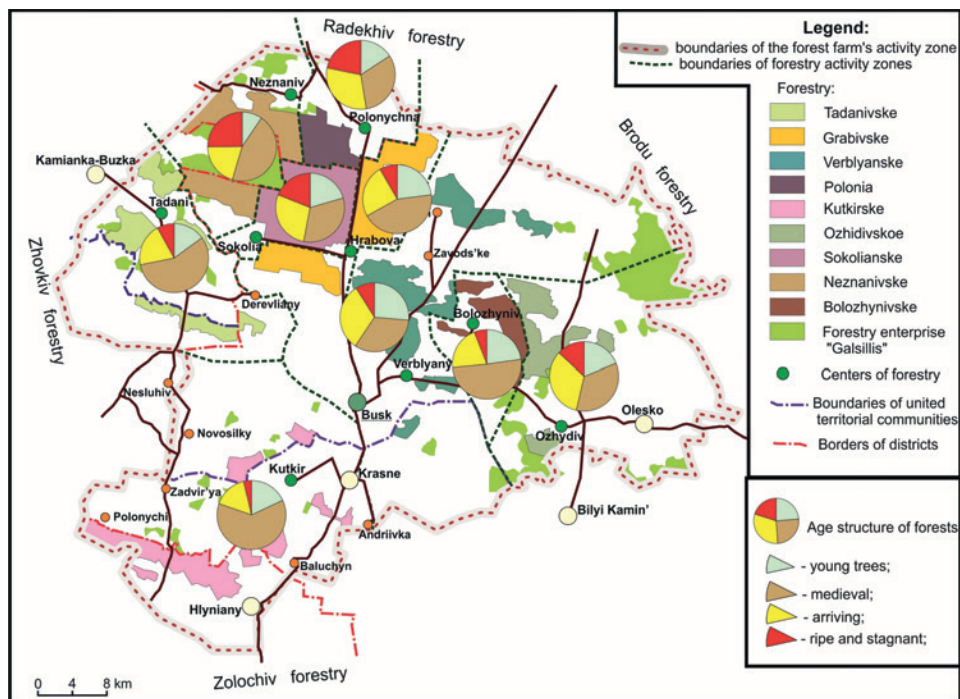


Fig. 6. Age structure of forest stands in the Busk forestry (authors' own study based on data from Project..., 2018; Stock..., 2022).

coniferous wood stock. The largest wood stock of hard-leaved species (223.28 thousand m<sup>3</sup>) is in the Kutkirske forestry, although the proportion of hard-leaved species in the Tadaniv forestry is the highest (47%). The Sokolianske forestry also has a relatively large hard-leaved wood stock (149.42 thousand m<sup>3</sup>). The proportion of hard-leaved species accounts for 24.3% of the total wood stock. The largest wood stock of soft-leaved species is in the Neznaniiv forestry. This is the only forestry where the volume of soft-leaved species accounts for over half of the total wood stock. The smallest wood stock of soft-leaved species is concentrated in the Tadaniv and Ozhidiv forestries. Most of this wood stock is represented by black alder.

Also, of interest is the indicator of forest provision for the population. It was only possible to calculate it for two territorial communities that are entirely within the forestry enterprise's zone of activity. Thus, in the territory of the Krasnenska community, forest lands occupy 2,108.8 ha, and 17,120 people live there. Forest provision here averages 0.12 ha per person. Of course, this indicator varies significantly in the western and eastern parts of the community, as most of the population is concentrated in the town of Krasne, while most of

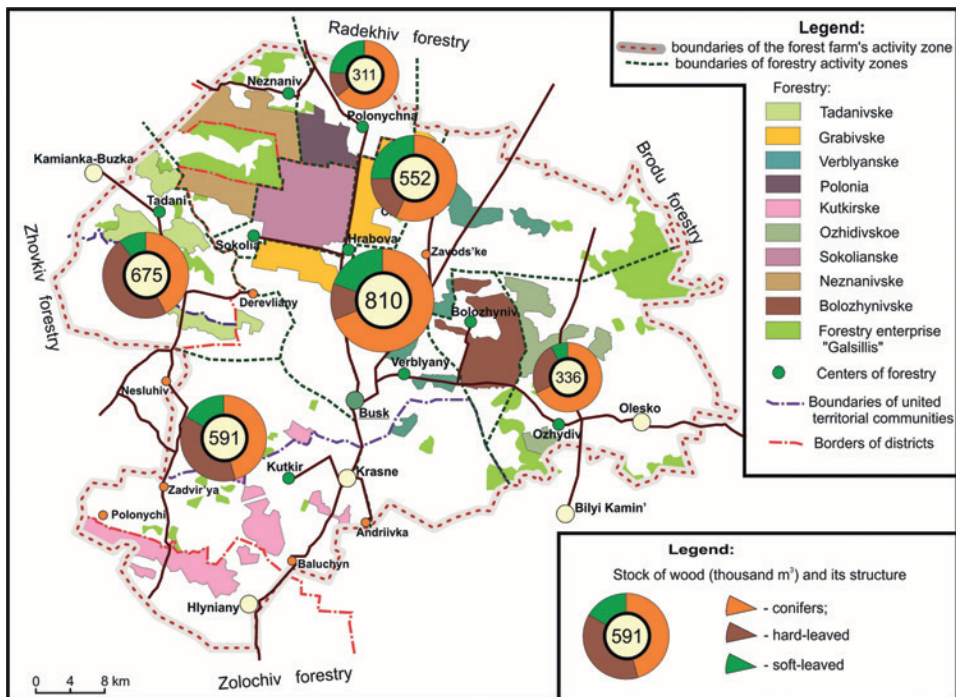


Fig. 7. Volume and structure of wood reserves by forest management units of Busk forestry enterprise (authors' own study based on data from Project..., 2018; Stock..., 2022)

the forests grow in the area of the Starostynsky district of Zadviria. In the Busk municipal community, the indicator is even more averaged due to the large area. Forest provision is 0.61 ha per person, while the most forested northern areas are also the least populated. The main population is concentrated in Busk and Olesko, where there is little forest land for various reasons.

## CONCLUSIONS

The zone of activity of Busk forestry enterprise entirely covers the territory of Busk and Krasne territorial communities and partially located on the lands of Dobrotvir, Novoyarychivska, Kamianka-Buzka, and Hlynianska territorial communities. The forests of the researched region are part of nine forest management units. The average forest cover of the studied region is 20.9%. The highest forest cover is observed in the northwest of Busk forestry enterprise's zone of activity.

Understanding the peculiarities of modern forestry land use can only be achieved through the prism of retrospective study. To this end, various temporal cartographic materials were used in the research, which allowed tracing the



development of several forest areas from the late 18<sup>th</sup> century to the present day. The study was conducted on four temporal sections: the von Mieg map of the late 18<sup>th</sup> century, the topographic map of the Austro-Hungarian Empire of the late 19<sup>th</sup> century, the topographic map of the Military Institute of Geography of the 1930s, and the current Google satellite image. Analysis of the various cartographic materials enabled the tracking of the development of several forest areas from the late 18<sup>th</sup> century to the present day. A gradual reduction in the area of the studied forest areas in the 19<sup>th</sup> and early 20<sup>th</sup> centuries was established. From the second half of the 20<sup>th</sup> century to the present day, the forested land areas gradually increase through the formation of forest plantations on adjacent slopes and the gradual expansion of tree vegetation on lands adjacent to the forests.

Characteristic features of forestry in the region include: uneven forest cover of the studied territory; significant fragmentation of the forest fund in the southern part of the forest district; large forest areas located in the northwest part of the forest district; domination of such tree species as pine, oak, and alder in forest stands; slight increase in forest cover on individual territories through the creation of pine forest plantations on unused lands and active expansion of black alder forests on waterlogged pastures.

In the age structure of forests, middle-aged stands (44.7%) and young stands (24.5%) dominate, while saplings occupy 19.4% and only 11.4% of the forested area is accounted for by mature and overmature stands. This age structure indicates intensive forest use in the forest enterprise's territory over the last decade and proactive work by foresters to shape the forests species composition.

The largest area of the Busk forestry enterprise's forest fund is occupied by exploited forests – 22,202.1 ha (87.8%). Protective forests account for 1.5% of the total forest area in the studied region, while recreational forests make up 9.5% of the forest fund's structure. Forests designated for nature conservation, scientific research, and historical-cultural purposes cover an area of 290.9 ha, which accounts for 1.2% of the total area of the forest management. The forest supply for the population in the Krasne territorial community averages 0.12 ha per person, while in the Busk forestry enterprise, it is 0.61 ha per person.

The total timber reserves in the forestry enterprise are 4,576.36 thousand m<sup>3</sup>. Conifers occupy 52.7% of the reserves structure, while hard-leaved and soft-leaved species account for 23.7% of the timber reserves in the studied region each. In geospatial terms, the distribution of timber reserves is extremely uneven and correlates with the areas of forestry.

The obtained results can be used by the Busk and Krasne communities in the development of programs for socio-economic development, in planning measures to expand the network of nature reserves and the development of green

and eco-tourism. Promising directions for further research on forest use in the region include studying the spatial-temporal peculiarities of forest stands and their completeness; justifying the optimal ratio of reserve and exploitation forests; applied research on individual areas for afforestation; and further scientific justification for measures to restore highly productive indigenous forests of the Small Polissya.

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