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Stands in Production Unit I Vlădila, within the Caracal Forest District, Olt Forestry Directorate

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Abstract
The study examines forest stands within Production Unit I Vlădila, managed by the Caracal Forest District (Olt Forestry Directorate), focusing on the influence of ecological factors on the dominant species - black locust (*Robinia pseudoacacia* L.) and Hungarian oak (*Quercus pedunculiflora*). Using forest management data and field observations, climatic, edaphic, and site conditions were assessed.
Results indicate a predominance of oak and black locust stands developed on cambic phaeozem and psamosol soils, characterized by medium productivity and generally satisfactory health. The study highlights the need for appropriate silvicultural measures to support natural regeneration, maintain productivity, and ensure the ecological stability of forests in the Oltenia Plain.

Keywords: black locust, oak, forest, soil, management

Introduction

For the optimal organization of forests in order to fulfill their assigned ecological, economic, and social functions, forest management planning requires a thorough assessment of forest vegetation, considering all factors that determine its current production and protection potential [3,12,18]. Accordingly, this study presents synthesized records that characterize the size, structure, and quality of the productive or protective forest resource [1,2,8,9,10].

These records primarily address the distribution of forest stands—by area and volume—across production classes, density categories, diameter classes, mixture types, as well as regeneration methods, vitality, functional groups and subgroups, structural types, forest formations, and forest typologies [4,6,7,12]. Average indicators are used to express and evaluate the condition and productive capacity of the forest and its component stands, including metrics such as average age, density, production class, volume per hectare, and current increment [9,13,15,16,17].

The information derived from these records will support a comprehensive analysis of the productive resource and its constituent stands from ecological, silvicultural, and protective perspectives, highlighting both alignments and deviations from site potential and ecological, economic, and social requirements [5,14,19].

The study of forest vegetation is conducted at the analytical level and is synthesized and evaluated at the level of the production unit U.P. I Vlădaia [12,22].

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The forests, afforestation lands, and areas designated for cultivation, protection, and production, organized within U.P. I Vlădaia of the Caracal Forest District, Olt Forest Directorate, constitute national forest land and are public property of the state [20,21,22].

These areas are located within the administrative boundaries of the following communes: Vlădila, Studina, Deveselu, Gostavăţu, Drăghiceni, Rusăneşti, Scărişoara, and the town of Caracal [22].

Geographically, the forests are situated in the Oltenia Plain, specifically in the Romanaţi Plain, which includes the Caracal Plain and the Leu–Rotunda Field subdivisions [514,19].

From a phytoclimatic perspective, the territory of U.P. I Vlădaia lies within the internal forest-steppe zone (S.s.) [3,5,14,19]. The distribution of state-owned forest land across administrative units is summarized in Table 1.

Table 1. The distribution of state-owned forest land across territorial-administrative units

Administrative-Territorial Unit	County	Component parcels (%)	Area - ha -
Grădinile	Olt	13-15	46,87
Rusăneşti	Olt	17, 18, 19, 58	37,43
Scărişoara	Olt	18, 19, 20-22, 58, 59, 64-66	132,31
Vlădila	Olt	23-45	364,50
Studina	Olt	46-48	66,12
Deveselu	Olt	49-57	175,11
Gostavăţu	Olt	73-75	28,26
Stoeneşti	Olt	78	20,54
Drăghiceni	Olt	81	7,19
Caracal	Olt	81, 82	6,57
TOTAL	**-**	**-**	**884,90**

It is worth noting that the territory of U.P. I Vlădila includes the following protected natural areas within the "Natura 2000" ecological network: ROSCI0376 Olt River between Mărunţei and Turnu Măgurele, ROSCI0183 Vlădila Forest, ROSCI0174 Studiniţa Forest, ROSPA0106 Lower Olt Valley, and RORMS0011 Confluence of the Olt and Danube Rivers [3,5,18].

From a geological perspective, the territory of Production Unit I Vlădila falls within the area of sedimentary formations of Tertiary–Neogene origin, characterized by the presence of Quaternary deposits of clays and high-terrace loess, typical of the Romanaţi Plain. These deposits constitute the parent material on which soils from the molisol class have developed, particularly typical cambic chernozems, which are favorable to the growth of characteristic forest vegetation such as grey oak stands and mixtures of grey oak with downy oak. In the floodplain of the Olt River, alluvial deposits predominate, consisting of very fine alluvium, sands, gravels, and terrace materials, which give rise to alluvial soils supporting riparian forest vegetation, including poplars and willows [11,14,19].

Geographically, the analyzed territory is located in the Caracal Plain and the Leu–Rotunda Plain, both part of the Romanaţi Plain, which is included in the larger geomorphological unit of the Oltenia Plain, itself an integral part of the Romanian Plain. From a phytoclimatic standpoint, the entire area of U.P. I Vlădila falls within the forest-steppe vegetation zone, characterized by the alternation of deciduous forests and xerophilous grasslands [5,14,15,18].

The relief is varied, including the lower floodplain of the Olt River, with average altitudes of approximately 55 meters, featuring a flat and slightly undulating morphology, with alluvial and proto-alluvial soils covered by natural riparian forests of poplars and willows. The high terrace of the Caracal Plain supports natural forest vegetation composed of *Quercus* species, such as grey and downy oak stands, as well as artificial vegetation represented by black locust from plantations or coppice stands. From a pedological perspective, the identified soils belong to the protisol and cernisol classes, reflecting the diversity of the geological substrate and local geomorphological influences [11,12,19].

In summary, the characteristics related to relief units, slope gradient, aspect, and other topographic elements will be presented in the following sections in tabular and cartographic format, to support the

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integrated analysis of the forest and soil landscape of U.P. I Vlădila.opographic characteristics of the study area, including relief units, elevation, slope gradient, and aspect, are presented in Table 2.

Table 2. Data regarding relief unit, slope, aspect.

Relief unit			Altitude	Slope gradient		Aspect		
Floodplain	Plain	Slope	0-200	$< 7^0$	$7 \div 15^0$	Îns.	P.îns	Shaded
ha %	ha %	ha %	ha %	ha %	ha %	ha %	ha %	ha %
35,84	727,87	24,36	884,90	876,08	7,72	769,05	5,32	13,70
5	92	3	100	99	1	97	1	2

The territory of U.P. I Vlădila lies between 54 and 126 meters in elevation (minimum altitude in subunit 59B and maximum in subunit 54B); the average elevation is 111 meters. Based on these data, it can be concluded that the area offers favorable conditions for the species identified in the forest composition (black locust, grey oak, downy oak, ash) [12,19]. Less favorable conditions are found near the Olt River, where, following river regulation works (embankment), the groundwater table has significantly dropped, resulting in large areas occupied by unproductive land (characterized by lithic alluvial protosols with fragipan), unsuitable for forest cultivation [11,14].

From a hydrological standpoint, Production Unit I Vlădila is marked by the absence of an internal hydrographic network, with most forest bodies located at considerable distances—approximately 15–20 km—from the Olt River, which defines the eastern boundary of the territory. In the terrace area, groundwater levels are deep, ranging from 8 to 25 meters, while in the floodplain of the Olt River, they are shallower, between 0.5 and 5.0 meters. Notable is the presence of the Vlădila stream valley, which separates the Cozia and Govora forest bodies, near the former management unit 38C (currently retroceded under land restitution legislation), where a dam was constructed. Additional valleys in the terrace area include Comanca (between parcels 54 and 55), Grădinile (north of parcel 15), and Osleni (west of parcel 81), with variable flow rates, susceptible to significant reductions or even disappearance during drought periods, directly affecting groundwater levels [11,14].

Significant changes in site conditions within the Olt floodplain occurred following the construction of the riverbank protection dike, which eliminated the phenomenon of periodic flooding. This intervention led to a marked decline in groundwater levels, negatively impacting soil moisture regimes and directly affecting the growth and development of dominant forest species.

Climatologically, the area is characterized by a thermal regime that allows for relevant conclusions to be drawn in support of forest management measures. The thermal regime is defined by monthly and annual average temperatures, thermal extremes, average temperatures during the bioactive and vegetative periods, as well as data on the first and last frost [3,5,18]. These parameters are essential for establishing specific measures related to the establishment and care of young forest stands [4,6].

Maximum temperatures occur in July and August, potentially harming young plantations, while absolute minimum temperatures are typically recorded in January and may damage oak seedlings, especially in years with little or no snow cover [3,18]. On average, the first frost occurs at the end of the vegetative period, and the last frost takes place approximately three days before its onset. However, late frosts may occur up to 30 days after the start of vegetation, with adverse effects on forest species, particularly oaks, causing defoliation and flower drop [3,5].

According to climatic data, the thermal potential of the Caracal Forest District, expressed as the sum of bioactive temperatures (above 0°C), is 4062°C, indicating highly favorable conditions for the development of oak species [5,15].

The pluviometric regime of U.P. I Vlădila is characterized by monthly and annual average precipitation, peak values recorded over short intervals, heavy torrential rains, potential evapotranspiration, the Martonne aridity index, and water compensation indices [3,5,18]. Multiannual climatic data indicate an annual average precipitation of 535.4 mm, with a maximum in June (73.4 mm) and minimum values in February (31.5 mm), March (32.2 mm), and September (36.6 mm). Past torrential rains, such as those

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recorded at Celaru (145.7 mm in 30 minutes) or Calopăru (40 mm in 10 minutes), highlight high intensities that can influence erosion and surface runoff processes [3,18].

Annual potential evapotranspiration reaches 707 mm, significantly exceeding average precipitation, indicating a pronounced water deficit during the growing season, with a peak in July–August. The Martonne aridity index, calculated at 25.9, places the territory within the forest-steppe zone, at the threshold of aridity, with direct implications for the regeneration and development capacity of forest species [3,5,18]. The water compensation index, calculated at 0.48, reflects low water availability relative to evapotranspirative demands, necessitating adapted silvicultural measures to maintain stand viability [4,6].

Snowfall plays an important ecological role by forming an insulating layer that protects the soil and young plantations. In forested areas, the snow cover duration is shorter than on open land, but its melting is delayed by 5–6 days in spring, contributing to soil moisture retention [4,6]. Between 1985 and 1995, a decrease in precipitation was observed, negatively affecting the vegetative condition of oak species. In recent years, more abundant rainfall has mitigated this phenomenon, though continuous monitoring remains essential [3,18].

The wind regime influences average temperature values, atmospheric humidity, and evapotranspiration through the nature, speed, and frequency of winds [3,18]. Although no local meteorological stations exist within U.P. I Vlădila, indicative data from the Craiova station show a maximum annual wind frequency from the east (24.6%) and west (18.7%), with a minimum from the south (1.9%). The average annual wind speed ranges from 1.2 m/s (south) to 4.2 m/s (east and west), being higher during the cold season. Winds have not caused significant damage, except in cases where trees were completely dry and sanitation works were not carried out on time.

The evaluation of ecological favorability reveals variable site conditions for the main forest species in the area, particularly black locust and grey oak. Annual average temperature, precipitation, cumulative daytime temperatures ≥0°C, length of the vegetative period, fine clay content, edaphic volume, groundwater depth, and soluble salt content are key parameters in determining ecological suitability [13,15,16,17]. Black locust shows high adaptability under conditions of annual average temperature between 9.0–11.5°C, precipitation >500 mm, and edaphic volume >0.85 m^3/m^2. Grey and downy oaks exhibit similar requirements, with high favorability under temperatures between 9.8–10.8°C, precipitation >500 mm, and groundwater depth >0.8 m [13,15,16,17].

The necessity of this study arises from the analysis of black locust and grey oak stands, which dominate the forest composition of the studied territory. The main objective of the research is to identify favorable factors influencing the growth and development of these species, in correlation with site conditions and prevailing pedological characteristics [11,13,15,16]. The targeted goals include identifying stands of black locust and grey oak, determining favorable ecological factors and optimal site conditions, and proposing the most appropriate silvicultural interventions to maintain and improve vegetative status [4,6,12,20,21].

Materials and Method

To conduct the study on black locust and grey oak stands within U.P. I Vlădila, the forest management map was used as the primary tool for field orientation, parcel delineation, and identification of stand composition. This map enabled the correlation of field observations with the spatial structure of the production unit, facilitating the analysis of forest species distribution in relation to site conditions.

The adopted research methodology was based on four complementary directions: consultation of relevant scientific and bibliographic documentation, utilization of practical field experience, application of direct scientific observation, and execution of specific measurements within selected parcels. These methods allowed for an integrated approach—both qualitative and quantitative—to the ecological factors and characteristics of the studied stands.

The species *Robinia pseudacacia* L., commonly known as black locust, is a category I tree that, under favorable site conditions, can reach heights of 30–35 meters and diameters of 80–100 cm. Its root system is deep and extensive, with a taproot descending to 1–2 meters and lateral branches exceeding 20 meters. The stem is straight, although isolated specimens may exhibit deformities. The bark develops a thick, deeply furrowed rhytidome with protective function and high mineral content. The crown is broad and luminous, with minimal soil coverage. Shoots are spiny, and the leaves are imparipinnate compound, with

elliptical, glabrous leaflets green on the upper side and greyish green beneath. The flowers are white, strongly fragrant, and melliferous, arranged in pendulous racemes. The fruits are reddish-brown dehiscent pods containing reniform seeds with a hard seed coat.

The species *Quercus pedunculiflora*, known as grey oak, is a tree that can reach up to 25 meters in height, with a straight stem and thick, deeply cracked rhytidome. Shoots are greenish-brown, and the leaves exhibit high morphological variability, with middle lobes nearly perpendicular to the central vein. The upper surface is dark green, while the underside is characteristically grey-frosted and pubescent. Flowering occurs approximately two weeks later than common oak, thereby avoiding late frosts. The fruits are large acorns born on long peduncles with characteristic cups. The natural range of grey oak includes the Balkan Peninsula, Asia Minor, and the Caucasus; in Romania, it is found in the forest-steppe zones of Oltenia, Muntenia, and Dobrogea, but is absent from Banat and Transylvania. It is a thermophilic species with moderate drought resistance, preferring deep loess-derived soils such as leached chernozems and psamosols, while avoiding excessive moisture.

The distribution of black locust and grey oak stands, based on forest type and climatic and site conditions, reveals the presence of seven forest types within U.P. I Vlădila. The total analyzed area is 788.07 hectares, distributed as follows: 29% consists of high-productivity forests, 67% of medium-productivity forests, and 4% of low-productivity forests. Pure grey oak stands develop on leached or slightly degraded chernozems with loess-like substrate, while mixtures with downy oak reflect adaptability to varied site conditions. Riparian forests of poplar and willow, present in the Olt floodplain, complement the typological diversity of forests within the production unit.

The analysis of forest formations in U.P. I Vlădila reveals a clear predominance of pure grey oak stands, occupying 57% of the total area, followed by mixtures of grey oak with downy oak, covering 39%. Pure poplar stands and mixtures of white and black poplar, as well as willow groves, are present in smaller proportions, below 5%. The current forest structure reflects the management practices applied over time, resulting from silvicultural interventions and adaptation to the phytoclimatic conditions specific to the area. The identified forest formations align with the forest-steppe vegetation zone, underscoring the need to maintain existing base species such as grey and downy oak, and to promote valuable stands capable of withstanding destabilizing factors.

The forest composition of U.P. I Vlădila at the time of management planning is dominated by black locust (48%), followed by grey oak (24%) and downy oak (20%), reflecting the current state of the stands and previous management practices. This structure supports the fulfillment of both production and protection functions of the forest, provided that appropriate silvicultural measures are applied. Analysis by species groups, age classes, and production classes indicates a significant increase in black locust presence, from 39% in 1990 to 48% in 2010, due to its individualization in post-2000 management plans. Meanwhile, the current increment index declined from 5.0 in 1990 to 2.1 at present, and the proportion of white poplar and various hard and soft species has decreased. Average density has remained relatively stable, between 0.73 and 0.78, and average volume per hectare has remained consistent, between 100 and 106 m^3/ha. The average age of stands has varied according to the evolution of age classes, reflecting regeneration dynamics and silvicultural interventions.

Site types were defined as equivalent ecological and silvoproductive units, characterized by similar physical-geographical conditions, including topoclimate, relief, lithological substrate, soils, and water regime. These units exhibit homogeneous vegetation associations, with comparable trophicity, moisture, and density regimes, suitable for the same forest vegetation and responding similarly to management interventions. The site study, conducted concurrently with parcel descriptions, enabled precise identification and delineation of site types for the application of adapted management measures. Within U.P. I Vlădila, five site types were identified, with clear territorial distribution: 29% of the area is of high site quality, 67% of medium quality, and 4% of low quality. The main limiting factors are reduced edaphic volume, low water retention capacity, and low to moderate soil trophicity, which negatively affect water availability during the summer season.

The distribution of soil types reflects the cumulative influence of climatic conditions, landform, lithological substrate, and forest vegetation on the ecological and productive potential of forest sites. Within U.P. I Vlădila, 73% of soils belong to the cernisol class, represented exclusively by cambic phaeozem, with the horizon sequence Am–Bv–C. The remaining 27% fall under the protisol class, including alluviosols

(dystric, gleyic, entic, entic-lithic) and psamosols with weakly developed fragipan. Psamosols cover an area of 179.05 ha (23%), while alluviosols account for 36.22 ha (4%). This pedological distribution confirms the predominance of soils with moderate fertility and variable water-holding capacity, with direct implications for stand composition and productivity.

The description of soil types and subtypes identified within U.P. I Vlădila highlights significant pedological diversity, with direct effects on forest productivity and species adaptability. The psamosol with weakly developed fragipan (code 0309), with an Aox–Cx profile, is formed on sand dunes in the forest-steppe zone. This soil exhibits a moderately acidic reaction, is low to moderately humiferous, and oligobasic to mesobasic in character. Its texture is fine sandy, with a dusty sand layer between 20–40 cm depth, where the fragipan horizon (Cx) forms. Although weakly developed, this horizon becomes compact during summer, limiting root penetration and resulting in medium to low site quality for black locust.

The cambic phaeozem (cambic chernozem, code 1310), with an Am–Bv–C profile, is formed on loess or marl in the plain. The soil is acidic at the surface (pH = 4.9) and moderately acidic in depth (pH = 5.5–5.6), with a high humus content (4.1–7.9% in the Am horizon, 30 cm thick). Base saturation ranges from 37–53% at the surface (oligo- to mesobasic) to 75–80% in the Bv horizon (eubasic). It is very well supplied with total nitrogen (0.21–0.40 g%) and has a loamy-sandy to loamy texture. This soil provides high to medium site quality for grey and downy oak due to its large edaphic volume, favorable moisture regime, and high trophicity.

The dystric alluviosol (code 0401), with an Aodi–Cdi profile, is formed in the floodplain on texturally heterogeneous alluvial substrates. It is moderately alkaline, slightly humiferous at the surface, with a loamy-sandy texture, offering medium site quality for white and black poplar. The gleyic alluviosol (code 0414), with an Ao–Go–Gr profile, is slightly to moderately alkaline, humiferous, and moderately to highly calcareous, with a loamy-clayey-dusty to sandy texture. It provides medium site quality for willow groves and willow-poplar mixtures.

The enticalluviosol (code 0417), with an Ao.en–C profile, is slightly humiferous, formed in the floodplain, with alternating layers of fine sand and loamy sand, low in trophicity but with moderate to high water retention capacity. It offers medium to low site quality for native poplars. In areas where bedrock is close to the surface (20–50 cm depth), the entic-lithic alluviosol (code 0418) develops, with low site quality for white and black poplar.

The sanitary condition of forest stands in U.P. I Vlădila is a key factor in assessing the regeneration capacity and ecological functionality of the forest resource. According to previous management records and forest history, no major calamities have significantly affected stand health. Most stands (71%) originate from coppice, as a result of repeated clearcutting in coppice systems. This practice, combined with prolonged and intensive grazing and the onset of dieback phenomena, has led to the degradation of certain stands, which now require extended periods for productivity recovery.

Currently, 36% of stands exhibit low vitality, necessitating the timely and appropriate application of silvicultural treatments specific to each stand to maintain adequate sanitary conditions. Stands in poor condition are primarily those originating from overaged stumps, affected by basal rot due to repeated cutting. The causes of degradation are multiple and complex, including climatic factors (prolonged droughts, late frosts), edaphic factors (compacted soils, lowered groundwater levels in the Olt floodplain due to embankment works), and biotic factors (defoliation by insects, repeated powdery mildew outbreaks).

Reported pests include Cerambyxcerdo (great oak longhorn beetle), Lymantria dispar, Operopthera brumata (winter moth), and Tortrix viridana (green oak leafroller). The development of these pests is closely monitored, and control is carried out using effective substances, contributing to the maintenance of acceptable sanitary conditions. Phytosanitary control involves pest identification, delineation of affected areas, and assessment of attack intensity. A clear record must be maintained for each management unit, with ongoing monitoring to enable prompt intervention.

To maintain appropriate phytosanitary conditions, it is recommended to perform hygiene cuttings in a timely manner, conduct phytosanitary inspections in accordance with current regulations, apply suitable measures based on attack intensity, maintain game populations within normal limits, prohibit grazing, and protect seedlings using physical or chemical means (polyethylene sleeves, repellent substances).

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Results and Discussion

Within U.P. I Vlădila, forest stands with special conservation functions (TII) primarily include *Quercus* species and black locust, managed with the aim of preserving biodiversity and ensuring ecological protection. In grey and downy oak stands, efforts are directed toward maintaining a minimum density of 0.8, while introducing valuable auxiliary species (cherry, ash, sycamore, field maple) to enhance structural and functional diversity. Black locust stands are managed until the onset of natural thinning, at which point conservation interventions are applied, focusing on regeneration through root suckers or coppice shoots and gap filling through planting.

Conservation operations involve low-intensity extractions, maintaining optimal stand density, tending of natural regeneration, and soil mobilization during seed-bearing years. The economic justification for these interventions lies in their protective effects: stabilizing degraded lands, preventing waterlogging, conserving the forest gene pool, and safeguarding valuable stands in the Oltenia Plain. Between 2020 and 2029, conservation and sanitation cuttings will be implemented, tailored to stand condition and bioecological requirements, with strict adherence to soil and residual tree protection guidelines.

Silvicultural treatments for tending and stand management aim to optimize species composition, improve phytosanitary status, enhance stability and productivity, and strengthen ecological functions. Measures include regulating density between 0.9–1.0, promoting valuable native species and individuals originating from seed or root suckers. The annual volume of secondary products increased from 155 m³/year to 167 m³/year, of which 32 m³/year result from cleaning operations (10.50 ha/year) and 135 m³/year from thinning (16.59 ha/year).

Thinning is applied differentially, depending on site type, tree origin, and stand structure. In oak and ash plantations, individuals with superior phenotypic traits are favored through combined interventions. In black locust coppice stands, root suckers are promoted while limiting the number of shoots per stump. Canopy closure must not fall below 0.8. The techniques and frequency of interventions are regulated according to current technical standards (1986, 2000), and extraction areas and volumes are determined at the management unit level, respecting forest transport infrastructure.

The improvement of stands affected by destabilizing factors is carried out based on impact intensity and stand structure, in accordance with forest management plans. Destabilizing factors are grouped into three categories: anthropogenic (unsustainable logging, abusive grazing), climatic and site-related (frosts, moisture deficits, soil acidification), and biotic (game, insects, cryptogamic agents). These causes are interdependent, and their elimination contributes to restoring ecosystem balance.

Remedial measures include complete sanitation of the forest, afforestation of gaps with site-adapted species, pest control, prohibition of grazing, and maintaining game populations within normal limits. Protection of young plantations through physical or chemical means is recommended. The main causes of productivity decline are limiting site conditions (high temperatures, summer drought) and improper application of tending operations.

To restore forest stands, it is proposed to maintain and improve natural structure on sites with difficult regeneration, reconstitute natural forest types on medium or high-quality sites, prohibit grazing in vulnerable stands, and eliminate silvicultural offenses. These measures are adapted to the operational capacity of the forest district and aim to restore the ecological and productive functionality of the forest.

Conclusions

Data analysis reveals a strong correlation between site conditions and forest vegetation, with forest type reflecting the uniformity of species composition, vegetation strata, fauna, and climatic, edaphic, and hydrological factors. The description of site types involves geomorphological and edaphic characterization, which is essential for determining appropriate silvicultural measures.

Dominant species such as black locust (48%) and grey oak (20%) are distributed in accordance with forest and site types, influenced by relief, substrate, ecological requirements, and resistance to limiting factors. To optimize site potential, the following measures are required: urgent afforestation of uncovered lands, timely application of tending operations, treatments adapted to forest functions, conservation of stands excluded from harvesting, improvement of low-density stands, and intensified surveillance to prevent wildfires and abusive grazing.

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