Forest Policy Report SFI/2024

Estimates of environmental indicators of the national forest inventory: available areas 2023

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About the Project "Sustainable Forestry Implementation" (SFI)

The project "Technical Support to Forest Policy Development and National Forest Inventory Implementation" (SFI) is a project established within the framework of the Bilateral Cooperation Program (BCP) of the Federal Ministry of Food and Agriculture of Germany (BMEL) with the Ministry of Environment and Natural Resources of Ukraine (MENR). It is a continuation of activities started in the forest sector within the German-Ukrainian Agriculture Policy Dialogue (APD) forestry component.

The Project is implemented based on an agreement between GFA Group, the general authorized executor of BMEL, and the State Forest Resources Agency of Ukraine (SFRA) since October 2021. On behalf of the GFA Group, the executing agencies - Unique land use GmbH and IAK Agrar Consulting GmbH - are in charge of the implementation jointly with the SFRA.

The project aims to support sustainable forest management planning in Ukraine and has a working focus on the results in the Forest Policy and National Forest Inventory.

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TABLE OF CONTENTS

TABLE OF CONTENTS **1**

1. INTRODUCTION **3**

1.1. Summary 3

1.2. Why report on the ecological state of forests? 3

1.3. Contribution of NFI to forest biodiversity assessment 3

1.4. Features of the methodology for calculating indicators and presenting results 5

2. INDICATORS OF BIODIVERSITY AND PLANTATION STRUCTURE **6**

2.1. Forest structure 6

6-1 Distribution of plantation area of dominant species by stand structure 7

6-3 Distribution of plantation area of dominant species by age structure 8

6-4 Distribution of the area of plantations of dominant species by the number of tree species in the stand 9

6-2 Distribution of the area of plantations of dominant species by naturalness 10

2.2. Dead wood 11

6-7 Total volume of deadwood in plantations of dominant species by age classes 12

6-8 Total volume of wood waste by species and stage of decomposition 13

6-9 Average volume per 1 hectare of woody debris in plantations of dominant species 14

2.3. Above-ground vegetation 15

6-5 Distribution of the area of plantations of dominant species by the degree of undergrowth coverage 16

6-6 Distribution of the area of plantations of dominant species by the degree of coverage with aboveground vegetation 18

3. INDICATORS OF THE SANITARY CONDITION OF PLANTATIONS AND TREES **19**

3.1. Condition of plantations 19

7-1 Distribution of the area of plantations of dominant species by type of impact 19

3.2. Condition of the trees 20

7-2 Distribution of the number of trees of forest-forming species by condition categories 20

7-6-3 Total number of dry trees of forest-forming species by reason of dying 21

7-5-1 Total volume of live trees of forest-forming species by type of damage 22

7-3 Distribution of forest-forming trees by degree of defoliation 23

7-4 Distribution of forest-forming trees by degree of dechromation 24

4. SELECTED EXAMPLES OF ENVIRONMENTAL PERFORMANCE ASSESSMENT IN OTHER COUNTRIES 25

Assessment of the conservation status of Natura 2000 forest habitats in Europe: opportunities, potential and challenges of national forest inventory data 25

Nationwide assessment of biodiversity, naturalness and status of old-growth plants using data from the national forest inventory - Italy 25

A basis for mapping the ecological base of a forest - an example from Norway 26

The ecological status of the NIL forests in the UK: Methodology 26

5. CONCLUSIONS 28

6. REGULATORY AND LEGAL ACTS AND LITERARY SOURCES 30

1. INTRODUCTION

1.1. Summary

The National Forest Inventory (NFI) provides data on the area and location of Ukraine's forests, as well as information on key forest indicators. This report presents the results of the assessment of the ecological state of forests by administrative regions and natural zones of Ukraine for the areas available for research in 2021-2023.
The report provides information on forest characteristics that were measured or assessed during the field surveys as indicators of the condition of stands or trees in terms of their potential importance for assessing biodiversity and ecological features of forest stands. This information is a part of the national reporting of SFM (groups 6 and 7 of the reporting tables of the SFM Procedure [1]) and can be used for forest management tasks and support of sustainable use of forest resources, protection and enhancement of biodiversity and formation of sustainable forests.

1.2. Why report on the ecological state of forests?

The main purpose of this work is to provide government agencies with NFI statistics on indicators of the ecological state of forests, to make informed decisions on the state of forests and their management in support of biodiversity.
A related task is to assist in the development of a national forest monitoring system as a component of environmental monitoring and to help Ukraine fulfill its international monitoring obligations.
The environmental monitoring system in Ukraine is in the process of being restructured. The general principles of environmental monitoring are proposed, in particular, by the draft Law "On Amendments to Certain Legislative Acts of Ukraine on the State System of Environmental Monitoring, Information on the State of the Environment (Environmental Information) and Information Support for Environmental Management" adopted by the Verkhovna Rada in the first reading [2]. .
The system of environmental monitoring of forests, which was implemented in Ukraine until 2016 and was based on ICP-Forests level I monitoring sites. However, due to lack of budget funding, the work was stopped. Despite the fact that this monitoring focused mainly on assessing the condition of trees (defoliation, dechromation), it was the only system supported at the national level at that time.
Therefore, among other things, the task of the NFI is to properly inform about the ecological state of forests, and based on the collected empirical data and the results of their statistical processing, to formulate proposals for building a modern forest monitoring system based on the NFI, expanding the role of forest monitoring in the formation of the national environmental monitoring program.

1.3. NFI contribution to forest biodiversity assessment

The conceptual study "National Forest Inventories: Contributions to Forest Biodiversity Assessments" (NFI-FBA, 2011) [3], conducted by ENFIN[1] under COST Action E43, showed that NFIs prefer biodiversity indicators based more on structural forest indicators - such as vertical

[1] European National Forest Inventory Network - https://www.enfin.info/

horizontal stand structure and diversity of species composition or dead wood - than on direct measurements of animal biodiversity such as birds and invertebrates or vegetative life forms such as bryophytes, fungi, grasses, forbs and mosses. The biotic diversity indicators were assessed as important but inappropriate because their assessment is too time-consuming, costly, and requires expert knowledge.
The indicators collected and assessed by national inventories of European countries are generally similar, but differ in terms of definitions, measurement ranges or classification systems, so harmonization to align reporting remains an important element of ENFIN's activities. The analysis shows that the indicators and reporting tables defined by the Procedure for conducting the National Forest Inventory of Ukraine fully cover the list of indicative indicators identified as important for biodiversity assessment (Table 1). Currently, the NFI of Ukraine does not define European forest types based on two levels of nomenclature: 76 forest types grouped into 14 main forest categories[2] .

Table 1: Correspondence of indicators used to assess biodiversity in European countries and Ukraine

Group of indicators	**NFI - FBA indicator**	**The NIL indicator of Ukraine**
Forest categories ()	European forest types	-
Forest structure		
	Wood species	Wood species
	The height of the tree	The height of the tree
	The diameter of the tree	The diameter of the tree
	Number of trees per 1 ha	Number of trees per 1 ha
		Sum of cross-sectional areas per 1 ha
	The social position of the tree	Kraft class
	Number of stand tiers	Description of all forest elements of all stand levels
	Tree coordinates	Tree coordinates
	The age of the tree	The age of the tree
	Distance to the nearest tree	-
	Richness of wood species in the tier	Description of all forest elements of all stand levels
	Forest boundary	Mapping parts of the inventory plot
	Gaps per 1 ha	Bio-lawns, bio-fields
The age of the forest	Forest development stage	Age class/Age group
Naturalness		Naturalness
Dead wood		
	Standing dead wood	Dry land
	Fallen dead wood	Wood breakage
Reforestation		Reforestation
Above-ground vegetation	Shrubs and bushes	Covering with undergrowth
	Ferns, lichens, mosses, liverworts	Covering with plants
The state of the trees		
		Damage to the living
		Defoliation
		Dechromation

[2] European forest types - European Environment Agency (europa.eu)

1.4. Features of the methodology for calculating indicators and presenting results

In the period from 2021 to 2023, 4163 forest inventory plots were surveyed in 17 administrative regions. The rest of the territories remain temporarily inaccessible due to safety conditions or temporary occupation or war with the Russian Federation.
The reporting calculation tables were obtained by statistical processing of the database information on environmental indicators collected during the survey of forest inventory plots in 2021-2023. These tables focus on damage, sanitary condition of plantations and trees, condition of tree crowns, naturalness, and age structure. For the calculations, we used detailed classifications provided for by the data collection methodology, as well as new classifiers based on the appearance of the reporting tables.
The formation of reporting tables was carried out in two stages: SQL queries in the database and calculations in the MS Excel spreadsheet editor. When working with the database, preliminary verification and preliminary data processing were carried out: individual indicators were checked, calculated or adjusted depending on the type of information links and expected results.
Calculations were made for each individual administrative region and year of the inventory. For the purposes of generalization and comparative analysis, this report also conventionally grouped the regions by forest vegetation zones (Table 2).

Table 2 Classification of the territory of the administrative region as a forest vegetation zone.

Group.	**Area.**
Forest-steppe	Cherkas'ka
Carpathians	Ivano-Frankivs'ka
Polissya	Zhytomyrs'ka
Carpathians	Chernivets'ka
Carpathians	Zakarpats'ka
Forest-steppe	Kyivs'ka
Carpathians	L'vivs'ka
Forest-steppe	Ternopil's'ka
Polissya	Rivnens'ka
Steppe	Mykolaivs'ka
Forest-steppe	Khmel'nyts'ka
Steppe	Dnipropetrovs'ka
Forest-steppe	Kirovohrads'ka
Steppe	Odes'ka
Forest-steppe	Poltavs'ka
Forest-steppe	Vinnyts'ka
Polissya	Volyns'ka
Forest-steppe	Sums'ka

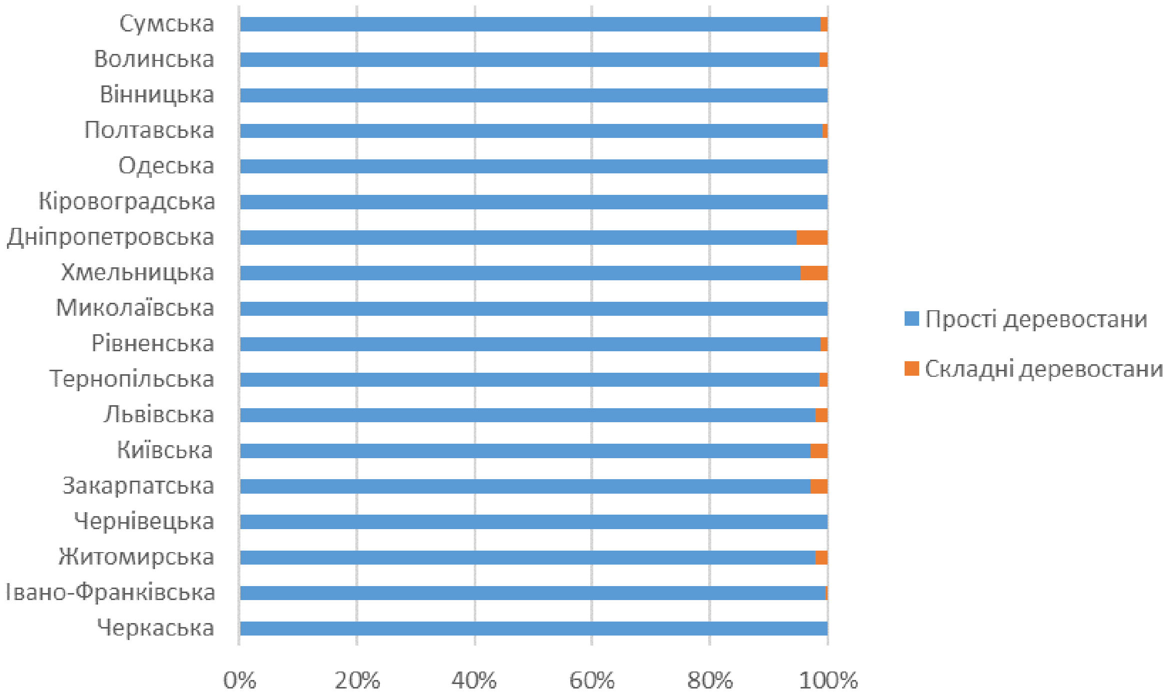
2. INDICATORS OF BIODIVERSITY AND PLANTATION STRUCTURE

2.1. Forest structure

Forest structure is one of the most important components of forest biodiversity as it defines the three-dimensional forest space using a combination of indicators representing horizontal and vertical structure and species composition. The approach to assessing forest structure is based on the physical organization of forest elements in relation to the composition and complexity of the stand.

6-1 Distribution of plantation area of dominant species by stand structure

The results are related to the assessment of the vertical structure of the stand, i.e. determination of the number of tiers, which is carried out in the field for the stand in the taxation unit in which the inventory plot or part of it is located. Each tree belongs to a forest element of a certain tier. Analytical methods of dividing trees into vertical tiers are not used.



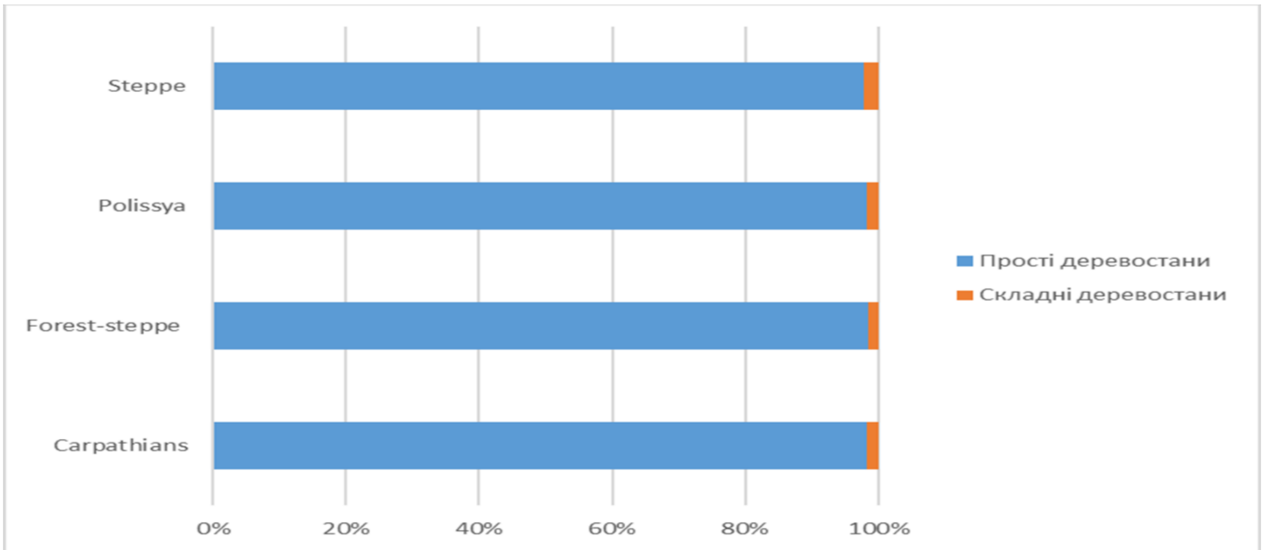


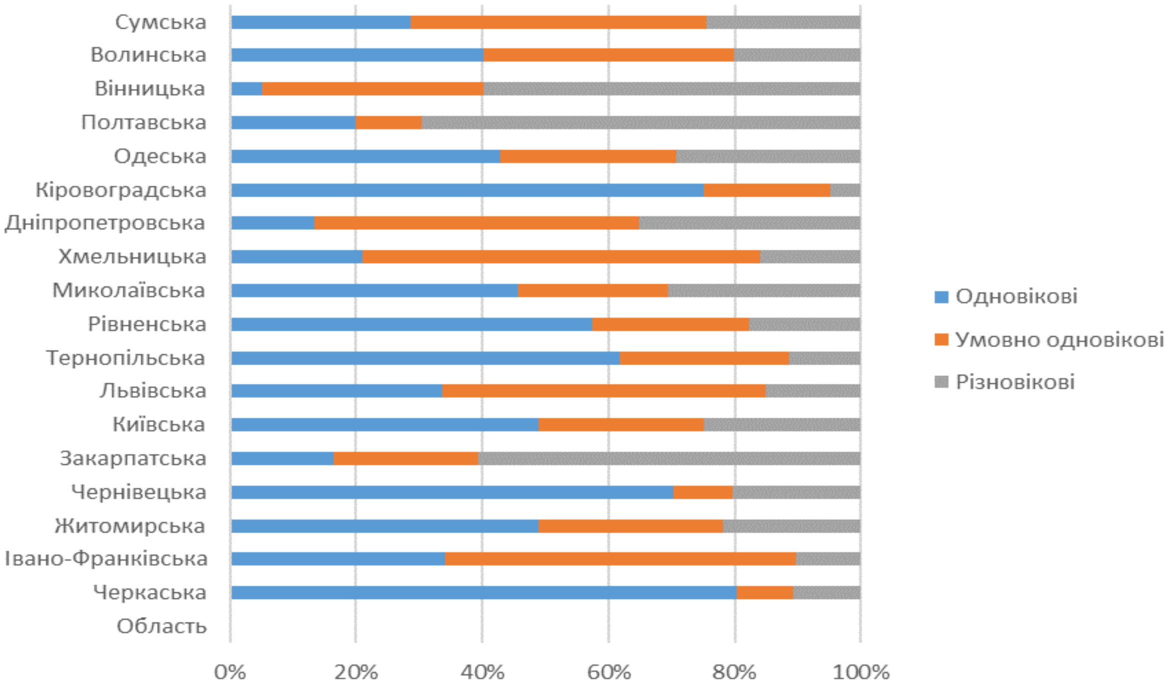
Figure 1. Share of the area of stands of different structures within administrative regions / forest vegetation zones

Simple stands consisting of a single tier predominate, with the share of complex multi-tiered stands at 1-3%, and only in some regions around 5%.

6-3 Distribution of the area of plantations of dominant species by age structure

It is carried out based on the results of the assessment of the trees of the dominant species in the stand belonging to the same age class in the inventory plots. If the trees of the dominant species are within the age group, the stand is considered to be conditionally single-aged.

In most NFIs, the division into same-age and different-age groups is not made, and even if it is available, it is important to compare them [3].



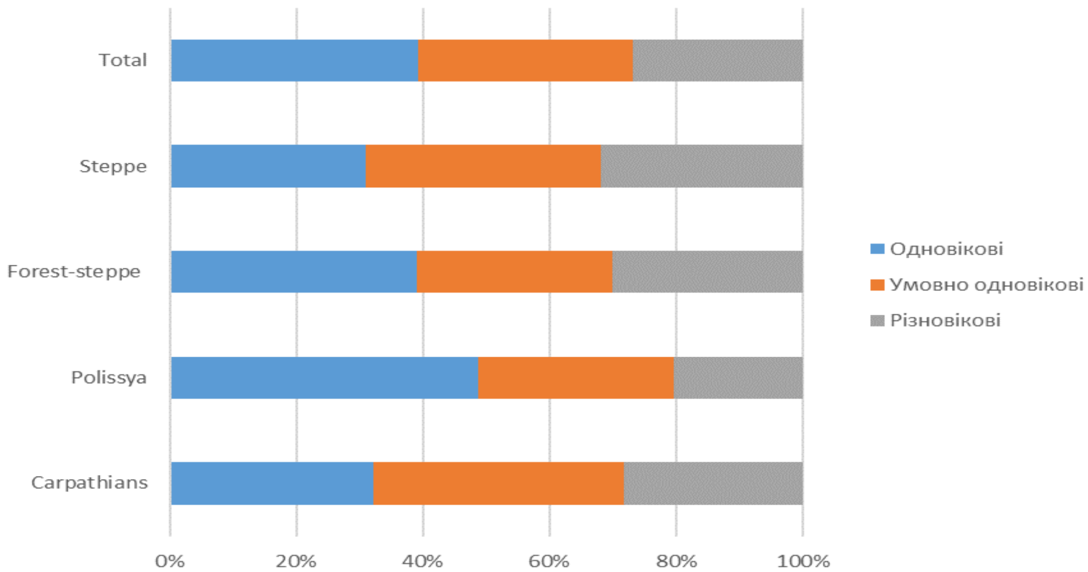
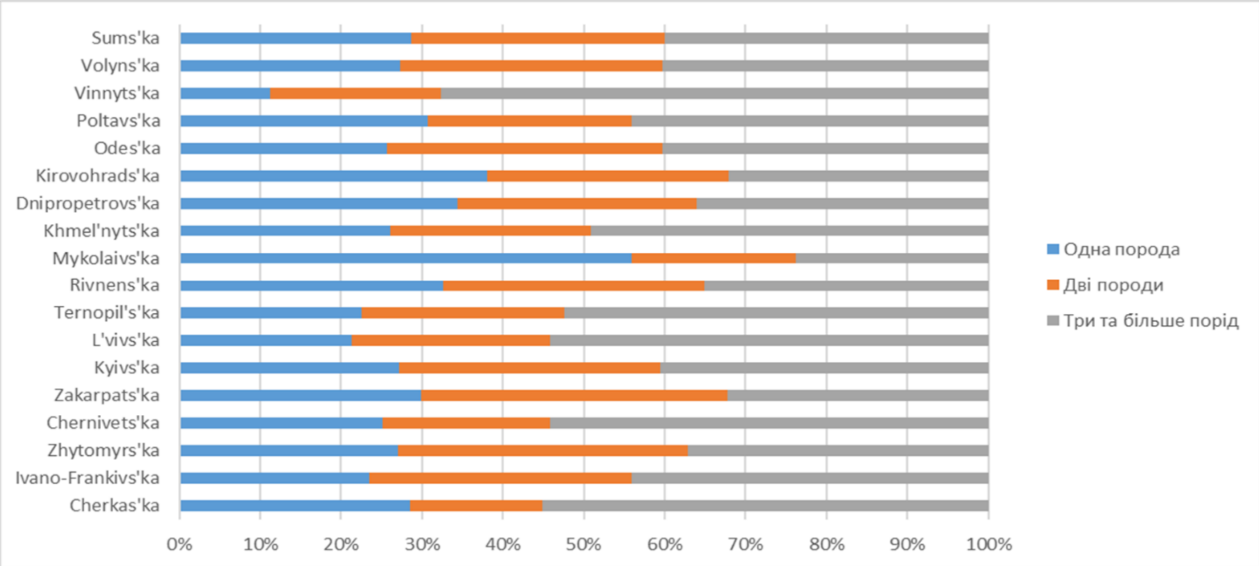


Fig. 2. Share of the area of plantations of dominant species of different age structure within administrative regions / forest vegetation zones

Single-aged and conditionally single-aged plantations predominate, but in some forest-steppe regions and in Transcarpathia there is a predominance of multi-aged plantations.

6-4 Distribution of the area of plantations of dominant species by the number of tree species in the stand

The number of tree species in the composition is determined depending on the taxation descriptions of forest elements by stand levels. That is, if the inventory plot contains trees of only one species, and the description of the stand contains several forest elements, the area of the plot is classified as having more than one tree species.



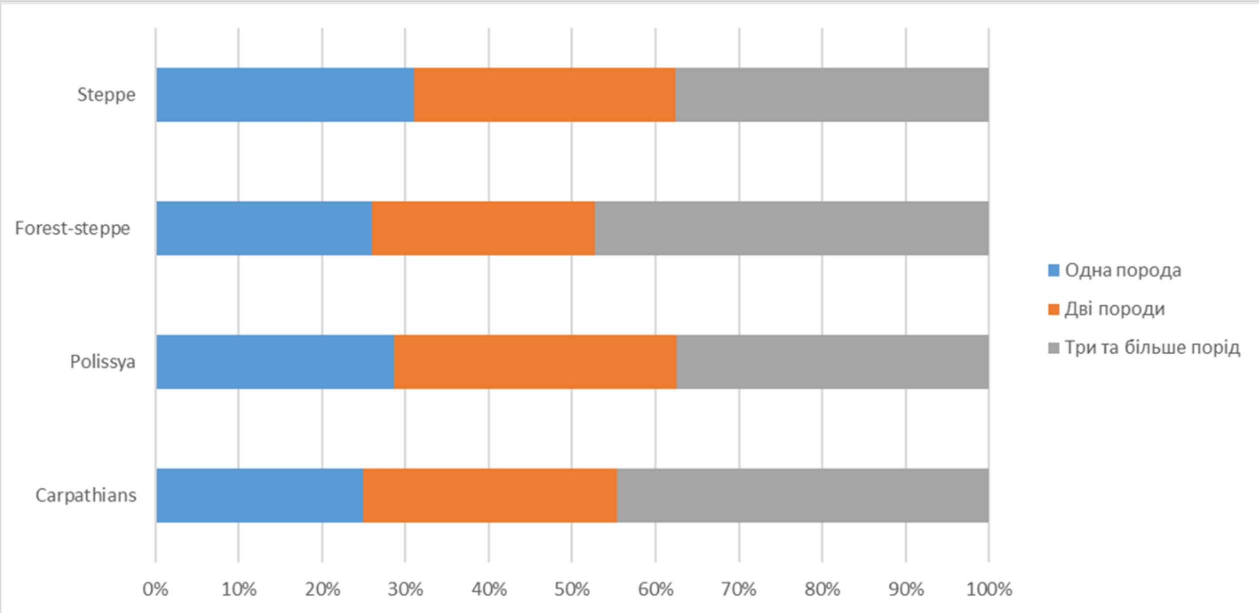


Fig. 3. Share of the area of plantations of dominant species by the number of species in the composition within administrative regions / forest vegetation zones

Plantations usually contain two or more species. Monocultures, consisting of trees of one species, are not as widespread as they are believed to be, but account for one third of the area. This means that there is considerable potential for re-forming such plantations within the overall concept of close-to-nature forestry.

6-2 Distribution of the area of plantations of dominant species by naturalness

The distribution of plantations by naturalness is based on an assessment of the degree of anthropogenic impact on plantations. The territories of virgin forests, quasi-virgin forests, and natural forests that have not been altered by humans have an official status [5]. Other categories are determined based on the results of a field survey.
Although naturalness is a well-known concept, there are few natural forests left in Europe. Branquart and Latham (2007) report that the ratio of near-natural forests to total forests and other forested land for Europe is 0.001 for Western Europe, 0.013 for Southern Europe, 0.025 for Central Europe, and 0.083 for Northern Europe.

Figure 4. Distribution of forest area by naturalness within administrative regions / forest vegetation zones

The predominant types of forests are natural forests altered by human activity and semi-natural forests formed by native species. In the Steppe, about half of the plantations are artificial semi-natural forests created by non-native species; in the Forest-Steppe, more than half are artificial semi-natural forests created by native species.
In the Carpathian region, more than 20% are natural forest ecosystems where anthropogenic impact has not changed the coenotic structure.

2.2. Dead wood

Standing dead trees, dead branches and fallen logs together make up some of the most important forest habitat for wildlife. Up to a third of European forest species depend on dead wood for their survival (Boddy 2001; Siitonen 2001).

Despite its importance, deadwood is currently at critically low levels in many European countries, primarily due to management practices used in commercial forests and even in protected areas. Typical European forests have less than 5% of the naturally occurring deadwood (WWF 2004). In many European and international agreements, deadwood is increasingly chosen as a key indicator of forest naturalness and sustainable forest management (MCPFE 2003). Forest inventories are crucial for assessing the state of deadwood and fallen dead wood in European forests [3].

6-7 Total volume of deadwood in plantations of dominant species by age class

Since the indicator correlates with the area of forests by region, it is necessary to additionally determine the average values per hectare, as well as the share of deadwood in the total volume of standing timber for comparison.

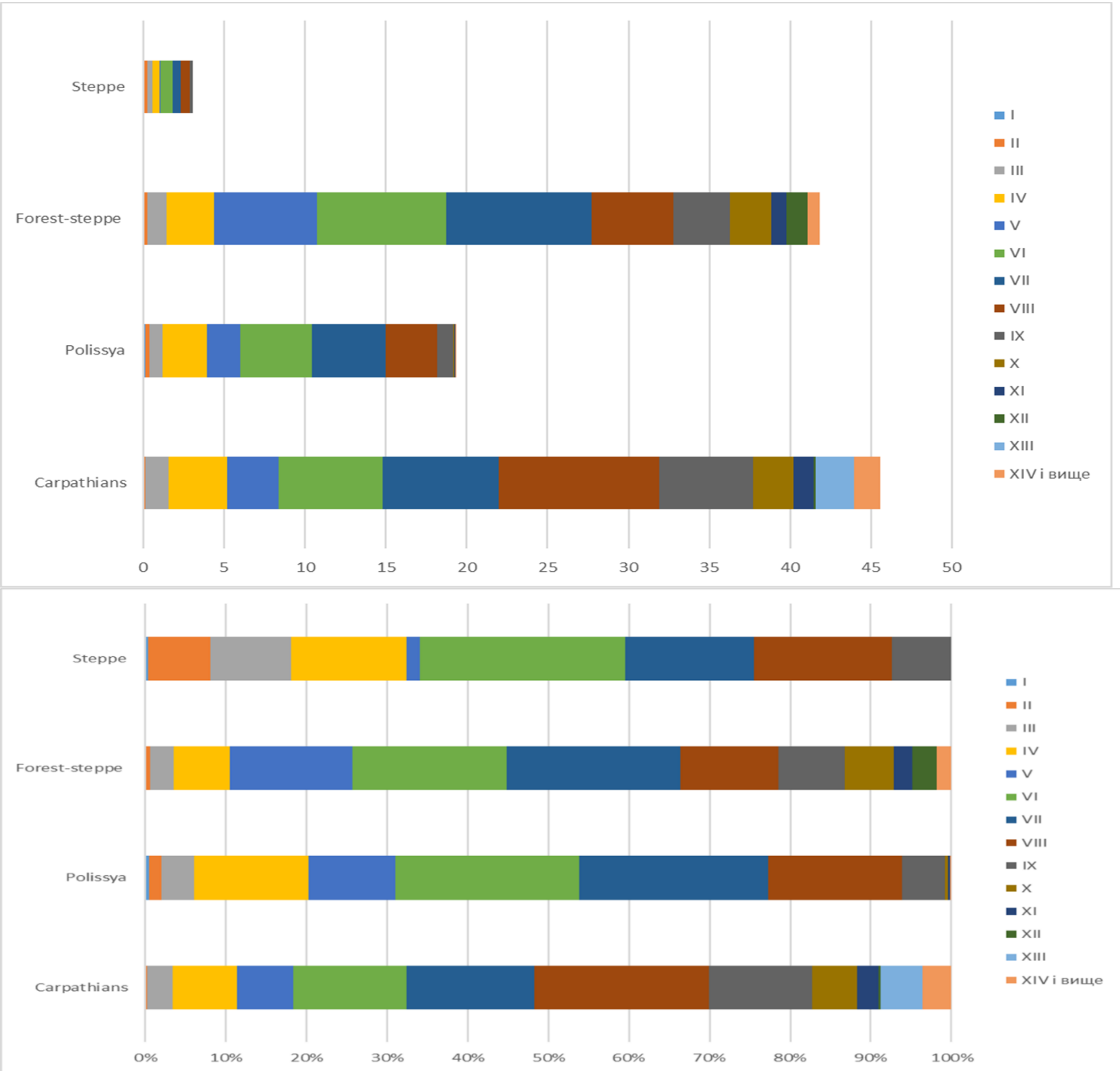


Figure 5. Total volume and share of deadwood in different age classes within forest vegetation zones

There is a relatively significant drying out in the VI-VIII age classes in all natural zones.
It is advisable to conduct further analysis by the species composition of the stands. For coniferous species, the age of 50-80 years is usually the time for thinning to generate growth. Instead, sanitary felling can obviously be carried out to remove dead trees.

6-8 Total volume of wood waste by species and stage of decomposition

The indicator correlates with the area of forests by region, and, logically, with the total volume of standing deadwood.

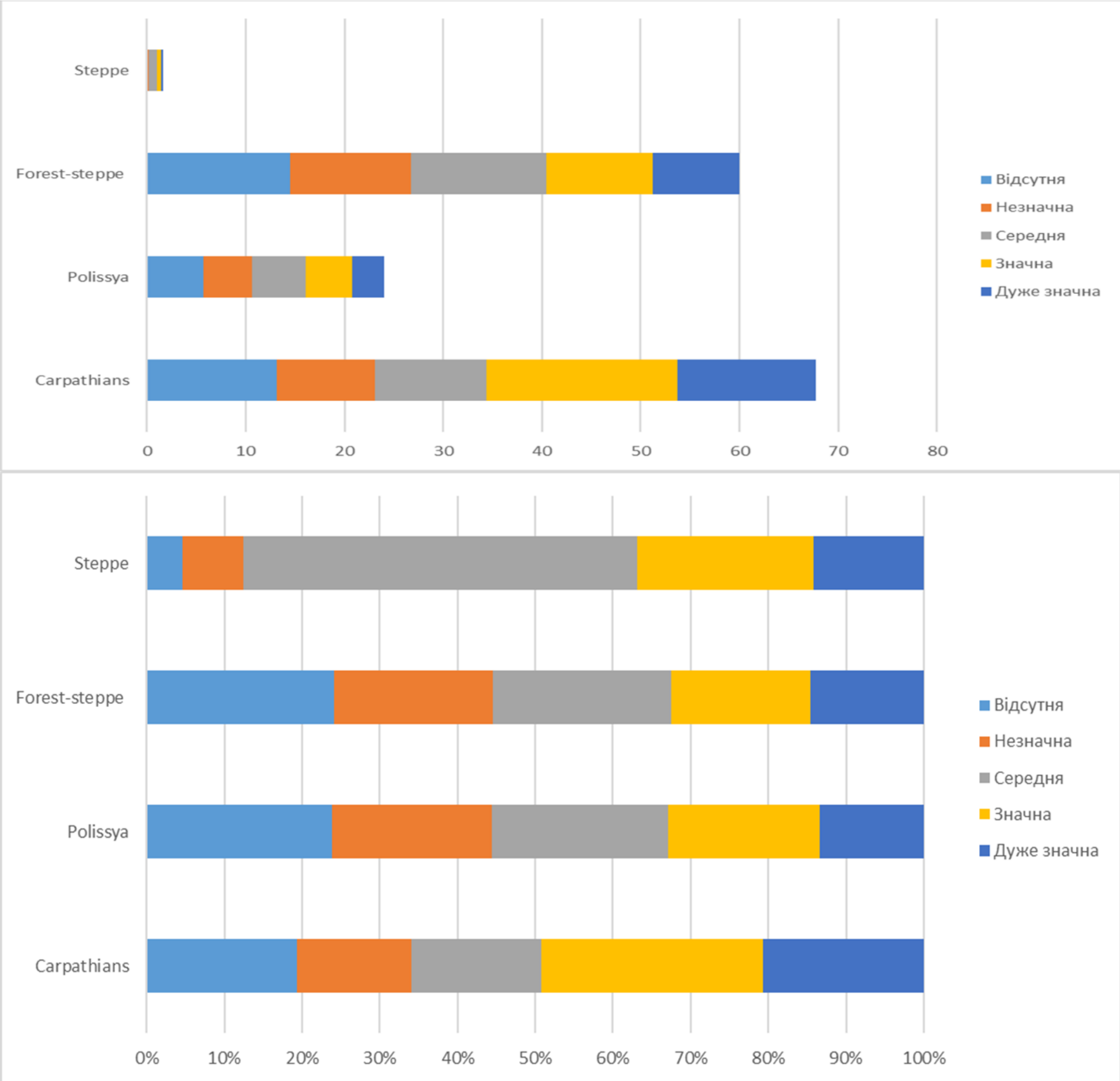


Fig. 6. Total volume and proportion of woody debris of different stages of decomposition within forest vegetation zones

Except for the Steppe, in all other natural zones, the share of woody debris suitable for use as fuel (no or little decomposition) is 35-45%.
According to estimates, in the Steppe region, about half of the volume of wood scrap has an average degree of decomposition (rot of 1-2 phases makes up 10-24% of the volume of damaged wood), which means that in xerophytic conditions the decomposition process takes longer, while up to 15% can be directly used for wood fuel in this region.

6-9 Average volume per 1 hectare of woody debris in plantations of dominant species

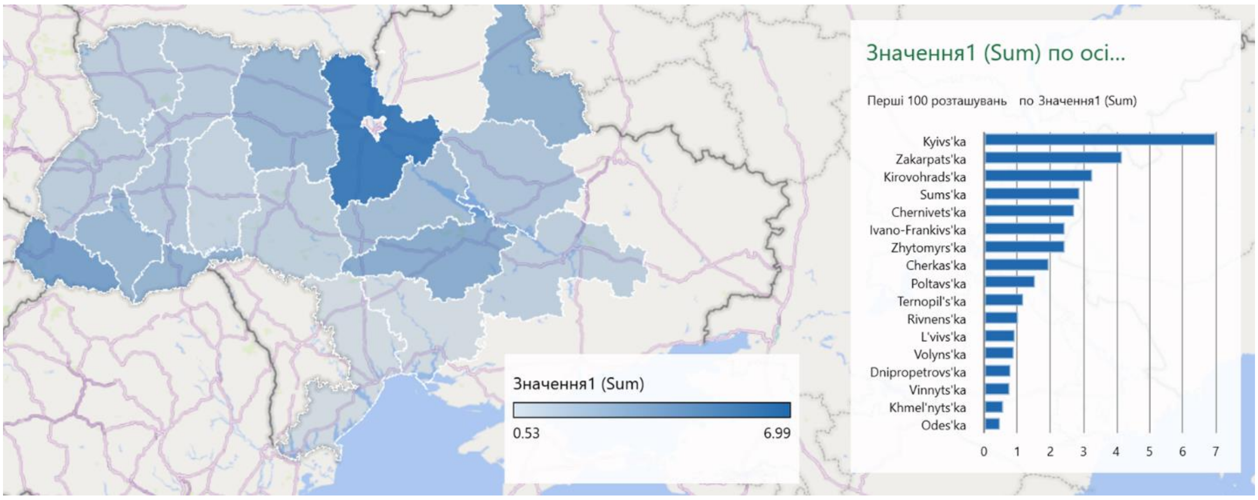


Figure 7. Average volumes of woody debris per 1 ha within administrative regions

The average figures were lower than expected and fluctuated mainly between 3-5 m3 per 1 ha.
Kyiv (Polissia), Kirovohrad (Forest-Steppe), and Zakarpattia regions have the highest average rates of fallen wood per hectare.
In general, there is a need to expand control over the completeness of data collection on wood felling.

2.3. Aboveground vegetation

The main life forms of the aboveground vegetation are usually designated as trees, shrubs, and grasses (Bonham 1989), although ferns and bryophytes are sometimes observed. The above-ground vegetation is related to both forest types and forest structure (Pitkänen 1998), with each forest type having a specific associated understory. Individual species or species groups of forest ground vegetation are used as indicators for site conditions (Khanina et al. 2007; Wilson et al. 2001). This approach is typical for the forest typology of Ukraine.

Woody species change site conditions, soil chemistry, litter cover, and light penetration, and these modifications lead to modifications in the aboveground vegetation (Augusto et al. 2003; Gärtner and Reif 2005). In addition, aboveground vegetation is strongly correlated with soil fertility and stand age (Pitkänen 1997). Changes in the composition and spatial distribution of vascular plants can indicate degradation of site conditions (COST E43, 2005). Above-ground vegetation is also used to detect changes in the ecosystem due to air pollution, particularly nitrogen deposition. Vegetation surveys have the advantage of being low cost compared to air or soil chemistry analysis (Thimonier et al. 2003).

Depending on the requirements of plant ecology and the purpose of the NIS, different classifications have been developed to provide detailed information on different components of the aboveground vegetation (Alberdi et al. 2010). Among the countries whose NIS collect data on above-ground vegetation, all record information on shrubs, 71% on grasses and ferns, 62% on lichens and mosses, and only 14% on liverworts.

6-5 Distribution of the area of plantations of dominant species by the degree of undergrowth coverage

Shrubs and tree species that may have a shrubby form are included in the description of the understory. For each undergrowth species, the projected coverage is determined as a percentage of the inventory plot area. The highest degree of coverage is taken as the score for the plot. Therefore, estimates of the degree of undergrowth cover should be considered minimal.

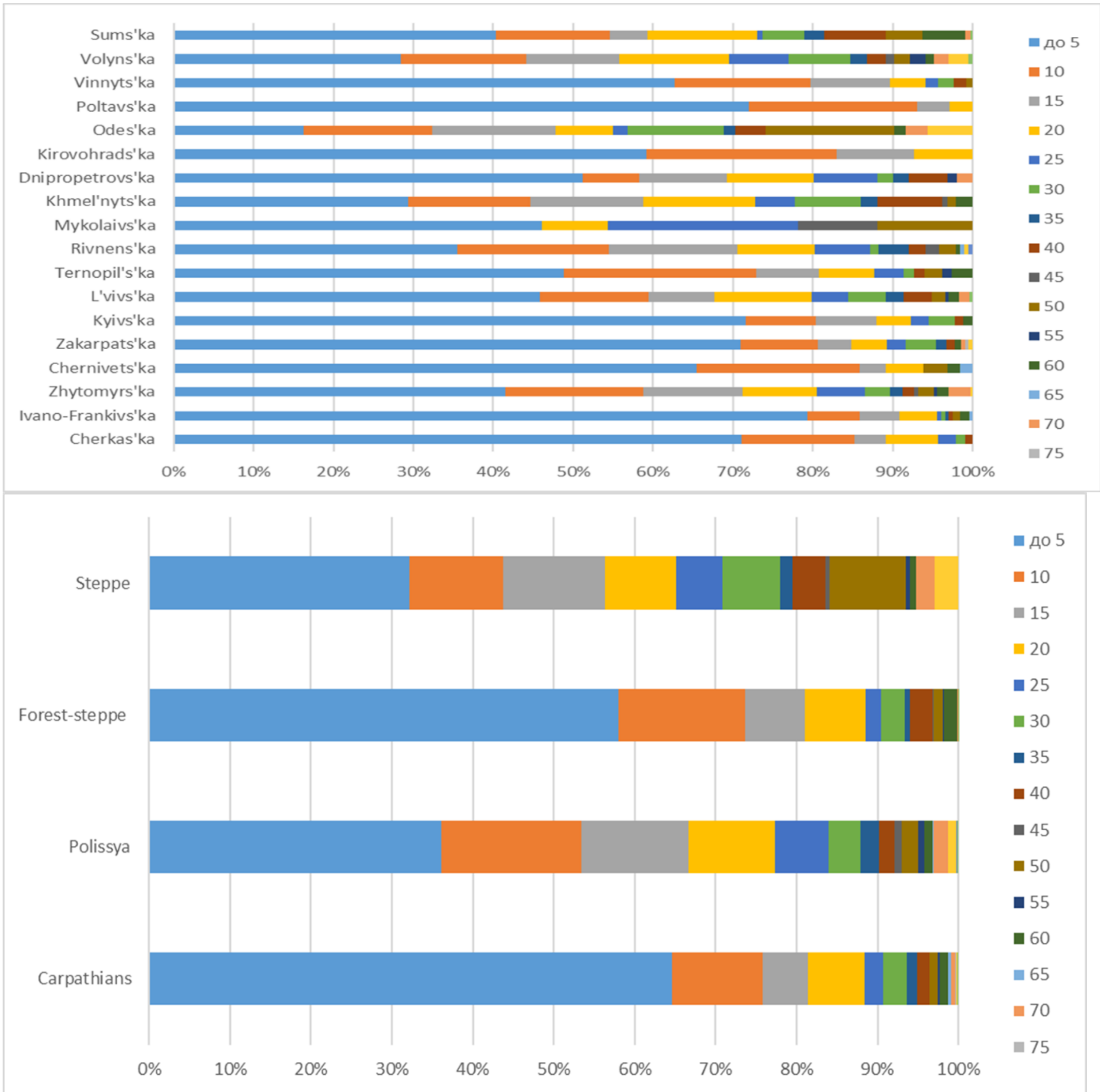


Figure 8. Share of plantations with different undergrowth coverage within administrative regions/forest vegetation zones

In Polissya and the Steppe, undergrowth is practically absent in one third of the plantations. Surprisingly, in the Forest-Steppe and Carpathians, the share of plantations with undergrowth coverage of up to 5% reaches two-thirds of all plantation areas.

Obviously, this is related to the state of development of the stand and soil and climatic conditions, in particular, lighting conditions. Therefore, further assessment of the undergrowth coverage should be analyzed together with the fullness of the plantations.

6-6 Distribution of the area of plantations of dominant species by the degree of coverage with aboveground vegetation

The description of the above-ground vegetation includes shrubs, grasses, cereals, mosses, and lichens. For each plant species, the projected coverage is determined as a percentage of the inventory plot area. The highest degree of coverage is taken as the score for the plot. Therefore, estimates of the degree of above-ground vegetation cover should be considered minimal.

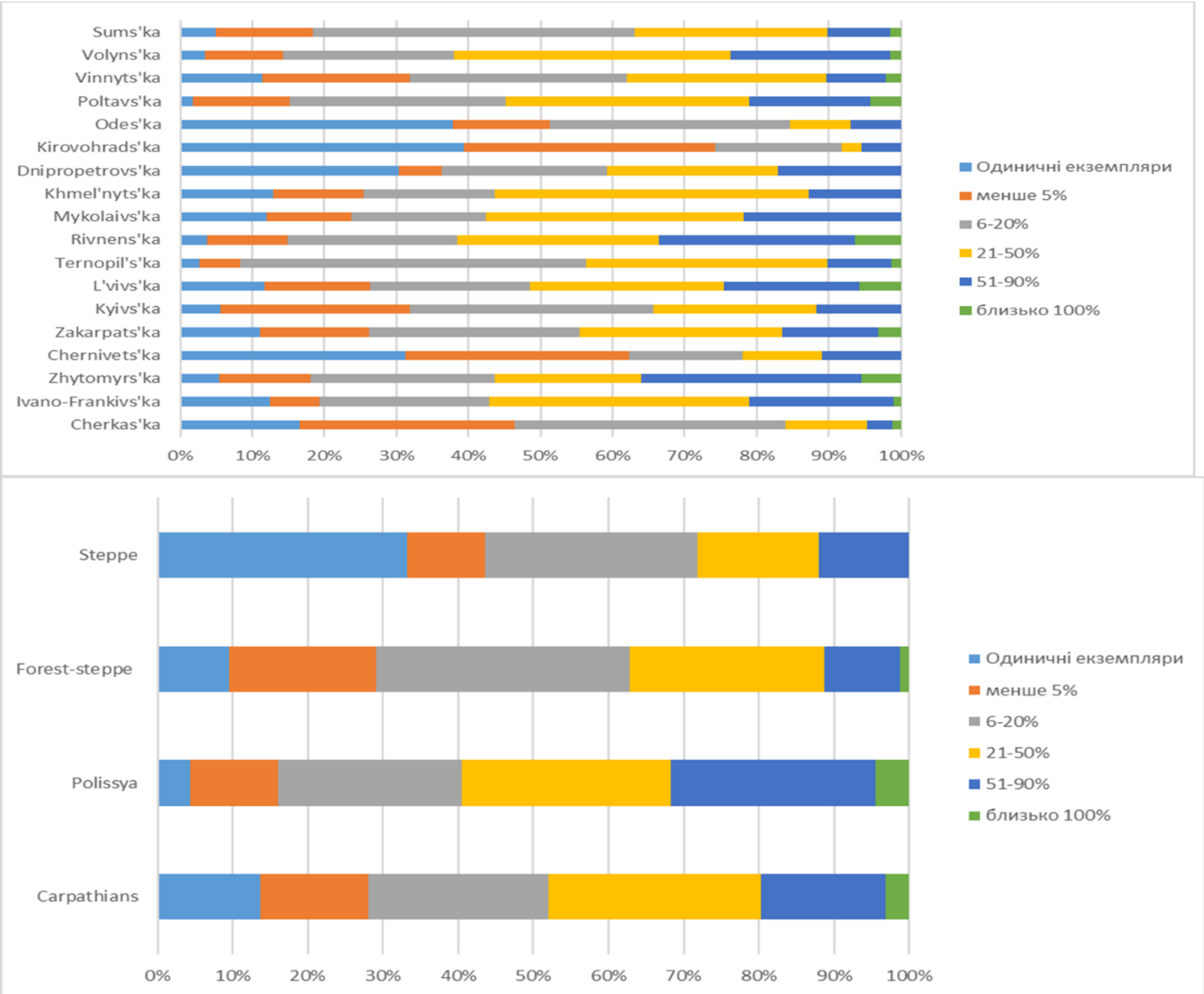


Figure 9. Share of plantations with different degree of aboveground vegetation coverage within administrative regions/forest vegetation zones

In general, about half of the plantations in all forest vegetation zones have moderate (6-20%) or abundant (21-50%) aboveground vegetation coverage, while only one fifth of the areas are characterized by single or weak spread (up to 5%) of herbaceous vegetation and shrubs.

3. INDICATORS OF THE SANITARY CONDITION OF PLANTATIONS AND TREES

3.1. Condition of plantations

7-1 Distribution of the area of plantations of dominant species by type of impact

Impact types describe information about external processes that have changed the growth conditions or composition of forest stands on the inventory plot.

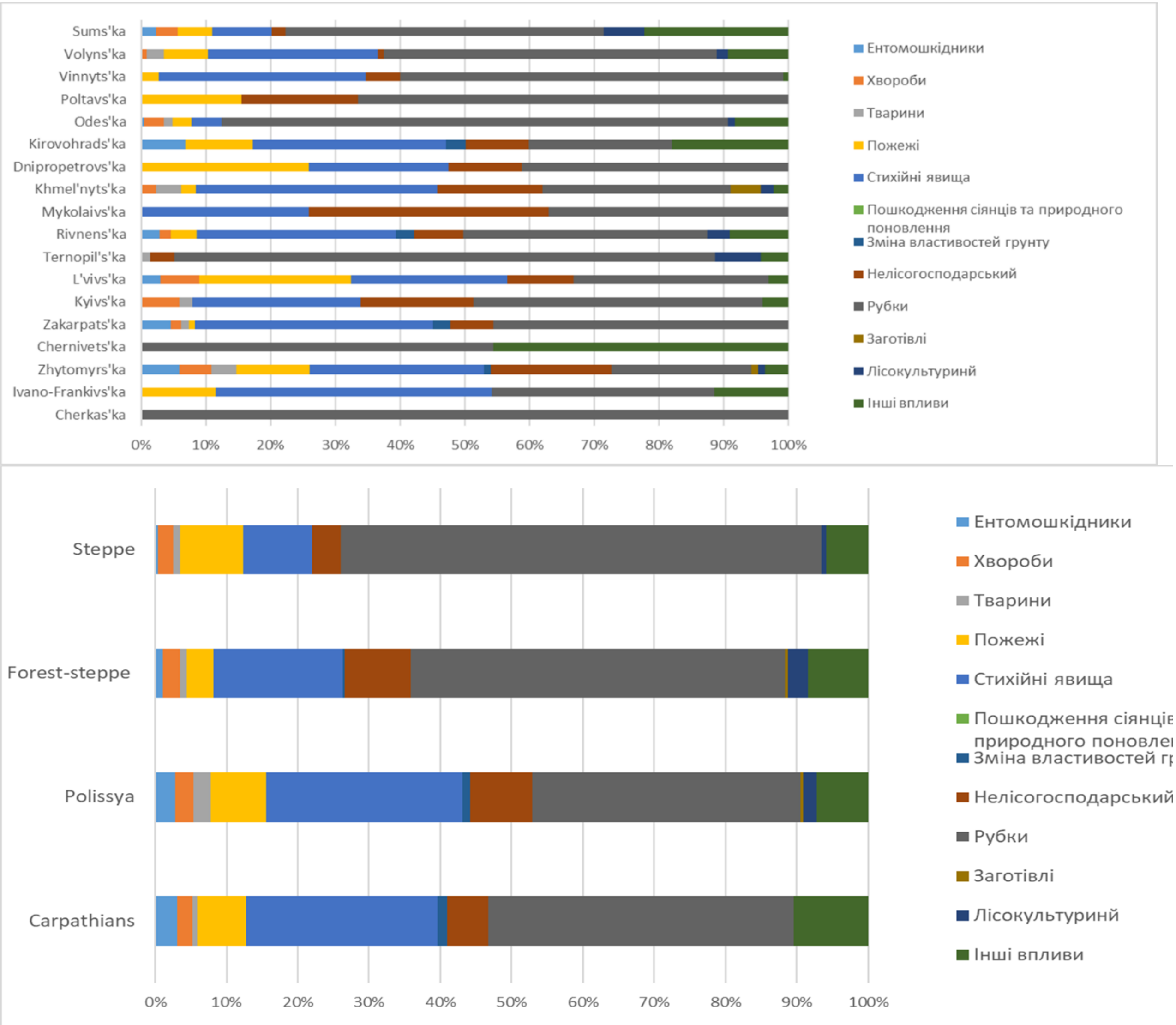


Fig. 10. Share of affected plantation area within administrative regions/forest vegetation zones

The area is dominated by anthropogenic impact, namely logging (from ~35% in Polissia to ~65% in the Steppe). There is also a non-forestry impact (5-10% of household and industrial waste, mechanical damage to trees, recreational pressure, etc.)
Among the abiotic influences on the development of plantations, fires (5-10%) and natural phenomena (from ~10% in the Steppe to ~35% in the Carpathians) play the largest role.

3.2. The state of the trees

7-2 Distribution of the number of trees of forest-forming species by condition categories

For all registered trees, the category of the tree's sanitary condition is established in accordance with the Sanitary Rules in the forests of Ukraine [6].

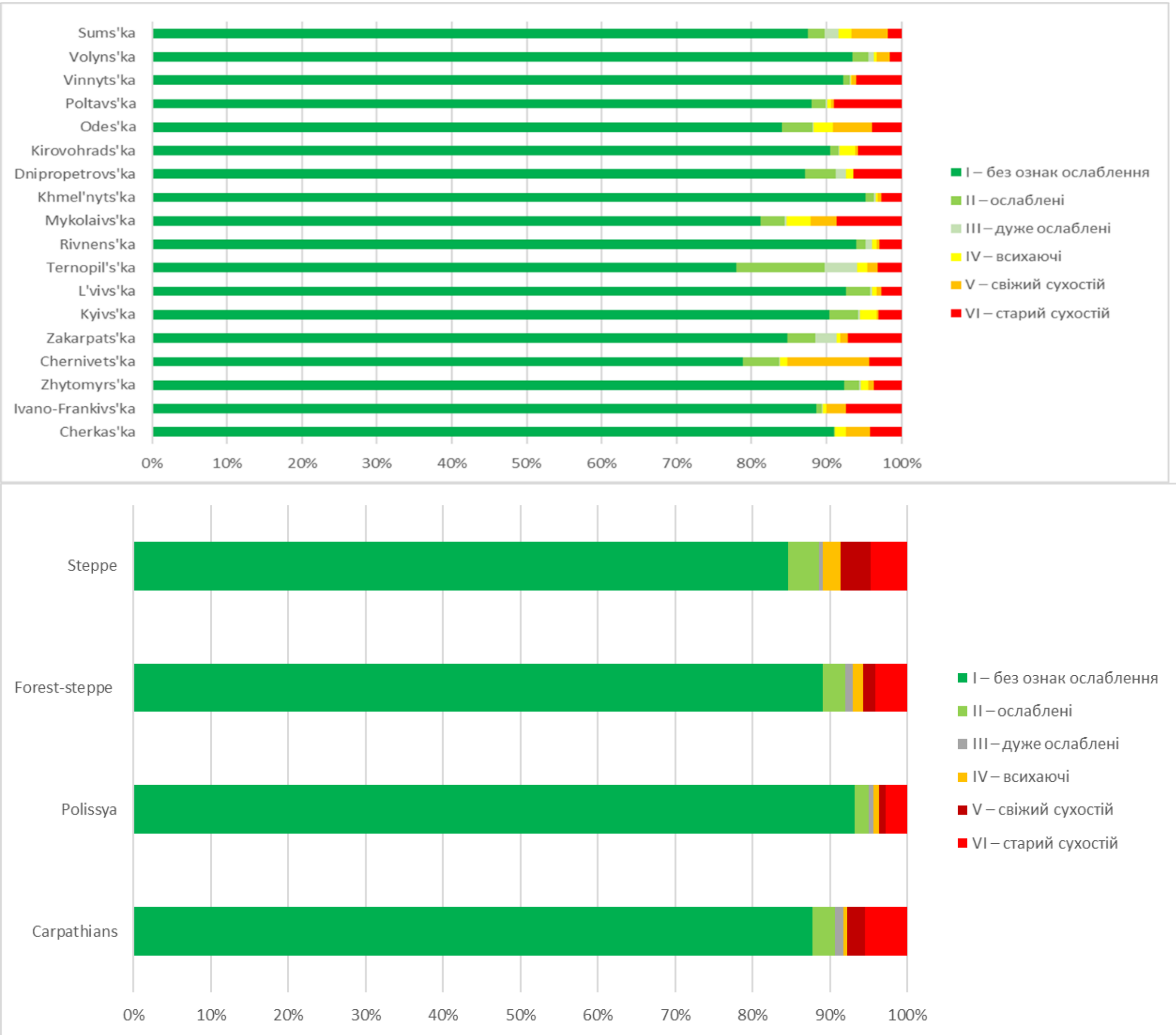


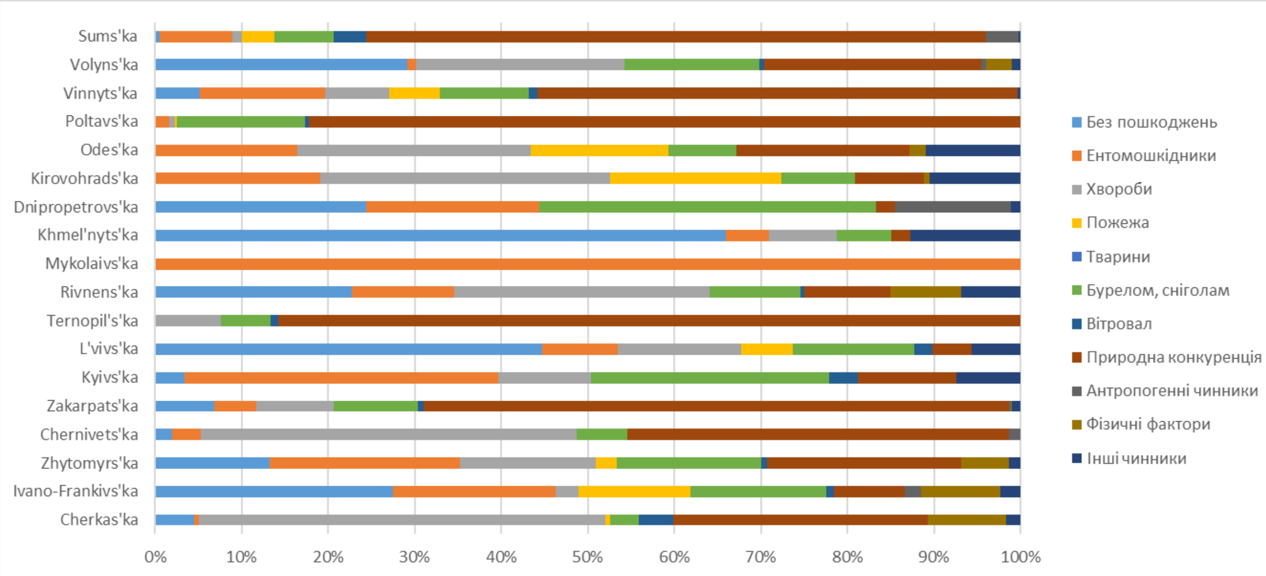
Figure 11. Distribution of the number of trees of different sanitary condition within administrative regions / forest vegetation zones

Deadwood accounts for up to 5-8% of the total number of trees (~ one in fifteen trees is dry). That is, statistically, typical Ukrainian forests have at least 5% of the deadwood expected to regulate natural conditions. At the same time, the geography of drying out centers should be tracked at the local level.

At the same time, more than 85% of the trees show no signs of weakening, which also raises the question of the spread of the practice of prescribing sanitary felling.

7-6-3 Total number of dry trees of forest-forming species by cause of death

Drying factors are also determined for dead trees.



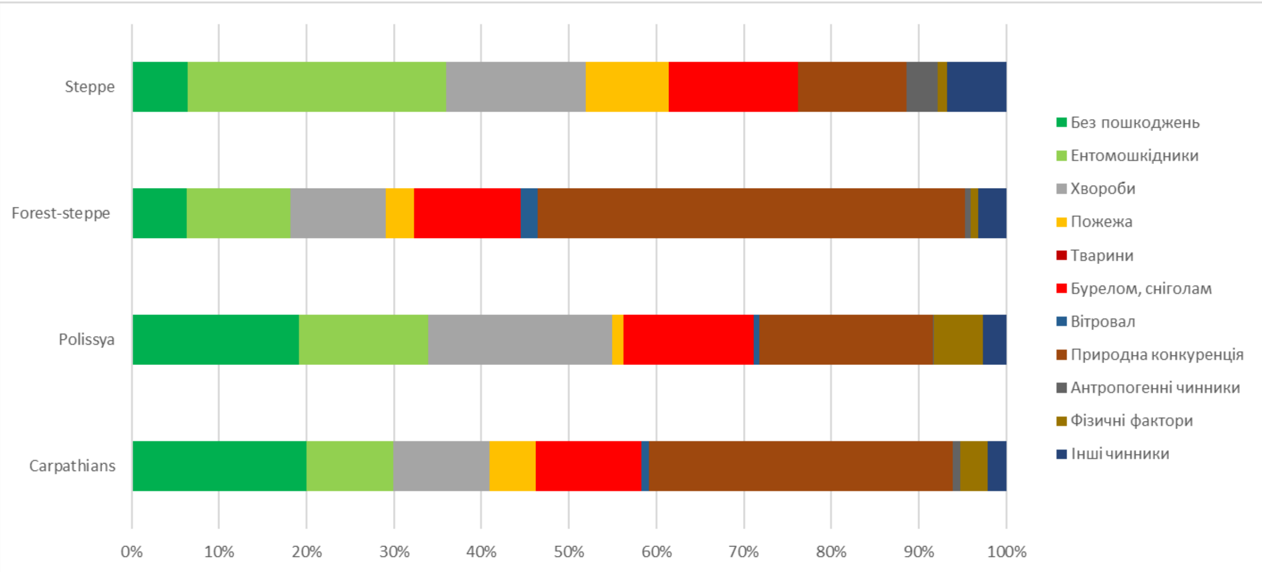


Figure 12. Distribution of the number of dry trees depending on the causes of drying within administrative regions / forest vegetation zones

Natural competition is the predominant main factor in drying out, along with entomopest and disease. Taken together, this may indicate a lack of timely care.

7-5-1 Total volume of live trees of forest-forming species by type of damage

For all the trees in the inventory, the presence of damage was determined, starting from a certain minimum intensity limit. Several damages are recorded according to their degree of threat. Therefore, only the most threatening types of damage recorded are presented in the assessments.

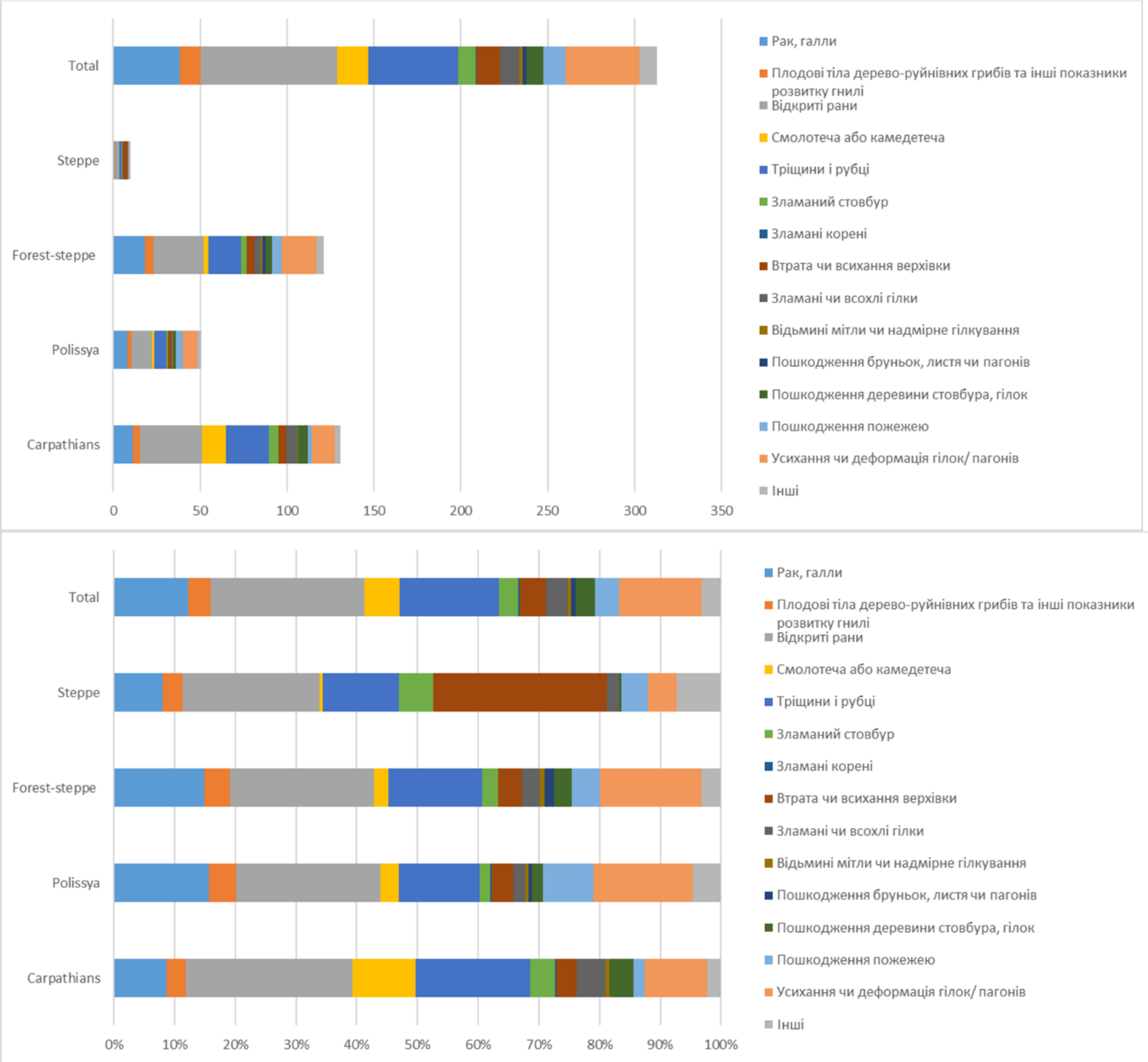


Figure 13. Distribution of the volume of damaged live trees within administrative regions / forest vegetation zones

Most often, visually noticeable damage is recorded - open wounds, cracks and scars, as well as drying and deformation of branches and shoots.
In the Steppe, about 30% of the damage was recorded as loss or drying of the tops, which requires determining the causes of this phenomenon (diseases, animals?).

7-3 Distribution of forest-forming trees by degree of defoliation

Defoliation characterizes the relative loss of leaf mass. Defoliation is determined visually using photo standards for model trees. The latter are selected from healthy reference trees with minimal damage. Therefore, defoliation estimates are usually biased towards underestimation, as weakened trees obviously have a greater loss of leaf mass, but are not included in the analysis.

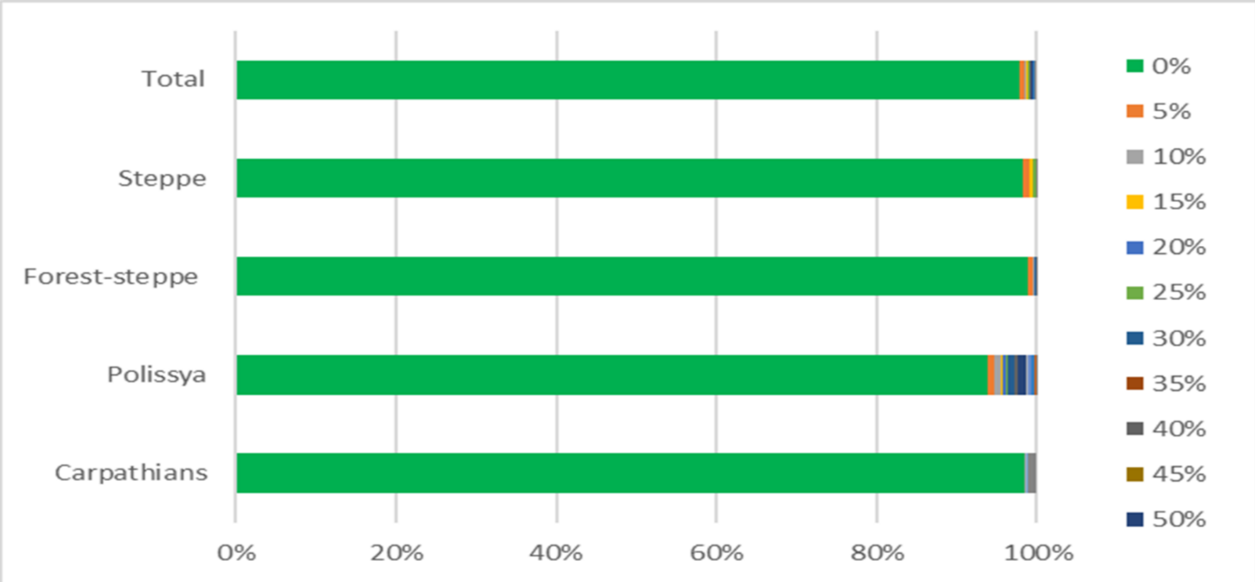


Figure 14. Distribution of the number of trees depending on the degree of defoliation within administrative regions / forest vegetation zones

The conclusion that leaf mass loss is not observed in 95% of trees is obviously not fully consistent with the actual situation.
It is likely that to improve the quality of defoliation assessments, it is necessary to expand the training program for NFI staff on how to determine this indicator.

7-4 Distribution of forest-forming trees by degree of dechromation

Defoliation indicates the proportion of leaves/needles of a model tree that have changed their normal color. Defoliation estimates are usually also biased towards underestimation, as weakened trees are not included in the survey.

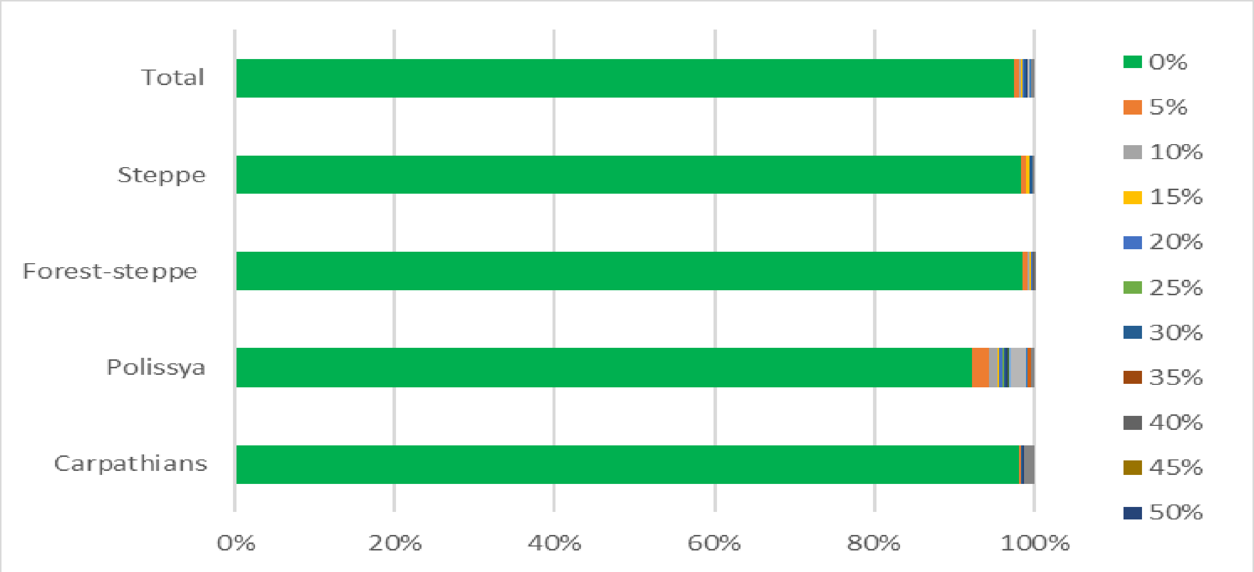


Fig. 15. Distribution of the number of trees depending on the degree of dechromation within administrative regions/forest vegetation zones

The conclusion that no change in leaf/needle color is observed in 95% of trees is obviously not fully consistent with the actual situation.
It is likely that to improve the quality of dechromation assessments, it is necessary to expand the training program for NFI staff on the determination of this indicator.

4. SELECTED EXAMPLES OF ENVIRONMENTAL PERFORMANCE ASSESSMENT IN OTHER COUNTRIES

Assessment of the conservation status of Natura 2000 forest habitats in Europe: opportunities, potential and problems of national forest inventory data

There is a need to improve the consistency of international information on the conservation status of species and habitat types in Natura 2000 reports. National forest inventories could contribute to a more objective and harmonized assessment, although their use demonstrates some problems, such as low accuracy for rare or small habitats. Recommendations are made for a set of 12 structural and functional indicators.
Based on the information available in the NFI, case studies and questionnaire results, a list of common indicators for each type of forest environment is proposed that can be assessed using the information provided by the NFI, regardless of the establishment of specific indicators for each type of forest environment.
The general indicators included in this first pilot list are as follows:

- richness of tree species; -
- non-native species; -
- renewal;
- distribution by diameter;
- large trees;
- vertical structural diversity;
- dead wood;
- tree cavities;
- damage to the crown;
- forest disturbance (fires);
- soil cultivation;
- tree pests and diseases.

Nationwide assessment of biodiversity, naturalness and status of old-growth plants using data from the national forest inventory - Italy

Assessing the biodiversity, naturalness and status of old-growth forests (B-N-OG) is crucial to support sustainable forest planning, but many countries lack comprehensive monitoring networks specifically designed for this purpose. National Forest Inventories (NFIs) are the official source of statistical data on forest status and trends. Although originally developed for timber production estimation, NFI data can be crucial for environmental monitoring of forests due to their robust sampling protocols that allow for statistical inference and regular field campaigns that ensure that information is constantly updated. As a result, in this study, we investigate the potential of NFIs to estimate B-N-OG indices with the aim of establishing compatible, scientifically meaningful and cost-effective indicators using existing NFI data at the European level. Based on the 2005 Italian NFI data collected from 6563 plots, 18 indicators were selected according to previous experience and then used to estimate aggregate B-N-OG indices. The relationships between the 18 indicators and the three indices were investigated, and their relationships were compared across the categories of forest types, management types, and protected and unprotected areas.

The results indicate that the NFI data provide valuable information on specific B-N-OG indices, especially on forest structure and dead wood. In addition, the indices contribute to the development of meaningful relationships between geographical regions, forest categories and management types. However, limitations in the field protocols of the NIL are obvious, as they are not explicitly designed for certain indicators. The study suggests the potential for NILs to become accessible, harmonized European reference networks for B-N-OG assessment to better support sustainable forest management, planning and conservation decisions related to forest ecosystems.

A basis for mapping the ecological base of a forest - an example from Norway

Spatial information on extent, condition and pressure is essential in the management of forest ecosystems. The current study presents a framework for a remote sensing-based forest ecological base map covering Norway.

The combination of remote sensing images from optical satellite systems such as Sentinel-2 and Landsat provides information on the extent of forest ecosystems and their changes over time. The use of the national Airborne Laser Scanning (ALS) dataset has made it possible to predict a number of attributes describing forest condition, including naturalness. Detailed maps of forest condition and forest pressure were aggregated at the local level using model-based inferences that provided mean and uncertainty estimates on a scale suitable for the development of ecosystem indicators. The set of map layers describing the extent, condition and pressure of forests form a forest ecological basemap that is important for natural resource management.

The pressure on forest ecosystems was mapped using a change detection algorithm and satellite data from 1986 to 2020. Change detection is a cornerstone in monitoring and understanding pressure on ecosystems. The predicted forest area had an overall accuracy of 85 to 89% on Sentinel-2 imagery from 2020 and 71 to 81% on Landsat imagery from 1986. For forest condition characteristics, the explained part of the deviations was >70% for biomass, height and volume, and 21% to 64% for stem number, crown cover and diversity index. Naturalness was classified with 77 to 98% accuracy, except for age determinations. However, there were a large number of false positives. The detection of changes was evaluated in terms of the final yield and was determined with an overall accuracy of 84-92%. The classification of land cover changes had an overall accuracy of 70-92%.

Based on the NFI data, volume (V), aboveground biomass (AGB), belowground biomass (BGB), height (H), density (number of stems) (N), and crown coverage (CC) were calculated for all sample plots. In addition, the Gini Diversity Index (GINI) was calculated based on basal areas at the tree level to describe the diversity of tree sizes. In addition, seven different definitions of naturalness were adopted and sample plots were classified as natural forest or not as a binary value for each definition.

The ecological status of the NIL forests in the UK: Methodology

The National Forest Inventory (NFI) provides data on the size and distribution of woodland and woodland species in the UK, as well as information on key forest attributes. The report outlines the methodology used by the NFI to assess the ecological condition of woodlands in the UK (GB) in terms of their likely value for biodiversity. It provides information on the forest characteristics measured during the NFI field survey as condition indicators and describes the rule sets used to classify woodlands into 'good', 'fair' or 'poor' woodland condition (WEC) status. The resulting statistics and classifications allow for comparison of WEC across different forest habitat types. This information will be used for national reporting purposes and can

be used for targeted resource use and forest management, support for the protection and enhancement of biodiversity and sustainable forests and woodlands.
The results of the WEC assessment of the first cycle of the NFI survey (data collected between January 2010 and January 2016), which serve as a baseline against which future results can be compared.

5. CONCLUSIONS

The Ukrainian NFI uses approaches to assessing environmental indicators that are generally consistent with those of other NFI in Europe: an exhaustive list of indicators is used, and appropriate methods of data collection and presentation are available. Among other things, this means that there are opportunities for harmonized comparison of results with other countries' NIS, and the necessary conditions and opportunities are in place to present environmental indicators of the Ukrainian NFI for European and international reporting.

The biodiversity indicators analyzed in the study related to the structure of plantations confirm that a long period of forestry management focused mainly on achieving high productivity of plantations eventually led to a significant spread of simple plantations (single-tier, single-age, monocultures). In the context of climate change, such plantations are unstable and vulnerable to external influences. This requires expanding the practice of implementing methods of close-to-nature forestry in the Ukrainian forestry sector aimed at forming plantations with a complex structure.

The sanitary condition of the plantations and trees does not appear to be threatening. According to WWF estimates, the presence of 5-8% deadwood is a necessary natural condition for the development of plantations, while more than 85% of trees in this study show no signs of weakening at all. Although these factors require further localized analysis, in general, no conditions for excessive sanitary felling have been identified. Natural competition, entomopest pests, and diseases prevail among the causes of tree mortality. Drying out of plantations is observed most often at the age of 50-80 years. Taken together, these factors may indicate an insufficient amount of maintenance (thinning).

The study revealed the need for further comprehensive analysis of indicators that would allow analyzing information from several reporting tables. For example, it would be logical to further analyze the relative volumes of deadwood accumulation in plantations compared to the total stock of stands. Accordingly, the spread of impacts on plantations, undergrowth and overgrowth coverage, and deadwood volumes should be further analyzed in conjunction with data on stand completeness.

The inclusion in the national inventory of indicators of the general condition (crown) of trees (defoliation, dechromation were assessed at the level I environmental monitoring sites until 2016) has not yet yielded results that can be taken as reliable estimates. In addition to the lack of field data, there is an objective need for expanded training of the NIL staff to assess these indicators. In a more general context, the challenge is to expand the role of the national forest inventory as a single platform for national forest monitoring within the national environmental monitoring system.

Examples from different countries of assessments of ecological conditions and biodiversity based on NIS data show the possibility of using the network of inventory plots for monitoring the state of Natura 2000 sites, assessing the naturalness of plantations, classifying forests by ecological conditions of growth, and assessing biodiversity at the level of inventory plots. For Ukraine, the development of the Emerald Network is among the priorities of environmental protection activities, and the network of NFI inventory plots can be considered as a network where objective data are collected annually to monitor the state of the Emerald Network. The areas of virgin, quasi-virgin and natural forests identified in Ukraine can also be subject to appropriate monitoring in the course of the NFI. The inclusion of the European forest types indicator in the NFI of Ukraine in combination with the forest inventory using remote sensing data will allow to refine the estimates of forest naturalness based on the distribution of certain tree species. Forest inventory using remote sensing data can be developed in the direction of building special ecological maps, such as diversity index maps to describe differences in tree size. The available NFI data can also be the basis for further scientific research on biodiversity assessment (indicators) at the level of inventory plots (assessment of phytocoenosis complexity).

6. REGULATORY AND LEGAL ACTS AND LITERARY SOURCES

1. Procedure for conducting a national forest inventory. Approved by the Resolution of the Cabinet of Ministers of Ukraine of April 21, 2021, No. 392
2. Draft Law on Amendments to Certain Legislative Acts of Ukraine on the State System of Environmental Monitoring, Information on the State of the Environment (Environmental Information) and Information Support for Environmental Management No. 7327 of 28.04.2022 https://itd.rada.gov.ua/billInfo/Bills/Card/39521
3. National Forest Inventories: Contributions to Forest Biodiversity Assessments" (NFI-FBA, 2011) https://link.springer.com/book/10.1007/978-94-007-0482-4
4. Guidelines for conducting field work on the national forest inventory. Approved by the Scientific and Technical Council of the State Agency of Forest Resources of Ukraine, Minutes No. 1 of March 10, 2021.
5. Order of the Ministry of Ecology and Natural Resources of Ukraine dated 18.05.2018 No. 161 On Approval of the Methodology for Determining the Belonging of Forest Territories to Virgin, Quasi-Virgin and Natural Forests
6. Sanitary rules in the forests of Ukraine. Approved by the Resolution of the Cabinet of Ministers of Ukraine of July 27, 1995 No. 555 (as amended by the Resolution of the Cabinet of Ministers of Ukraine of October 26, 2016 No. 756)