



National Forest Inventory

How forest policy contributes
to public acceptance of forest use

Contents



State Agency for
Forest Resources of Ukraine

dkg.kmu.gov.ua



German-Ukrainian
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www.apd-ukraine.de

Disclaimer

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Ukrainian forests – our wealth

Forest ecosystems cover currently 16% of the area of Ukraine. For centuries they have provided a whole range of positive impacts on human welfare and are still an important asset for the Ukrainian people.

As these positive aspects depend on the extent, quality and structure of forests, sufficient knowledge about forests is essential to meet the societal needs in an appropriate manner. Moreover, the current controversial discussion about timber use requires a transparent approach towards reliable information about the state of forests, protection, harvesting and regeneration measures as well as the expected development of forests in the future.

International experiences in all EU countries, USA, Canada, Australia, China, India, Japan and many other countries indicate that National Forest Inventories (NFI) are an appropriate and effective tool for gathering such information and providing it in a transparent way as a base for forest policy decision making.

During 2008-2015 the Ukrainian government supported regional forest inventories in Sumy and Ivano-Frankivsk oblasts across an area of about 1 Mill. ha, using statistical methods of NFI, characterized by reliable accuracy. The outcomes from these regional inventories revealed

significant discrepancies between traditional methods of analyzing the extent and structure of forests in comparison to NFI results. Policies, built on insufficient data about Ukrainian forests might lead to undesired forest policy decision making.

This brochure presents the approach and major outcomes from these regional forest inventories. It demonstrates the usefulness of the methodology of National Forest Inventories. Further, Ukrainian inventory specialists have now gained experiences on how to implement a NFI and are able to carry out a forest inventory for the whole country.

A new powerful impetus for the development of a National Forest Inventory was given by the Decree of the President of Ukraine No. 381/2017 “On Additional Measures for the Development of Forestry, Rational Use of Nature and Preservation of Natural Reserve Funds” issued on November 21, 2017. The President ordered the Cabinet of Ministers of Ukraine “to ensure a national inventory of the forest fund of Ukraine taking into account best international practice”. To execute the President’s Decree the State Forest Resource Agency approved a Plan of Measures in 2018 for Preparation of a National Forest Inventory.

FORESTS:

Represent a less influenced ecosystem, when comparing them to urban and agriculture land use

Are the base for recreation of people and biodiversity of flora and fauna

Absorb CO₂ from the atmosphere and thus have a positive impact on climate change

Provide the resource for forestry, timber industry and wood exports

Offer jobs and incomes for thousands of families in rural areas



Forest ecosystem - what is it in reality?



Photo: Oleg Malov

Once visiting the forest, we all seem to understand what a forest is.

The Forest Code of Ukraine defines “forest” as a type of natural complex (ecosystem), which combines mainly woody and shrub vegetation with appropriate soils, herbal vegetation, animal world, microorganisms and other natural components that are interconnected in their development affecting each other and the environment.

Forest areas may be covered with forest vegetation, and

also permanently or temporarily not covered by forest vegetation, due to the heterogeneity of forest natural systems, protection measures, planting, harvesting or natural disturbances, etc.

For the Ukrainian NFI it is proposed to use a comprehensive definition of forest as a land parcel with an area of not less than 0.1 ha and more than 20 m wide, which is covered with woody and shrub vegetation, with crowns covering not less than 30% of the area of the parcel, and height at maturity of at least 5 m.

NFI - the statistical view on forests

Generally, there are two major data sources on forests in Ukraine.

Forest management is traditionally based on data, provided by forest planning over a 10 years period. This approach is focused mainly on the commercial use of forest and related supporting (e.g. protection and regeneration) measures. The so-called forest planning data is collected from all forest stands in a given enterprise, thus data gathering by this means is a quite expensive process. Further, data for a particular enterprise is assembled during the given year of implementation of the forest planning project. Combining data of all enterprises into a country data set will provide limited results, as the data stems from various years with a time lag of at least 10 years. Due to the lack of data on the accuracy of estimates for individual forest stands, the boundaries of errors for consolidated forest information data cannot be established.

In comparison to this, the NFI is designed to obtain information on all forests of Ukraine as a whole, based on a small number

of sample plots, presenting inventory sites. These plots are distributed over the territory in regular squares. Thus, NFI is more efficient and provides data simultaneously for the whole country at one time. NFI's are a relatively inexpensive way to obtain reliable estimates for the whole country, regions or natural areas. Each analyzed parameter is linked to a confidence interval.

The accuracy of estimates of analyzed characteristics depends on the accepted pattern of probability sampling. Therefore, the estimations of national inventory are carried out with given boundaries of accuracy. The sampling of plots is designed so that the statistical error of the estimation of the total growing stock for all forests will not exceed 3%. With each new inventory, the accuracy of data in the statistical and forestry terms will increase significantly.

In the following graphs distribution of plots in forest area is given for the two oblasts where regional forest inventory was implemented earlier.

Forest cover of Sumy oblast – 17.8%



Forest cover of Ivano-Frankivsk oblast – 41.0%



NFI – first steps in Ukraine

The technological process of forest inventory that were carried out in Sumy and Ivano-Frankivsk oblasts included three stages:

- I. Preparatory work, including e.g. identification of characteristics to be gathered, classification of remote sensing data with the subsequent assignment of inventory plots to forest, non-forest and indicative plots.
- II. Field work, which involves identification of forest plots in the territory, collecting data of defined characteristics, recovering sample plots during re-measurements. Field-Map software and equipment developed by Institute of Forest Ecosystems Research (IFER, Czech Republic) were used for the data gathering process in the forests.
- III. Analytical work, during which the compilation and statistical processing of field data and the elaboration of reports are performed. The obtained parameters are statistically generalized. Summary results are averaged over a five year period. Results are to be published.

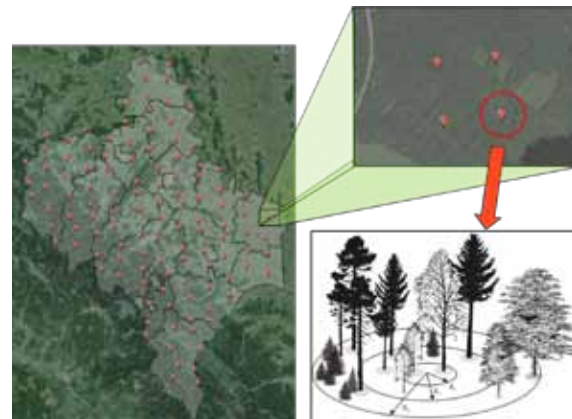
In the period of 2008-2013 forest inventories in Sumy and Ivano-Frankivsk oblasts was carried out based on international experiences in NFI: Groups of four circular sampling plots (tracts) have been distributed over the whole area in systematic order, but randomly located in the internals of the squares with a side length of 4950 km. More than 120 characteristics have been measured and described during each forest inventory

cycle on every forest plot. Re-measurement on the forest plots was implemented during 2014-2015.

Analyzed characteristics range from measurements of tree stem diameters and heights to the estimation of stand's disturbances and biodiversity indexes - in order to provide the informational base on the various questions, which might get to the agenda by forest policy decision makers.

During forest inventory in Sumy oblast 1 118 forest sampling plots were laid down and 1 106 in Ivano-Frankivsk oblast. Of these, re-measurement of 662 respectively 385 plots have been performed. In total, in the two regions more than 46 thous. trees have been measured.

Network and design of inventory plots for Ivano-Frankivsk oblast in 2009



Forest Area and Growing Stock

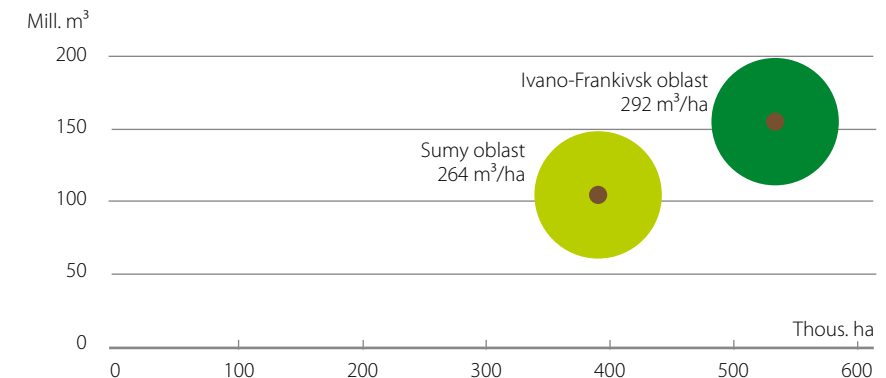
Major results of NFI are related to forest area and growing stock.

As to forest inventory results, forest area amounts to 405 thous. ha in Sumy oblast and to 531 thous. ha in Ivano-Frankivsk oblast. Standing volume sum up to 107 Mill. m³ in Sumy oblast and to 155 Mill. m³ in Ivano-Frankivsk

oblast. These parameters are statistically consistent with the indicators of state forest cadaster of 2011.

The following graph provides the outcomes of forest inventory in Sumy and Ivano-Frankivsk oblasts. Remarkable are the differences in average growing stock: 292 m³/ha in Ivano-Frankivsk and 264 m³/ha in Sumy oblast.

Total area and growing stock of forests in Sumy and Ivano-Frankivsk oblasts



How many trees and what species are there in our forests?

It is important that the methodology of National Forest Inventory allows to consider forests not only as a set of stands, but, above all, as a set of individual trees. Only NFI allows to find out how many trees grow in our forests, taking into account the set limit of error. At the same time, NFI allows to perform estimations of forest stands characteristics.

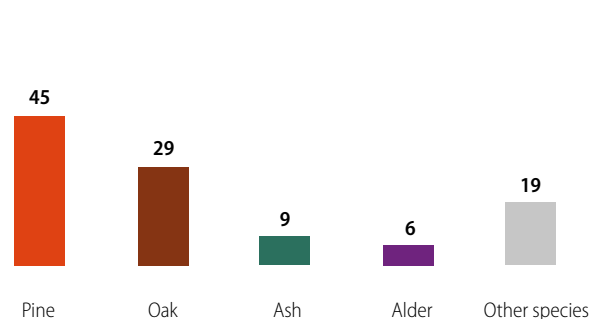
According to regional forest inventories in Sumy oblast, there are about 174 Mill. trees, in the forests of Ivano-Frankivsk oblast there are 255 Mill. trees. This is a truly impressive number of living trees.

There is a considerable variety of tree species in each of the oblasts covered by the regional inventories.

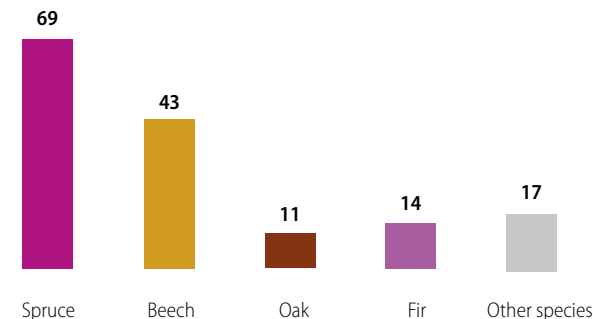
As expected, in the Forest-steppe and Polissya in Sumy oblast, tree species are predominantly represented by pine (*Pinus sylvestris*) – 53 Mill. trees, and oak (*Quercus robur*) – 26 Mill. trees. In addition, there is a number of tree species such as ash, birch, lime, maple, alder, and aspen as forest stands.

Tree species in the mountainous conditions of the Carpathians in Ivano-Frankivsk region are represented by European fir (spruce) (*Picea abies*) – 105 Mill. trees, and beech (*Fagus sylvatica*) – 50 Mill. In addition to fir and beech, in this region there are significant stocks of fir, oak, hornbeam, and birch stands.

Forest stand stock of Sumy oblast, Mill. m³



Forest stand stock of Ivano-Frankivsk oblast, Mill. m³

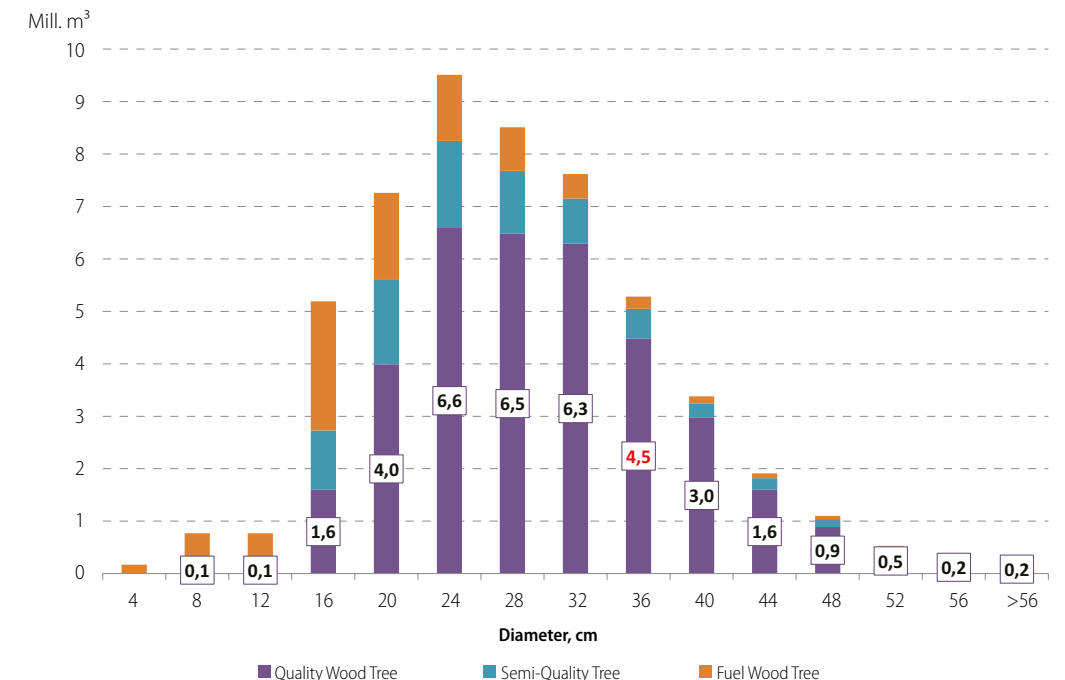


How much timber and what quality is out there?

Beside the tree species, commercial potential of timber is mainly described by diameter as well as quality standards. The National Forest Inventory provides answers not only to the question how much timber is out there in Ukrainian forests, but also in what quality. A National Forest Inventory can provide foresters, ecologists, woodworkers, officials and citizens with data on 'commodity valuation' of wood of the surveyed forest area.

The regional inventory carried out in Sumy oblast, for example, shows that 5.5 Mill. m³ are currently "at the diameter class of 36 cm", out of which 4.5 Mill. m³ is "high-quality wood". If one assumes an average price of 1500 UAH/m³, this would lead to an asset of approximately 8.2 Billion UAH, just for the single diameter class of forests of Sumy oblast.

Volume of pine trees by thickness classes in Sumy oblast

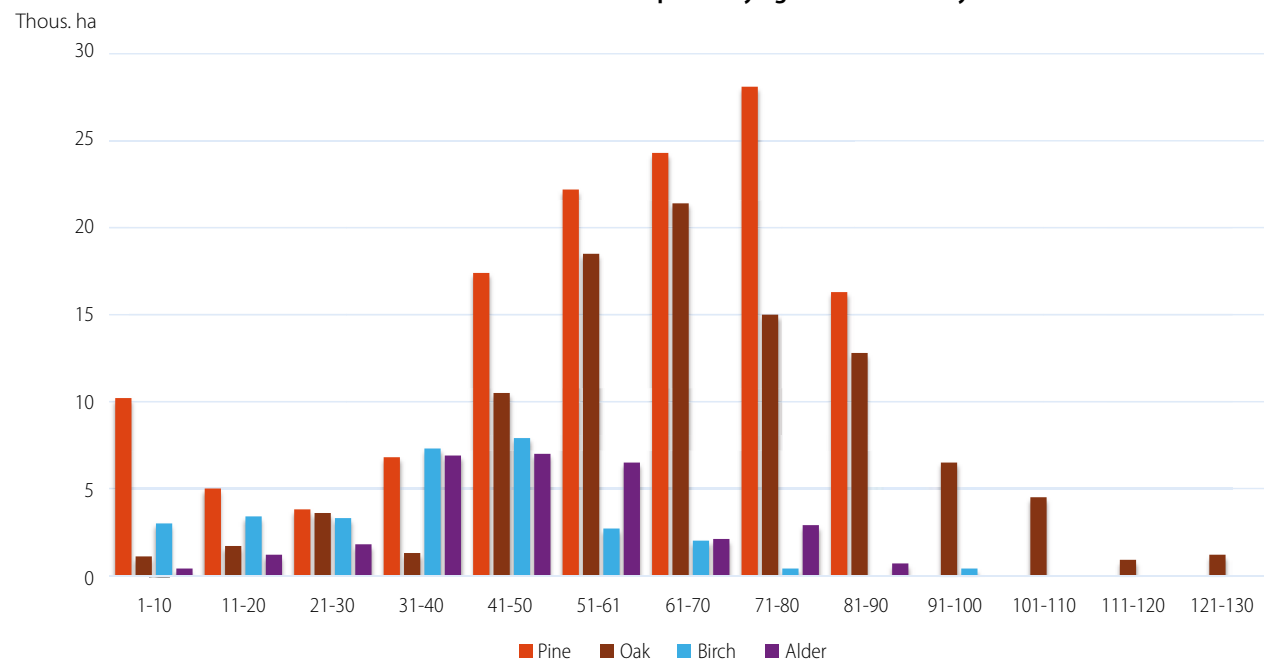


Should we be afraid of the age of trees?

The structure of managed forests by age is an important indicator for increment and harvesting potentials: middle-age stands can refer to higher increment, than older stands; only mature forest can be used for final felling. Moreover, felling is a prerequisite for regeneration. The age structure is a quite stable issue over the long term and is only to a certain extent a result of human influence over decades.

Distribution of forest stands over 10 years age classes in Sumy oblast indicates the predominance of middle-aged and under mature forest stands, which opens the potentials for future final felling. The outcomes from regional inventory also show, that over recent three decades final felling of pine have gradually increased from 4 thous. ha to 10 thous. ha.

The area of stands of main tree species by age classes in Sumy oblast



Natural succession – there are more forests than expected

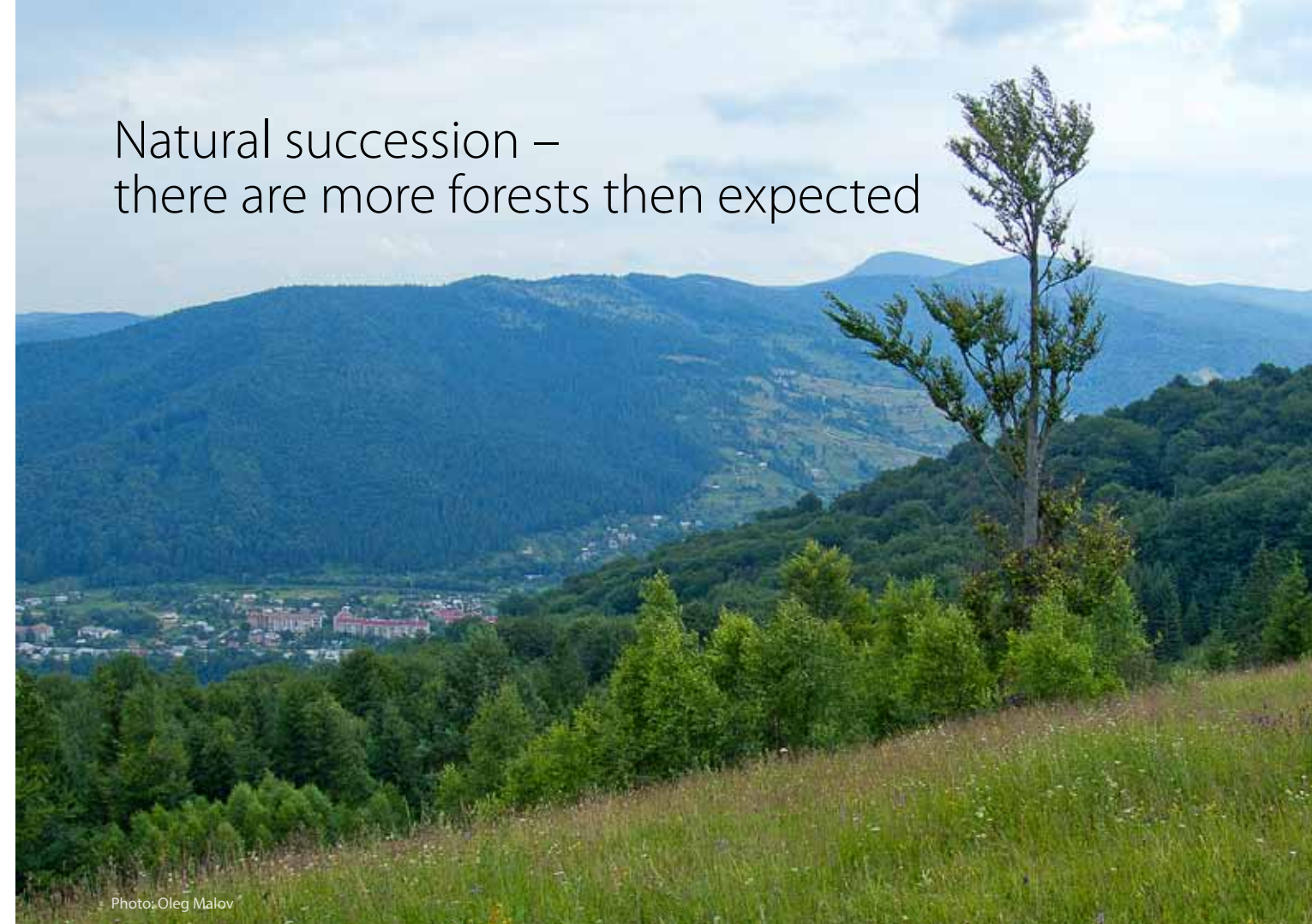


Photo: Oleg Malov

During recent decades, natural succession of forests into abandoned agricultural land can be observed across huge areas. This occurs mainly in Polissia and in the Carpathians, with favorable climatic conditions. These land plots remain beyond the attention of legal counting of forests, based on the forest code, although these areas are forests by definition of NFI.

Regional inventories in Sumy and Ivano-Frankivsk oblasts provide estimates of such areas on a level of 17 thous. ha respectively 33 thous. ha. Such an extent of natural succession proves that a more proper regulation of their legal status is of national importance.

Cornerstone of forestry research

NFIs data are of special scientific interest as well as the basis for thorough scientific research. The longer the period of systematic inspections on permanent inventory plots, the higher is the value of the data obtained. At the same time, due to scientific research, modern methods of national inventory are provided with well-grounded methods of measuring and statistical processing of results.

Knowledge and forecasting of the growth of forest stands is the basis for long-term planning of forest management. Currently, in Ukraine, there are practically

no permanent research sites, in which observations would be conducted during the life of the forest stands from planting until the age of final felling. Instead, all growth tables are constructed by means of regression analysis of data collected on temporary sites.

With national inventory of forests, the number of inventory plots is sufficient to compile regional forest growth tables using traditional simulation methods. In the long run, data from a national inventory will allow building growth curves for tree stands, using time series of data and functional analysis methods.

Average parameters of growth of pine stands in Sumy Oblast

Age Classes	Diameter, cm	Height, m	Site index	Density	Volume*, m ³ /ha
1 - 10	7	4	Ia.8	0,79	4
11 - 20	12	8	Ia.3	0,65	57
21 - 30	18	14	Ia.1	0,59	269
31 - 40	23	18,5	Ia.1	0,81	332
41 - 50	25	21,5	Ia.4	0,72	401
51 - 60	29	24	Ia.2	0,74	415
61 - 70	31	26	Ia.3	0,86	448
71 - 80	34	27	Ia.5	0,77	530
81 - 90	36	28,5	Ia.6	0,81	564
91 - 100	38	31	Ia.9	0,91	510

*recalculated at density 1.0

Standing dead trees - between sanitary measures and biodiversity needs

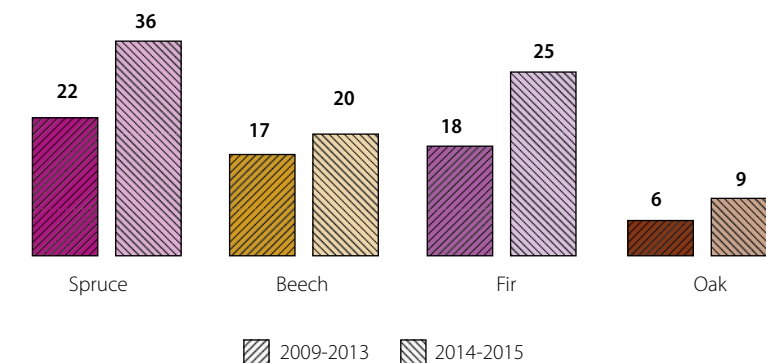
Modern scientific research indicates that it is advisable to maintain a certain amount of standing dead trees in forests in order to maintain biodiversity. At the same time, excessive amounts of deadwood trees might be caused by climate factors, pollution, damage by pests and diseases, late sanitary felling and thus lead to an undesired intensification of natural mortality.

In forests of Ivano-Frankivsk oblast, in addition to the total standing volume of living trees at 155 Mill. m³, the regional inventory data for 2009-2013 showed a significant volume of standing deadwood trees - 8.4 Mill. m³, including spruce of almost 5 Mill. m³. The re-inventory of 2014-2015 estimated the total dead wood of all species at an amount

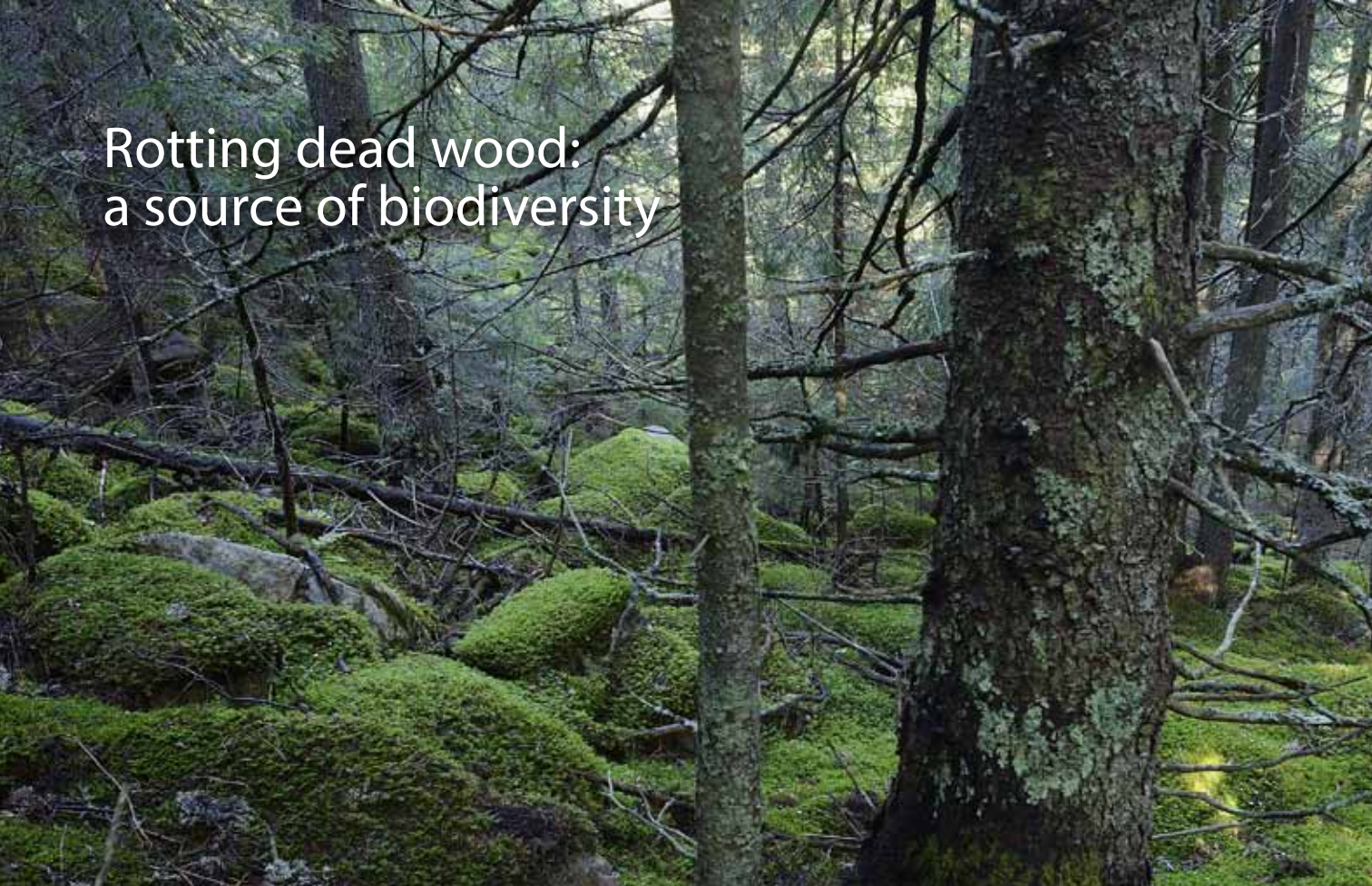
of 11.8 Mill. m³, including 7.3 Mill. m³ of spruce trees. Thus, the inventories objectively confirmed the progressive accumulation of standing dead trees in forest stands of the analyzed region. Today, according to estimates, approximately every twentieth tree in the forests of Ivano-Frankivsk oblast is dead.

An increase in the volume of standing deadwood trees occurred for all the prevailing forest types in both plain and mountain forests. According to estimates of the first inventory, the average forest stand in Ivano-Frankivsk oblast contains about 16 m³/ha of deadwood trees, and according to repeated measurements - 23 m³/ha. Similarly, for the forests of the Sumy region, - 12 m³/ha and 15 m³/ha.

Average volume of standing dead trees in stands of main tree species of Ivano-Frankivsk oblast, m³/ha



Rotting dead wood: a source of biodiversity



Dead wood is a part of the natural chain in the forest ecosystem. Many species of fauna and flora, including rare ones, benefit from this. Mushrooms, mosses, insects and birds are settled on and fed by the presence of wood residues. Dead wood is an important factor in biodiversity. Forests that do not contain wood residues are more like a commercial forest stand, than an ecosystem.

Due to the implementation of corresponding methodology during gathering of characteristics at

inventory sites, it was possible to get estimates of reserves of dead wood.

Total reserves of dead and down wood in Sumy region amount up to 785 thous. m³ and in Ivano-Frankivsk – to 1991 thous. m³, including wood without signs of deterioration – 150 thous. m³ respectively 226 thous. m³. According to very conservative estimates, Sumy oblast stands contains 2 m³/ha of dead and down timber on average; whereas in Ivano-Frankivsk oblast the similar figure counts for 4 m³/ha.

For the first time in Ukraine: the annual increment and natural losses of forests can be measured

A unique characteristic of NFI methodology is periodic re-measurement of forest plots, which provides reliable information on changes in the forests, e.g. on increment and natural losses of stands.

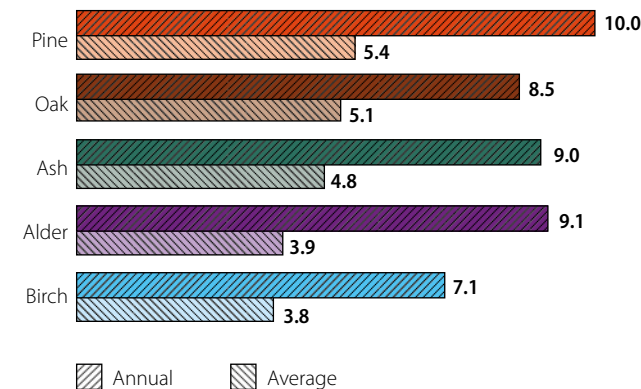
In 2013-2015 – with a time lag of five years - for the first time in Ukraine, a similar large-scale inventory was carried out as a re-measurement of a part of the sample plots in order to analyze the increment of trees in forest stands located within the two administrative areas.

As a result, of the forest inventory of Sumy region, the net annual increment (average annual change of volume of wood over the five years reference period, less natural

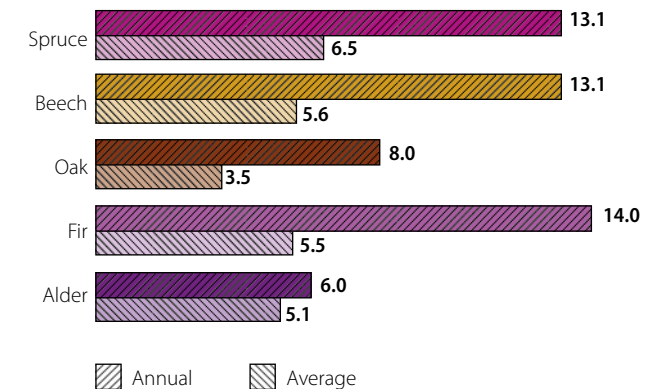
losses) of pine stands was estimated to 10.0 m³/ha per year. At the same time, the mean increment (average annual change of volume of wood over the stand age) of pine stands in Sumy amount to 5.4 m³/ha per year. Estimation of the annual increment of oak stands sums up to 8.5 m³/ha per year, ash stands – 9.0 m³/ha per year, birch stands – 7.1 m³/ha per year.

Similarly, the annual increment of forest stands of the main species in Ivano-Frankivsk region significantly exceeds the mean increment. The inventory identified the following values of the annual increment of stands: spruce – 13.1 m³/ha per year, fir – 14.0 m³/ha per year, beech – 13.1 m³/ha per year, oak – 8.0 m³/ha per year.

Increment of stands of main tree species
in Sumy Oblast, m³/ha per year



Increment of stands of main tree species
in Ivano-Frankivsk Oblast, m³/ha per year



Formula of forest balance

Estimates of annual increment and mortality of trees in forest stands, obtained by the regional inventories, substantially change the view on the course of natural growth and the nature of the use of forest resources of the regions.

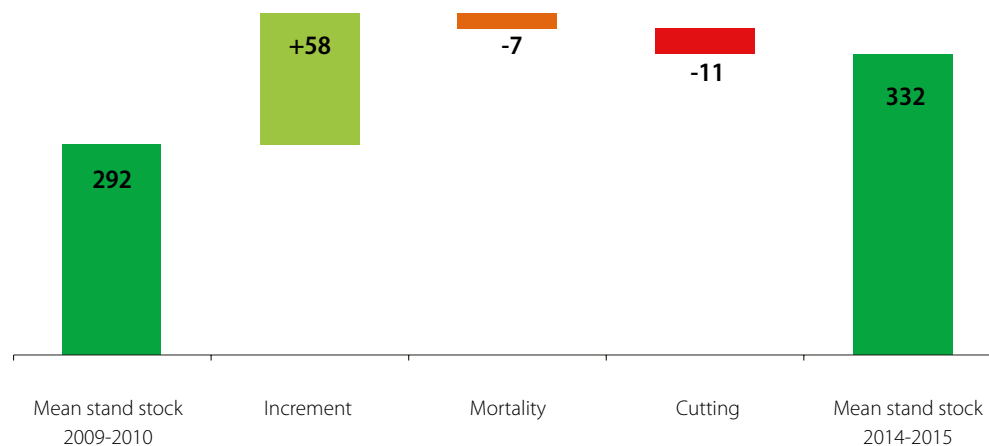
Based on these parameters a balance formula was calculated and the intensity of the forest use in both oblasts was estimated, as this is usually done in forest statistics of other European countries.

According to the inventory data, forest stands of Ivano-Frankivsk oblast increased annually by 5.93 Mill. m³ of

wood, with natural mortality of 0.73 Mill. m³ and felling of 1.11 Mill. m³. Consequently, the average stocks in forest stands increased by 4.09 Mill. m³. The intensity of wood use, defined as according to methodology in forest statistics of European countries - as the ratio of felling to an annual increment – amounts to 19%.

In 2017, the information on forest balance indicators was provided by Ivano-Frankivsk Oblast Department of Forestry and Hunting for a session of Ivano-Frankivsk District Council to prepare a decision “On the state of forest resources use in the region”.

The changes of forest stand stock in Ivano-Frankivsk oblast - from 2009-2010 to 2014-2015, m³/ha per 5 years



From national to international forest statistics

Ukraine follows a number of international processes on forestland and its use and is obliged to provide reliable information on Ukraine forests to international statistics. National Forest Inventory can improve quality and accuracy of such data and information. Some of them can be generated only on the base of a National Forest Inventory.

Global Forest Resources Assessments carried out by FAO, the Ministerial Conference on Protection of Forests in Europe (MCPFE), the United Nations Framework Convention on Climate Change as well as the Kyoto

Protocol require information, e.g. on natural forests succession, net annual increment, above ground biomass, forest litter and dead wood, which can be derived only from national monitoring system as NFI represents.

Also, national inventories will provide data to annual forest monitoring reports at the national and international levels (International Co-operative Program on Assessment and Monitoring of Air Pollution Effects on Forests – UN-ECE ICP Forests).

Monitoring of Ukrainian greenhouse gases will benefit from National Forest Inventory

The Ukrainian national inventory of anthropogenic emissions sources and removal by sinks shows that the only category, in which greenhouse gas emissions are absorbed is the land use category “Forest lands”. For the period since 1990 there is a fairly stable level of absorption of greenhouse gases by Ukrainian forests indicated – at a level of 58.1 - 68.1 Mill. tons of CO₂ equivalent per year.

Taking into account that the National Forest Inventory allows to determine the annual increment in forest stands, on the basis of these empirical data, it is advisable to update the national coefficients of biomass increment, which are crucial for assessing changes in carbon sequestration by forest stands.

The regional inventories carried out in Sumy and Ivano-Frankivsk oblasts have shown rather high increment. Therefore, new calculations might lead to increase of the total level of greenhouse gas absorption forests, reported by Ukraine to the United Nations Framework Convention on Climate Change.

What can NFI be used for and how much does it cost?

National Forest Inventory provides many data e.g. on forest area, volume of forest stands, increment, felling and mortality, volume and number of trees, growth, indicators of biodiversity and sanitary condition of stands, forest regeneration, data on forest types and many others. The potential of reporting tables is determined just by the needs of the consumer of information due to the use of modern databases and means of data representation. It is planned that the Ukrainian NFI will annually provide refined data, and after the end of the five-year data collection cycle, official summary results will be presented.

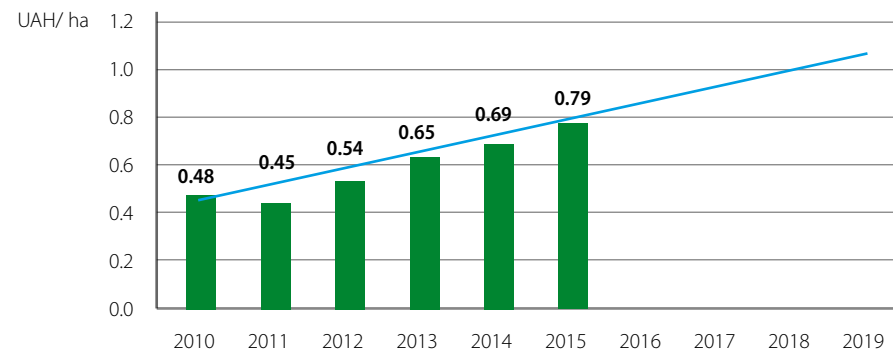
NFI data can be compared with other statistical data by extent and structures. Conclusions could be drawn about methods and accuracy of statistical data on cuttings and regeneration measures. Further, NFI data can be used for modelling development of forests under various

assumption of policy scenarios on planned wood cuttings and regeneration measures.

The value of NFI data will increase significantly with any additional inventory cycle. Due to the periodic evaluation and processing of accumulated information, experts will be able to develop more and more reliable models of forest growth and general development.

In comparison to other approaches for getting a reasonable understanding about extent and quality of forest ecosystems National Forest Inventory is a quite inexpensive venture. Based on experiences during the inventories for Sumy and Ivano-Frankivsk oblasts, the costs per hectare of forest have been less than 1 UAH/ha and are expected to get close to 1 UAH for planned inventory work during the coming years.

Forest Inventory Costs per year



Crucial: Transparent access to National Forest Inventory data

National Forest Inventory is a public asset by itself. It is paid via the state budget by Ukrainian taxpayers. Thus, results are expected to be accessible not only to state authorities, Ministries and specialized state agencies, as State Forest Agency, but also for the broader public, including organizations of civil society.

Periodic brochures - as the current one - as well as a special web site will provide all aspects of NFI in a

comprehensive way, by structure tables, graphs and maps. While access to detailed, original data is expected to be restricted to state authorities, it might be made accessible for scientific and commercial purposes, but on a case-to-case decision, taking legal constraints, e.g. on data protection, into account. The commercial use of NFI data, e.g. for long-term planning of investments by timber exporters or wood processing industry, should require a fee.



National Forest Inventory in Ukraine: Steps ahead

Since mid 2017 the German-Ukrainian Agripolicy Dialogue (APD) provides support to Ukrainian experts and policy decision makers with capacity building, related to the preparation of a NFI in Ukraine.

Since editing of the current brochure, (end August 2018) important steps for the introduction of a comprehensive NFI have been implemented:

- Methodological basis “Instrukzija” including description of characteristics to be collected and required hard and software elaborated,
- Corresponding draft law with the definition on the right to access forests for NFI purposes is registered at the Verkhovna Rada,

- Budget request for implementation of NFI as from 2019 is submitted to relevant state institutions,
- NFI website has been drafted and filled with data from preliminary forest inventory in the two mentioned oblasts.

These activities are expected to be finalized by end 2018, so that pilot inventory field teams can start working from beginning of 2019.

Also, the issue of deviation of forest area data structured by the various users from corresponding data state cadaster of Ukraine should be explored entirely in close collaboration with the responsible state institutions before starting implementation of NFI.



National Forest Inventory

How forest policy contributes
to public acceptance of forest use