

Proceedings International scientific and practical  
conference “Addressing Ecological and Social  
Challenges for Forests and Forest Management”  
Kyiv, October 22-24, 2018  
Book of Abstracts



## **Book of Abstracts**

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## РЕЗОЛЮЦІЯ

міжнародної науково-практичної конференції «Екологічні та соціальні виклики лісам і лісовому менеджменту та їх подолання»

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Міжнародна науково-практична конференція «Екологічні та соціальні виклики лісам і лісовому менеджменту та їх подолання», що відбулася у м. Києві, організована Національним університетом біоресурсів і природокористування України, Національним представництвом FSC в Україні, Державним агентством лісових ресурсів України, Національним лісотехнічним університетом України, Товариством лісівників України за підтримки Німецько-українського агрополітичного діалогу, була присвячена актуальним питанням функціонування та розвитку лісової галузі України.

Конференція передбачала проведення 1 пленарного, 2 секційних та заключного засідання. Було представлено 26 усних доповідей, присвячених оцінці стану лісів і лісового господарства, інституційним та економічним механізмам трансформації лісового господарства до адаптаційного лісового менеджменту.

У роботі взяли участь провідні вчені науково-дослідних інститутів і вищих навчальних закладів лісівничого профілю з Австрії, Білорусі, Італії, Китаю, Німеччини, Румунії, України, керівники і провідні спеціалісти лісової галузі, представники неурядових організацій, лісгосподарських підприємств, аудиторських компаній та помічники Народних депутатів України.

Учасники конференції відзначали, що зміни клімату спричиняють глобальні виклики лісам і лісовому господарству. Вони проявляються у виникненні катастрофічних природних явищ, зокрема, зростанні кількості великих неконтрольованих лісових пожеж, зменшенні біологічної стійкості лісів і як наслідок масової загибелі лісових насаджень. В країнах перехідної економіки, зокрема Україні, ситуація ускладнюється тривалим процесом трансформації на фоні загострення соціально-економічних проблем.

Відсутність політичної волі та державницьких підходів у здійсненні реформ, низький рівень правозастосування, нерозвиненість соціальних інститутів суспільства, деградація культури багатостороннього діалогу посилюють недооцінку політичної ролі лісів і лісового господарства в суспільному розвитку та економічному зростанні. Відсутність Національної Лісової Політики та Стратегії як підґрунтя комплексної програми підтримки лісоресурсного і екосистемного потенціалу лісів країни в системі наука-освіта-інновації-виробництво й надалі призводитиме до наростання усього комплексу проблем.

Ліси України відрізняються підвищеною уразливістю до природного і антропогенного впливу внаслідок того, що половина лісових насаджень є штучно створеними, а практика відтворення і формування лісів сприяла утворенню монодомінантних насаджень зі спрощеною просторовою, видовою та

ценотичною структурою. Організація лісового господарства на основі класів віку та постійне зростання частки лісів із обмеженим режимом лісокористування визначили тенденцію до старіння лісів.

Процес реформування у лісовому господарстві носить не системний, а часто дискримінаційний характер, який призводить, з однієї сторони, до посилення фіскального тиску на підприємства, позбавляючи можливості розширеного відтворення лісоресурсного потенціалу, а з іншої, - запровадження додаткових законодавчих обмежень господарської діяльності і штучних бар'єрів у ліквідації природних стихійних явищ, проведення заходів поліпшення санітарного стану тощо.

Наростання протилежних запитів одночасного збільшення продукування корисних властивостей і зростання виробництва деревини в умовах відсутності суспільного консенсусу щодо ролі і значення лісів та документів щодо стратегічного розвитку лісової галузі унеможливають використання загальноприйнятих та апробованих у розвинутих країнах моделей лісового менеджменту.

Важливу роль у досягненні балансу конфліктних інтересів відіграє лісова сертифікація за міжнародною схемою Лісової Опікунської Ради (FSC).

Відповідь на сучасні виклики у лісовому господарстві має здійснюватися шляхом трансформації інтегрованого лісового менеджменту на основі адаптаційного підходу. Необхідними вбачаються такі кроки:

- формування широкого національного діалогу щодо ролі та значення лісів з метою пошуку суспільного консенсусу шляхом розробки і затвердження Національної лісової політики України та Національної стратегії розвитку лісового господарства;
- внесення змін до законодавства щодо скасування дискримінаційного податкового навантаження (Закон України від 10.07.2018 №2497-VIII «Про внесення змін до Податкового кодексу України та деяких законів України щодо стимулювання утворення та діяльності сімейних фермерських господарств»);
- внесення змін до законодавства, яке необґрунтовано накладає екологічні обмеження діяльності лісогосподарських підприємств та перешкоджає зменшенню наслідків поширенню всихання лісів, зокрема: Санітарні правила в лісах України (від 26.10.2016 № 756 КМУ), Правила поліпшення якісного складу лісів (від 12.05.2007 № 724 КМУ), Закон України "Про оцінку впливу на довкілля" (від 23.05.2017 № 2059-VIII), Закон України «Про тваринний світ» від 13.12.2001 № 2894-III (із змінами) ст.39, Про врегулювання питань щодо спеціального використання лісових ресурсів (від 23.05.2007 № 761 КМУ) та ін.;
- розробка ризик-стійких стратегій розвитку лісового господарства, в т.ч. з урахуванням змін клімату;

- удосконалення системи моніторингу та запровадження національної інвентаризації лісів, зокрема, з метою отримання достовірної інформації про лісові ресурси, прогнозу та попередження розвитку осередків шкідників і хвороб;
- широке впровадження у практику лісового господарства технологій еколого-орієнтованого відтворення лісів та наближеного до природи лісівництва з метою підвищення біологічної стійкості лісових насаджень;
- впровадження у державний класифікатор професій України професії «лісовий пожежний» та «керівник гасіння лісових пожеж», а також розробка системи кваліфікаційних вимог та створення національного центру підготовки лісових пожежних та керівників гасіння великих пожеж з метою зниження ризиків для здоров'я лісового персоналу, населення, сільської та іншої інфраструктури під час гасіння великих пожеж.

Інституційними та економічними механізмами реалізації поставлених завдань є:

- посилення міжнародного співробітництва щодо обміну досвідом і проведення спільних наукових проектів і досліджень з метою покращення наукового забезпечення переходу до сталого управління лісами;
- налагодження систем трансформації новітніх знань і інновацій в систему прийняття управлінських рішень на національному, регіональному і локальному рівнях;
- створення мережі дослідних об'єктів і господарств адаптивного ведення лісового господарства;
- популяризація ідеології сталого ведення лісового господарства та відповідального споживання лісових продуктів, в т.ч. через лісову сертифікацію за схемою FSC;
- впровадження FSC національного стандарту системи ведення лісового господарства в Україні;
- диверсифікація напрямів сертифікації та посилення економічної життєздатності підприємств галузі за рахунок сертифікації більшої кількості груп продукції з деревини, недеревинних продуктів лісу і екосистемних послуг;
- посилення роботи з громадськими організаціями та місцевими громадами через донесення як проблемних питань в лісовій галузі, так і шляхів їх вирішення та формування механізмів громадського контролю.

Вважати за доцільне направити резолюцію до Верховної Ради України, Президенту України, Кабінету Міністрів України, міжнародним організаціям і установам, центральним органам виконавчої влади, органам місцевого самоврядування.

*Оргкомітет*

## RESOLUTION

of International scientific and practical conference  
«Addressing ecological and social challenges for forests and forest management»

October 23, 2018, Kyiv

International scientific and practical conference «Addressing ecological and social challenges for forests and forest management» has taken place in Kyiv, Ukraine. It has been organized by National University of Life and Environmental Sciences of Ukraine, FSC Ukraine National Representative, State Agency of Forest Resources of Ukraine, Ukrainian National Forestry University, Ukrainian Forestry Society under assistance of German-Ukrainian Agropolitical Dialogue. The conference was devoted to hot issues of functioning and development of Ukraine's forestry branch.

The conference provided for holding 1 plenary, 2 technical and closing sessions. 26 oral reports have been presented on assessing state of forests and forestry, institutional and economic mechanisms of forestry transformation to adaptive forest management.

Leading scientists of research institutes and higher educational institutions of forestry profile from Austria, Belarus, Italy, China, Germany, Romania, Ukraine, heads and leading specialists of forest sector, representatives of non-governmental organizations, forestry enterprises, certification bodies and assistants of Verkhovna Rada Members of Ukraine have taken part in the conference.

The conference participants have noted that climate change is causing global challenges for forests and forestry. They are manifested in occurrence of catastrophic natural phenomena, in particular increase of large uncontrolled forest fires, worsening biological stability of forests and as a consequence – large-scale dieback of forest stands. In transition economy countries, particularly in Ukraine, the situation is complicated by lengthy process of transformation and aggravation of socio-economic problems.

Lack of political will and statecraft approaches to reforms, low law enforcement, undeveloped social institutions, and degradation of culture of multilateral dialogue increase underestimation of political role of forests and forestry in social development and economic growth. Lack of National Forest Policy and Strategy that is a basis for a comprehensive program on support of forest resources and ecosystem potential of the country's forests in the system of science-education-innovation-production, will further exacerbate the whole range of problems.

Forests of Ukraine are characterized by increased vulnerability to natural and anthropogenic impacts due to the fact that a half of forest stands have been artificially planted, and practice of reforestation and tending contributed to formation of monocultures with a simplified spatial, species and coenotic structure. Organization of

forest management planning on basis of age classes and continuous increase in proportion of forests with limited use regime has determined the trend towards aging of forests.

The reform process in forestry sector is not systematic, but often discriminatory. This leads, on one hand, to increase of fiscal pressure on enterprises, eliminates possibilities for extended reproduction of forest resource potential, and, on the other hand, to introduction of additional legislative restrictions on economic activity and artificial barriers in eliminating consequences of extreme natural phenomena, implementation of measures to improve forests' sanitary condition etc.

Increasing controversial demands for simultaneous increase in securing useful properties and wood production under absence of public consensus on forests' role and importance and documents on strategic development of forestry sector make it impossible to use forest management models that are commonly accepted and tested in developed countries.

Voluntary forest certification in accordance with international scheme of FSC plays an important role in balancing the conflicting interests.

Reacting to the current challenges in forestry sector shall be done through transformation of integrated forest management based on adaptive approach. The following steps are deemed necessary:

- to organize a nation-wide dialogue on role and importance of forests aimed at finding societal consensus by development and approval of a law on National Forest Policy and National Strategy for Development of Forestry;
- to adopt amendments to the legislation to cancel discriminatory fiscal load (Law of Ukraine adopted 10/07/2018 No 2497-VIII "On Amendments to the Tax Code of Ukraine and Certain Laws of Ukraine on Stimulation of Formation and Activity of Family Farms");
- to adopt amendments to the legislation which unreasonable enforce ecological limitations on forestry enterprises activities and prevent the reduction of consequences of forest dieback spread, in particular through: Sanitary Rules in the forests of Ukraine (adopted 07/26/2016 No 756 of the Cabinet Ministry of Ukraine (CMU), Rules for improving the quality of the forests (adopted 12/05/2007 No 724 of the CMU), the Law of Ukraine "On Environmental Impact Assessment" (dated 23/05/2017 No 2059-VIII), the Law of Ukraine "On the Fauna" adopted 13/12/2001 No 2894-III (as amended) Act 39, On Regulation of Issues Concerning the Special Use of Forest Resources (No 761 of the CMU adopted 23/05/2007) etc.;
- to develop risk-resilient strategies of forestry development, including those accounting for climate change;

- to improve forest monitoring system and to implement national forest inventory aiming at obtaining adequate information on forest resources, forecasting and preventing development of pests and diseases hotspots;
- to facilitate wide introduction of environment-oriented technologies for reforestation and close to nature forestry to forestry practice with the aim to enhance biological stability of forests;
- to add to the State classifier of professions of Ukraine professions of “forest firefighter” and “lead forest firefighter”, to develop a system of qualification requirements, and to create a national center for training of forest firefighters to mitigate health risks for forestry personnel, population, rural and other infrastructure at fighting major forest fires.

There are the following institutional and economic mechanisms for implementing the outlined tasks:

- strengthening international collaboration on experience exchange and holding joint scientific projects and research aimed at improving scientific support of transition to sustainable forest management;
- setting up systems for transforming the latest knowledge and innovations into managerial decision support system at national, regional and local levels;
- creating a network of experimental facilities and enterprises on adaptive forest management;
- popularization of sustainable forest management ideology and responsible consumption of forest products including means of forest certification under FSC scheme;
- implementation of the FSC National Forest Stewardship Standard in Ukraine;
- diversification of certification directions and strengthening economic viability of forest industry through certification of a larger number of product groups, non-timber forest products and ecosystem services;
- strengthening of collaboration with NGOs and local communities through reporting both problematic issues in forestry sector and ways of their resolving, formation of public control mechanisms.

It is deemed worthwhile submitting this Resolution to Verkhovna Rada of Ukraine, President of Ukraine, Cabinet of Ministers of Ukraine, international organizations and entities, central executive bodies and local government bodies.

Organizing committee



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## ASSESSMENT OF FORESTS AND FORESTRY

## Forest condition in Ukraine on the base of monitoring data

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**Keywords:** forest monitoring, Ukraine, UN-ECE ICP Forests, defoliation, damage.

The forest monitoring activity under the UN-ECE ICP Forests method is conducted in Ukraine since 1989. Defoliation is one of the Pan-European Indicators for Sustainable Forest Management, which indicates the forest condition and sustainability.

Condition of 33882 trees in 1414 monitoring plots in 24 regions of Ukraine was estimated at 2015 within the natural zones by the biotic damages and defoliation classes: none- defoliation 0-10%, slight- 11-25%, moderate- 26-60%, severe- 61-99% and dead- 100%. Defoliation below 25% is considered to be the norm within the limits of natural fluctuations, while above 25% indicates damage of trees.

In 2015, forest stands in Ukraine were mainly none and slightly defoliated (52.6% and 41.3%, respectively). Defoliation above 25% was at 6.1% of the plots. Biotic damage was registered at 19.2% of trees in third of the plots. Deciduous were more damaged than coniferous (27.5% and 8.2%, respectively). Coniferous trees mostly had crown dieback (3.2%), and insects' damage (1.4%), while deciduous were mainly damaged by insect pests (12.4%), and diseases (4.1%). The intensity of damage was low.

The best health condition was observed in Polissya and in the Forest-steppe, where nondefoliated stands predominate (63.6% and 52.2% respectively), the share of trees with defoliation > 25% was insignificant (3.3-3.5%). In Polissya the smallest number of biotic damage of trees (4.7% conifers and 13.6% deciduous) was registered.

The worst forest condition was in the Steppe, due to the permanent effect of water and temperature stress on the forests.

In the Carpathians, both a proportion of trees with defoliation > 25% (18.6% of spruce and 14.7% of beech forests), and with biotic damage (22.4% conifers and 50.3% deciduous trees) was relatively high, which proves the presence of forests deterioration in the region.

The condition of majority of forest stands in Ukraine in 2015 was satisfactory. The health condition of the deciduous was slightly worse than the conifers due to biotic damage. The best health condition of forests was in Polissya, while the worst was in the Carpathians and Steppe zones.

Recent deterioration of pine forests condition caused by bark beetle was registered in Polissya, but monitoring data is not available for the last 3 years due to the termination of the state program "Forests of Ukraine". So, it is important to resume the forest monitoring activities in Ukraine.

**Disturbances impact on ecosystem services in forest ecosystems of Ukrainian Polissya**

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**Key words:** carbon sequestration, oxygen productivity, energy, live biomass, dead biomass.

Ecological and social benefits of forests contributing to climate change mitigation, wildlife and human well-being are hitherto underestimated in Ukraine. Efforts directed to minimize known and appeared uncertainties in assessment of the most important forest ecosystem services for Ukrainian society, are focused on application of different earth observation techniques for strict and robust estimation. Satellite imagery of high spatial resolution coupled with ground-based inventory data allow to obtain reliable estimates on state and dynamics of forests, important biomass parameters and might be consistent base for ecosystem services modelling, including carbon sequestration, biomass and energy accumulation, oxygen productivity.

Experimental polygon that established in Snovsk district of Chernihiv region and has 45 km<sup>2</sup> area, represents typical for Ukrainian Polissya geographical conditions and tree species (*Pinus sylvestris* L., *Betula pendula* Roth, *Alnus glutinosa* (L.) Gaertn., *Populus tremula* L. and others) composition, thus being reliable base for respective case ecosystem services study. The processing of multispectral satellite images for two periods (RapidEye – for 2010 and Spot-6 – for 2015) using Random Forest method for land cover classification and *k*-Nearest Neighbors imputation – for biomass parameters modelling has shown to be effective to reflect ground-based forest inventory data for selected years. In total, forests within experimental polygon accumulated 114 Gg C in 2015. We examined how several natural disturbances (huge storm in 2013, wildfires in 2015, insect outbreaks) and clearcutting during 2010–2015 had affected ecosystem services in the study area. These disturbances caused 21% of total carbon emission into atmosphere, simultaneously removing 8 % of stored biomass energy and decreasing annual oxygen productivity of studied forests by 4%. Thus we concluded, that provision for ecosystem services for any object being assessed must be validated considering different disturbance factors, since the influence might be significant and further development of estimation methods are needed to get more reliable results.

## Amending the existing regulatory documents on forest management as the way to mitigate the consequences of forest pests spread

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**Key words:** pests, fires, clear-cuts, forest legislation.

Over the past 20 years, size, intensity, and frequency of forest disturbances have increased in many regions of the world, and particularly in Ukraine. *Predisposing* factors (climate change, anthropogenic loading) determine the stand susceptibility to *inciting* factors (drought, fire, windstorm), which provoke tree resistance decrease and promote forest pests survival, which are *contributing factors* and "accompany" forest decline (Manion, 1981).

Bark beetles complex with the dominance of *Ips acuminatus* (Gyllenhal, 1827: Curculionidae, Scolytinae) is the main visible cause of Scots pine mortality.

Our researches on bark beetles allowed developing "Methodical recommendations for the survey of forest stem pest foci" (2011), evaluating numerical score of injuriousness of stem pests in different natural zones, considering insect associations with blue-stain and wood decay fungi. An algorithm for prediction the risk of bark beetles spread was developed. It considers forest site conditions, stand characteristics and the change of land category of neighboring subcompartments. It helps to upgrade the accuracy of prediction, to evaluate the optimal area of survey and to plan control measures against insect pests.

"Provisional recommendations on priority measures in pine forests damaged by bark beetles" (2017) were developed and adopted but cannot be implemented without amending regulatory documents on forest management, particularly "Rules for improving the qualitative forest composition (2007) and "Sanitary rules in the forests of Ukraine" (2016) on the issues of limits for relative stocking density for clear sanitary felling and its area. Execution of statement on planned activities assessment in the forest sector of the Law of Ukraine "About environmental impact assessment" (2017) prevents in time removing the trees infested by bark beetles.

In connection with earlier vegetation beginning and bark beetles swarming it is necessary to establish the deadline of timber moving out from forest after winter felling to the earlier date (March 15) and point it in the Resolution of the Cabinet of Ministers "On regulation of issues related to the special use of forest resources" (2007). Timber from any type of summer felling in pine forest must be immediately removed or debarked or protected with insecticides. Wood debris must be also removed, protected with insecticides, chopped or placed in a way for rapid drying.



## Importance of trans-border cooperation for producing better scientific results

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**Keywords:** forest management, information support, field data, cooperation, exchange.

Forest management system in Ukraine is currently facing an increasing pressure from different societal groups, environmental movements and economic agents, all having diverging forestry-related interests. It also has to account for a wide variety of factors of a changing world to secure Ukraine's forests' ecosystem services for future generations. All these objectives are achievable only at a condition of having a vast and modern system of information support for assessing functions and services provided by forest ecosystems. Modern approaches to forest assessment employ up-to-date mathematical and statistical tools and are capable of better use of field data available. Nonetheless, availability and quality of primary field data is generally improved slower than modern research approaches are proposed and applied, thus often making regional and global research data-constrained.

A good example for the statement above is the undergoing research on developing a system of models of biomass expansion factors (BEFs) for main forest-forming tree species of Ukraine. The best available up-to-date methodology (Schepaschenko et al., 2018) has been proposed and approbated by foreign scientists in a comprehensive research covering a vast territory of Russian Federation. Although there is a considerable amount of field data accumulated in Ukraine (Lakyda et al., 2016; Lakyda et al., 2017), the result of modelling effort employing the methodology mentioned above is non-satisfactory for many species due to presence of high uncertainties mainly driven by lack of sufficient data. The most probable successful way out of this situation would be to expand Ukrainian dataset by complementing it with available data from other countries and regions (for example, Schepaschenko et al., 2017; Jagodzinski et al., 2017), while following distribution of empirical data by ecoregions and tree species. The most promising is inclusion of field data from Republic of Belarus and Poland, since they have been collected using similar technique and methodology. Such enhancement of the input dataset could reduce uncertainties in BEFs estimation as much as by 30 percent. All this underlines importance of a well-established scientific dialogue, cooperation and information exchange between Ukrainian institutions and their partners from the neighboring countries.

## On the issue of reason and preventing the phenomenon of mass drying trees and forest stands

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Under the conditions of global warming, the current significant deterioration of sanitary state of the country's forest ecosystems, caused by massive drying of trees, forest stands of pine and other forest species, grounds particular relevance of increasing the biological resilience of future forests along the whole process of their cultivation, since the moment of their creation. Should be noted, that artificial forest stands are drying mostly and mistakes that were made during their creation in most cases cannot be corrected over the next decades.

Forest scientists identify the circumstances that lead to the weakening of the forest stands during creation stage:

- ignoring seeding, as close to nature method of forest restoration for oak, pine, beech, spruce and other forest species;
- not always justified use of planting material with traumatized roots system (first of all it concerns *Quercus robur* L. and other tree species with tap-roots system) for the forest coenosis creation;
- untimely and poorly seedlings planting to a permanent place - not adhering to the required depth of planting and unnatural transformation of root system (roots flattening, bending etc.);
- use for reforestation and afforestation purpose out-zoned seeds or grown from it planting material (it was used for creation drying stands *Picea abies* (L.) Karst. in the part of the Carpathians, especially in Zakarpattia);
- not ensuring of the dominant role to the main species from the first stages of the forest coenosis development (low initial density in stands) or to natural regeneration and, as a result, the composition and structure of forest biogeocoenosis are not relevant to the indigenous forest stand (violation of the principle of adequacy - the unity of the forest and the environment) and a number of others.

In this context, taking into account global warming, special attention should be paid to the following measures to improve the biological stability of future forests at the stage of their restoration:

- an increase in the proportion of seed natural regeneration in the total volume of forests restoration, especially in areas with successful or satisfactory natural regeneration and high forestry potential;
- using seeds collected from natural forest stands that grow in more southern areas or drier forest types. Expediency of such measure is evidenced by the better growth and state of *Pinus sylvestris* L. southern climate types in the

ecological-geographic plantations on the territory of Separated Division of NULES of Ukraine "Boyarka Forest Research Station":

- during arid years;
- increase of the share of main forest species' in stands (especially *Quercus robur*), created by seeding, in the total volume of artificially restoration forests;
- reduction of the forest stands area established with planting material with an injured root system due to scientifically substantiated application of ball-rooted seedling;
- increase the share of recovered planting material with traumatized root system in the process of cultivation, in the total volume of establishing forest stands by seedlings with an bare root tree system.

Investigations of Staff Department of Forest Restoration and Meliorations on recovering of conifer species seedlings by their "hospitalization", the use of fertilizers and biologically active substances, indicate a remarkable effectiveness of the above measures to increase the biological resilience of future forest ecosystems to adverse factors. Wider implementation in practice of forests' restoration will significantly reduce the extent of drying trees and plantings of main forest species.

## Assessment of fuel load in Scotch pine stands of the Western Polissya region of Ukraine

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**Key words:** forest fuels, forest fires, Ukrainian Polissya.

Nowadays forest fuel (FF) assessment studies is becoming increasingly important in Ukraine due to increasing of fire hazard in forests. General characteristics of FF will contribute to the development of standard fuel models for long-term and operational forecasts of vegetation fires parameters.

FF classification has been made according to their distribution into groups by N.P. Kurbatsky. The FF load was determined by the mass method with selecting and weighing ground fuels from the plots during period of their mass stabilization (July-August). The research objects represented by healthy high-productive pine stands with mixture of birch and oak in the age between 9 and 135 years old.

The load of FF group 1, which includes litter and moss layer, is fairly stable in young, premature, mature and overmature Scots pine stands and varies within 7.70-7.93 tons per hectare. Load of FF group 2 increases with increasing of age by 2.1-2.3 times from 42.95 tons per hectare in young stands to 99.46 tons per hectare in mature and overmature stands. Share of FF of group II in mature and overmature stands higher compared with young ones by 7 %.

Assessment of moisture content of FF shows that increase of the class of fire weather hazard from I to V radically changed properties of fuel. The critically low moisture content for FF group II was during all classes of fire hazard in summer fire peak. The moisture content of 87 % of the litter mass has been dried to critical value already during the 2nd class of fire hazard, and mosses has been reached critical value already during the 3rd class.

Research results allow better understand the formation of fire risk in Scout pine stands and could be used to develop a new paradigm of the "integrated system fire management" which is a more flexible tool than the current paradigm of "forest protection from fires", because last one excludes positive role of fire in the forest ecosystems.

## Impact of climate change on coniferous forest in the steppe zone of Ukraine

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**Key words:** climate change, *Pinus sylvestris*, steppe zone.

Climate change and heavy impact of the global warming on biodiversity of forest phytocoenosis are expected primarily in the areas where already appear certain vegetation types of environmental constraints. Forest in the steppe zone of Ukraine which created mostly by artificially is a vivid example. Today, there are a few of the significant factors in reducing the levels of biodiversity - shrinking and fires, particularly observed in forests with a predominance of coniferous tree species, in particular species *Pinus sylvestris* L.

Main cause of the obligate periodic drying of artificial and natural stands in the steppe zone of Ukraine is the deterioration of the soil water regime by human activity and prolonged droughts. Changes in the water regime of soils are often accompanied by a negative change in the salt and redox conditions that exacerbate the condition of the main species. Negative side of the substantial part of created arrays in artificial forests in the steppe zone of Ukraine and part natural arrays as well, such as floodplains, can be interpreted as the absence of objective conditions for the existence of forests here, as evidenced by the low durability of the main species, their self-thinning, lack of obligate conditions of forest forming process.

Forest fires play a key role in the existence of forest phytocoenosis and serve as one of the most important engines of nature, which occur through successional processes. Forests in the steppe zone of Ukraine are among the most fire hazardous and the prevailing type of forest fires in this natural area is the grass roots fires. In particular, according to forest management of Dnipropetrovsk forestry, in plantations *P. sylvestris* number of forest fires in the last half century has increased by half, due to global climate change, as well as the intensification of anthropogenic impacts on forest plant communities. Due to fires, there are serious problems of the integrity of forest ecosystems and the interaction of its individual components.

Desiccation and fires lead to predestination change of tree species and species-ground cover which can better adapted to growing in these climate conditions.

In general, in the nearest future, humanity must decrease the rate of loss and degradation of natural habitats, which include forests with the constituent components of plant and animal communities, at least twice, and any impact should be minimized as much as possible.

## Black locust (*Robinia pseudoacacia* L.) above-ground biomass potential in short-rotation forestry within Steppe Zone of Ukraine

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**Keywords:** woody biomass, steppe forest, black locus stands.

The production of woody biomass as a renewable resource for bioenergy has become increasingly important in Ukraine during recent decades. However, the traditional use of woody biomass as firewood is changing to a versatile source for larger biomass power plants. In developing countries, as Ukraine, a severe wood shortage exists. Tree species within steppe sites should be evaluated to determine their potential to overcome this challenge.

Short-rotation forestry has great potential to contribute to such increased demands for growing woody biomass.

The purpose of this study was to establish baseline information characterizing Black locust stands as an energy feedstock and to provide empirical data on biomass yield data on steppe sites in the Ukraine.

Black locust (*Robinia pseudoacacia* L.) is one species that appears promising because it has many desirable wood quality and ecological characteristics: high energy content, adaptability to many limiting abiotic factors, rapid rate of growth. The rapid growth is what distinguished the Black locust from other woody plants in the study region. It has wide adaptability and high potential importance as a fuelwood.

The twenty samples plots established for the purposes of this study are located in artificial black locust forest plantation (49°10'N, 48°11'E) in the Steppe zone, Ukraine. Estimating a yield above-ground biomass were used regression models of dependence from tree biometric indices.

Black locust stands in study region occupy an area of 17683.7 ha, or 26.9% of the total area covered with forest vegetation with total wood stock  $2.6 \cdot 10^6 \text{ m}^3$ .

With age there was a significant increase in the values of components of biomass of the above-ground part per ha. The maximum biomass is fixed for trunk wood ( $81.46 \text{ t} \cdot \text{ha}^{-1}$ ). Investigated plantations generate up to  $1.8 \cdot 10^6 \text{ t}$  of aboveground biomass, which makes it possible to deposit up to  $0.9 \cdot 10^6 \text{ t}$  of Carbon. The energy potential of black locust plantations within Steppe of Ukraine is 32188.14 GJ.

We evaluated the biomass potential of *R. pseudoacacia* which showed a higher yield and a faster harvest time than other woody plant species in Steppe zone. Black locust stands are showing great potential as a biomass crop for Ukrainian Steppe zone energy production.

## Monitoring of condition of ash stands in western Podillya of Ukraine

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**Key words:** *Fraxinus excelsior* L., mico- and microorganisms, pathogen.

*Fraxinus excelsior* L. is an important forest tree which rather susceptible not only to different systematic and functional groups of mico- and microorganisms, but also to numerous types of harmful entomofauna.

Study objective was scientific analysis of specialized literature on symptomatology and etiology of common ash that develop under the influence of pathogenic mico- and microorganisms, such as pathogens of infectious diseases and pests, and their analytic generalization. Another goal was to investigate the primary factors of common ash pathology in Western Podillya. The study approach included the application of a variety of research methods, including specific forest pathology and phytopathology methods and surveys. Species diversity of mico- and microorganisms, and pests were classified according to indicators.

Almost all known groups of microorganisms that are pathogens of diseases, as well as algae and lichens, can be found on common ash. There is also a large variety of pests that are especially dangerous for weakened *F. excelsior* stands.

Identified all 10 species and 7 genus of *Fungi* which belong to anamorphic species (*Deuteromycota*), including identified only to the level of genus *Fusarium* sp., and *Phoma* sp. Established that *Ulocladium botrytis* Preuss is a typical dominant. The species of *Phoma* sp., *Cladosporium cladosporioides* (Fres.) De Vries, *Mycelia sterilia* (orange) are numerous species; other species of *Acremonium strictum* W. Gams., *Cylindrocarpon didymum* (Harting), *Fusarium sporotrichiella* Bilaivar. poae (Peck) Wollenw., *Fusarium heterosporum* Nees, *Fusarium* sp., and *Mycelia sterilia* (dark) are rare species as automikobiota of *F. excelsior*.

Our results demonstrate that the most common and dangerous ash disease is tuberculosis. Its causative agent – *Pseudomonas syringae* pv. *savastanoi*. Bacteria can infect trees of one-two years of age. Instead of smooth greenish bark, there are small elliptical soft tumors filled with grey sticky odorless bacterial mass. A crack is formed in the center of tuberculous formations that is eventually partially overgrown. As a result, individual perennial lesions are formed, resembling scab.

We were able to isolate multiple bacteria from affected leaves, inflorescences, branches and trunks of *F. excelsior*. In particular, *P. syringae* pv. *savastanoi* and *Xanthomonas* sp. were isolated from infected generative organs. The artificial infection with isolates proved them to be pathogenic to ash seeds and branches, and non-pathogenic to ash leaves.

There are a variety of other pathogens and pests that considerably slow ash growth, development and reduce its qualitative characteristics. The greatest harm to *F. excelsior* is caused by some representatives of the *Coleoptera* order.

## Monitoring of condition of birch stands in Zhytomyr Polissya of Ukraine

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**Key words:** phytosanitary condition, *Betula pendula* Roth., causative agent, vital obligates.

Birch forest is important both in the structure of forest plantations and in the structure of the forestry complex (as a source of woodworking, chemical, fuel, food and pharmaceutical industries). In recent years there has been a steady deterioration in the sanitary state of birch stands throughout Ukraine, and this problem is particularly acute in the woods of Zhytomyr Polissya. Due to the lack of rainfall in the region under study and the increased temperature during the growing season, weakened stands have become an enabling environment for the successful development of bacteriosis. Lack of awareness, invisibility of phytopathogenic bacteria during surveys led to a «biological fire» in plant biocenosis, namely, the progression of bacterial dropsy (the causative agent *Enterobacter nimipressuralis* affects non-restorative tissues and organs of a tree plant). At one time, for this kind of disease, no measures of struggle and prevention were developed, as the deaths of birch trees occurred rarely.

In the work, the methods of forest pathological, microbiological, mycological and phytopathological examinations. The index of sanitary condition of the studied stands varies in the range from I, 10 to II, 75 points. Currently, there is a dynamic increase of pathology that has an epiphytotic nature with a dieback area of 2.964 ha.

Experimental studies of epiphytic and endophytic automyco- and microbiota, incl. and its phytopathogenic components, indicate a potential powerful endogenous vector in the occurrence of epiphytotic pathologies associated with the so-called vital obligates. From the externally healthy 5-7-year-old birch, phytopathogenic bacteria *Enterobacter nimipressuralis* have been isolated, which showed pathogenic properties both during spring and autumn artificial infection of birch trunks. There is reason to believe that the loss of birch is associated with endophytic infection, with the direct involvement of *E. nimipressuralis* and its associated bacteria *Pantoea agglomerans*, *Xanthomonas campestris*, *Bacillus subtilis* and micromycetes of the genera *Rhizopus*, *Mucor*, *Penicillium*, *Acremonium* (they were isolated from the pathology of bacterial dropsy).

In this situation, a complex of effective disease control is needed, combining both early diagnostics and the capabilities of modern technologies, which will allow us to deeply study the pathogen and to develop measures to combat this disease.



## Reserves of terrestrial forest combustible materials in the Kyiv Polissya forests

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**Key words:** forest fuels, pine forest.

The complex of socio-economic, natural, and climatic factors determines the growth of indicators of the forest flammability in the Kyiv Polissya. The fire occurs and spreads in the presence of oxygen and forest combustible materials (FCM) and heat energy, which heated the material to the ignition temperature. Consequently, the emergence and spread of fires in the forests depends on the active reserves of FCM (stock that will burn in case of a possible fire), especially in pine plantations, which are the most fire hazard due to the presence of resinous substances.

Purpose of the work was to investigate the reserves and fractional composition of FCM in pine plantations of the Boyarka Forest Research Station (FRS). Among the FRS forests dominate the most firefighting coniferous stands – 84.4%, where more than 70% of forest fires occurred. Found that the growth of reserves of terrestrial FCM with increasing age of the tree stand is uneven, especially in fresh sub-regions. Established that with increasing age of tree stand and soil nutrient status, fractional composition changes and the FCM reserves increase. In conditions of pine forest and fairly productive soil in the young forest growth of the 15-year-old age the largest proportion of needles has been detected.

The thickness of forest litter tends to a gradual increase of its thickness with age. The least thickness and swelling influencing the FCM combustion rate were noted at a young age, namely, at the age of 15, in the conditions of C<sub>2</sub> – 2 cm and at the same age in conditions of B<sub>2</sub> – 3 cm. Data on the FCM accumulation, obtained as a result of research, allow determining the most fire hazardous forest plantations. Data obtained on combination with meteorological indicators in the region and the use of modern methods and software, allow to create of a system for forecasting the occurrence of fires in order to improve the state of forest protection against fires and their management.

## State and dynamics of natural regeneration of the scotch pine in fresh pine site after narrow clear felling

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**Keywords:** clear-cut, natural regeneration, density, availability, growth, seedlings.

The regeneration of pine plantations is one of the most urgent problems, especially in case of possible change of the main tree species to less valuable. The natural regeneration of Scotch pine in Kyiv Polissya studied by scientists: N. Kobranov, V. Maurer, S. Kovalevsky, V. Rybak, M. Kocherga et al. Seed artificial and natural regeneration of forest plantations are topical issues in Ukraine and abroad. Researchers J. Delaney, S. González-Martínez and F. Bravo, L. Ackzell., Y. Gong, S. Kellomäki, H. Väisänen, R. Kinnunen, N. Lust, T. Pukkala et. al believe that in the process of natural regeneration tree species are highly productive and stable. However, it is necessary to develop methods of felling and other measures that have a positive effect on the forest environment without violating its biocenotic structure.

The study of natural regeneration was carried out in Boyarka Forest Research Station. We researched regeneration of pine in the conditions of poor pine site with the participation of pioneering species – *Betula pendula* Roth. and *Populus tremula* L. (A2) and fresh pine site (B2) in the absence of squeezing the area. The average annual availability of natural pine observed on an area of 15 ha. The experimental object is put down on a log after a clear narrow felling (50 m) of the 101-year-old plantation, which was characterized by the following forestry and biometric parameters: composition 10 *Pine+Quercus*, average height - 32 m, average diameter - 40 cm, stock - 520 m<sup>3</sup>·ha<sup>-1</sup>, the number of trees – 295 pc·ha<sup>-1</sup>. A Clear-cut was carried out in January-May 2010. The type of forest is a fresh hornbeam-oak-pine association.

The state of growth was characterized by indicators: healthy, normal, healthy, overweight, mournful and doubtful. The following categories were distinguished in quality: healthy or well-established growth, without signs of oppression, disease, mechanical damage; doubtful growth - suppressed specimens with signs of drying above-ground parts that have mechanical damage, etc., but still capable of further life; dry - dead specimens of growth.

The state of the natural regeneration presented as a good and satisfactory state, although at the counting plots 8, 10-13 and 15 unsatisfactory trees were more than satisfactory in connection with the defeat of the tops of trees by the fungus *Lophodermium pinastri* (brown chute or brown snow mold of coniferous tree species).

Our research shows that it is inappropriate to plant forest cultures in the zone of favorable for the emergence of natural regeneration, but it is necessary to focus on natural regeneration, as was done in the block of 275 in Plesetsk Forestry, where two years after the narrow-cutting forest regeneration there were 43.400 of 1-3 year old pine-trees.

Despite the significant decline in self-seeding, especially one-year, during the first years, at the time of recent research on the area, 9.6 thousand seedlings and one self-seeding pine grows on the area, of which 5.2 thousand seedlings are three years old and older. Such a quantity of natural regeneration is quite enough to form pine stand of high density.

## Dynamics of providence of Ukrainian settlements by green plantations

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Green plantations are considered as an important component of sustainable urban development, which provides a number of benefits both at the national and local levels. Green plantations help to identify and maintain the identity of cities, promote their competitiveness, and increase their attractiveness and quality of urban life. As the main principle of landscaping of inhabited places is the principle of uniformity. According to expert data, over the last 5 years in Ukraine, the area of all types of urban green spaces has increased by 3 times on average, and in cities and industrial centers of Donbass and Prydniprovya - by 5 times. It is noted that the area of parks, gardens, squares, boulevards exceeds 20 m<sup>2</sup>/capita in many cities. There was an idea to confirm or refute this assertion by analyzing the statistics. The purpose of the study is to determine the real situation regarding the number of green spaces of settlements by the administrative regions of Ukraine and their dynamics for further use in regional landscape planning.

For the analysis of the dynamics of urban green spaces, the materials of the public forms of state statistical reporting "Green economy" for 2012-2014 were used as well as statistical data on the population in terms of administrative areas (without Kyiv city). According to generally accepted methods, provision for green areas of the inhabitants of the regions was made.

During 2013, the total area of green plantations in Ukraine decreased by 27.2 thousand hectares. The total area of green plantations in the 9 regions remained unchanged: Vinnytsia, Volyn, Dnipro, Zhytomyr, Ivano-Frankivsk, Kherson, Khmelnytsky, Cherkassy and Chernihiv. In 2014, all categories of greenery reduced their area in compere with 2012.

The maximum number of green plantations of general use and the total area of all green plantations was observed in Luhansk region, which in 2013 accounted for 29.9% of all general use plantations in Ukraine. The least (0,2-0,3%) of green spaces of general use is concentrated in the Zakarpatska, Rivne, Ternopil, Kherson and Chernivtsi regions.

Urban forests are not listed on the territory of settlements of six regions and in the Crimea. The largest number of them is concentrated in the Donetsk, Zhytomyr and Kharkiv regions. Positive dynamics was not found in any of the areas. By contrast, in 2014, the area of urban forests in the Dnipro region has halved.

The largest number of green plantations of limited use is noted in Donetsk and Dnipro regions. The largest number of special purpose green areas is concentrated in Dnipro, Donetsk and Odessa regions.

The providence of population by green plantings are uneven across the regions and vary tenfold: ranging from 602.3 m<sup>2</sup>/capita in Lugansk, 226.4 in Donetsk and 196.6

in Khmelnytsky to 20.7 in Chernivtsi and 16.3 m<sup>2</sup>/capita in the Ternopil regions. The correlation between the number of inhabitants of the region and the number of green plantations of general use is low ( $r = 0.443$ ), ranging from 242.8 m<sup>2</sup>/capita in Lugansk, 71.5 in Poltava, 50.7 in Kharkiv to 6.9 m<sup>2</sup>/capita in Chernivtsi and 3.2 m<sup>2</sup>/capita in the Zakarpatska region, which is clearly not enough.

The considered situation suggests the inappropriateness of subordination of green economy to communal services and the urgent need to return to the professional development of perspective plans for integrated landscaping of the country. We consider it expedient to include the green economy in the environmental structure.

## Harmful entomofauna as a cause of damage of plants genus *Ulmus L.*

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**Keywords:** harmful entomofauna, pathogenesis, incidence of diseases, harmfulness.

Primary sources indicate that insects trophically and ecologically associated with *Ulmus L.* plantings in the context of accumulation, conservation and primary attack on trees by various phytopathogens. Thus, fragmentary research in infectious pathology indicates the explicit role of phytophagous insects that are either directly or indirectly, ecologically and trophically associated with *Ulmus L.*, that serve as vectors in the spread and accumulation of an infectious background.

The aim was examination of species composition of the harmful entomofauna of elm species in Kyiv Polissya Region, analytic generalization, identification of their species diversity, spreading and harmfulness.

The trees genus *Ulmus* with characteristic figures of damage by entomophages were selected as the object of research. In the elm woods of the research region we identified activity of more than 10 species of phytophagous insects. There are representatives of *Coleoptera*, *Hemiptera*, *Homoptera* and *Lepidoptera* series. The areas of the majority of the species have episodic or migrational character and cause physiological damage to trees. It should be noted that recently the proliferation of sawflies - elm (*Trichiocampus ulmi L.*) and ulmus (*T. eradiatus Htg.*) which damage the trees in urban plantations of Kyiv region characterized the highest data of density (within 20%) among pests of the assimilation apparatus of trees.

Dutch elm disease of the elm species and woods is one of the most dangerous vascular infectious diseases of the elm species that affects life of plants. Developing both in natural forests and in elm stands in the city, the Dutch disease leads to massive drying of trees and destruction of woodlands. The exclusive role in the spread of the disease is played by *Scolytus laevis*. It was found that *Scolytus multistriatus* Marsh., *Scolytus scolytus* F. and *Scolytus pygmaeus* are the most widespread and the attack rate of these species is determined as 33.4%, 12.4% and 16.7%.

As a result of research, we identified the dominant species of phytophagous insect that trophically associated with the vegetative organs of tree plants of the genus *Ulmus L.* Based on the analytical analysis of these relationships we have noted the existence of possible ecological and trophic links between insects (in particular cambium beetles) and Dutch disease agents *Graphium ulmi S.* as a constituent of circulatory processes in ecosystems. Noted the role of insects in the process of accumulation of primary infection, conservation and transformation with subsequent damage of plants. It is likely that the primary affection of trees by genus *Ulmus L.* with Dutch disease pathogen occurs with the participation of cambium beetles' populations.

# INSTITUTIONAL AND ECONOMIC MECHANISMS OF FOREST MANAGEMENT TRANSFORMATION

**Institutional development: from national forest policy to close to nature forestry**

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**Key words:** forest policy, legislation, strategic priorities, close to nature forestry.

An analysis of forest management system of the vast majority of countries in the world shows that state regulation of forestry is present practically in every country, regardless of the ownership of forests. The practical implementation of such regulation is through development and implementation of forest policy carried out by state authorities. The role of a state in governing their forest sectors lies in creating conditions for sustainable (balanced) development of forest industry through maintaining a balance between economic, environmental and social components. Achieving this balance is possible through fulfillment of certain functions by a state. Despite certain discrepancies in definitions, the most well-founded and recognized (for example, in European countries) are legislative, controlling, ownership and supportive functions. It is on this basis that the national forest policy of a state rests, which is a key element of institutional development chain: the Constitution of Ukraine → Forest Policy of the State or the National Forest Program (absent) → Forest Code → Laws, regulations.

The long discussions between national and foreign experts, international projects, funded by international organizations and funds, unfortunately did not lead to establishment and adoption of an agreed draft national forest policy. Owing to, first of all, foreign experts due to their intellectual assistance in development of national forest policy, it should be noted that now using only the efforts of Ukrainian politicians, scientists, forestry practitioners and progressively oriented public organizations it is possible to bring the legislative process to adoption of this important document by Verkhovna Rada of Ukraine.

Of course, any law is a basis on which framework solutions for a particular problem are being built. Speaking about ecologically oriented (close to nature forestry), the main priorities of forest policy implementation in this direction are: a) conservation of biodiversity in forests, forest management on the basis of close to nature forestry; b) extended afforestation and reforestation based on national programs, legal and financial support of the state; c) effective monitoring and control of forests' condition, their protection against fires, pests and diseases; d) rational and integrated use of all resources, utilities and ecological functions of forests; e) under climate change conditions, ensuring transition to gradual and selective forest management principle, a broad promotion of natural regeneration of forests under appropriate conditions.



## FSC controlled wood in a context of European requirements to legality of wood

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**Keywords:** controlled wood, National risk assessment, legality of wood products.

The guarantee of the fact that wood and wood-based products originate from responsibly-managed sources is a result of forest certification under FSC scheme. FSC Controlled Wood occupies the leading position in this system, considering the need to meet market demand for certified raw materials given its limited offer worldwide. This status of wood can be acquired in course of confirmation on basis of FSC-STD-40-005 that it does not originate from so-called unacceptable sources, which include: illegally harvested wood; wood harvested in violation of traditional and human rights; wood from forests, where high conservation values are threatened by management activities; wood from forests being converted into plantations or non-forest use; wood from forests in which genetically modified trees are planted. In general, this standard defines the requirements to be met by companies with FSC certified supply chains for production and sales of FSC Controlled Wood and/or FSC Mix products. Such requirements foresee necessity for companies to use a system of measures to assess and mitigation risk of occurrence of unacceptable wood categories. For the purpose of risk assessment at the national level, FSC National risk assessments of Controlled Wood are applied.

The approaches underlying the FSC Controlled Wood system are harmonized with European requirements for legality of wood products origin, in particular, EU Regulation 995/2010. Requirements and procedures of the FSC Controlled Wood standard and EU Regulation 995/2010 cover levels of forest management (legality of forest management where logging occurs) and control of supply chain. Both initiatives include use of due diligence system to avoid wood products of illegal origin entering supply chains. The components of this system are availability of necessary information on wood and wood products, procedures for assessing and mitigating risks of obtaining products from unacceptable sources.

Category 1 Controlled Wood Indicators, that have formed a basis for implementing FSC National Risk Assessment, relate to applicable legislation that complies with the procedures linked with legality of wood origin within the EU Regulation and allow for harmonization of approaches for both of these initiatives. However, FSC's National Risk Assessment of Controlled Wood is based on a wider list of indicators than risk assessment under EU Regulation 995/2010, confirming in general both harvest legality and sustainability.

The results of the FSC National Risk Assessment for Ukraine, according to which specified risk was designated for Controlled Wood Categories 1 to 4, determine

application of control measures by companies to mitigate the risk. Improvement of forest management practices at the level of forestry enterprises-suppliers of wood – is an integral part of effective implementation of international requirements regarding legality and sustainability of forest products both within FSC system and considering requirements of EU Regulation 995/2010 and integration to Europe vector of Ukraine's development.

## FSC National Forest Stewardship Standard for Ukraine

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**Keywords:** forest certification, standard, criteria and indicators, adaptive management, sustainable forest management.

The need to address global environmental and socioeconomic challenges has conditioned importance of finding appropriate tools at both international and national levels. Provision of responsible forest management, aimed at ecologically balanced, economically efficient and socially oriented use of forest resources, is an integral part of supporting forest component of the environment.

The approaches form the basis of FSC Principles, Criteria and International Generic Indicators on which FSC National Forest Stewardship Standards are based, which represent a tool for securing sustainable forest management. Designed by the national working group, such a standard for Ukraine, after its approval at the international level in accordance with FSC procedures, will facilitate implementation of international forest certification requirements, taking into account national forest management practices.

The requirements of FSC National Forest Stewardship Standard (NFSS) not only create opportunities for development of new areas of forest certification in Ukraine, but also, in the face of global challenges, contribute to continuous improvement of forest management practices aiming at increasing viability and sustainability of forests, reducing their vulnerability to negative factors, and strengthening adaptive capacity of forest ecosystems.

The scope of draft FSC NFSS covers both timber and non-timber forest resources, as well as ecosystem services of forests, which facilitates diversification of forestry enterprises' activities, helps increase their economic potential and enhance competitiveness. The foreseen by draft FSC NFSS assessment and monitoring of environmental and socio-economic impacts of forestry enterprises' activities, measures to preserve environmental values, applied forestry methods aimed at forest use, while covering elements of risk management concept, are important for reducing human-induced load on forests, securing performance of forests' diverse functions in the long run. Such measures are consistent with the adaptive forest management strategy, which is especially relevant under climate change conditions. An integral part of draft FSC NFSS is represented by requirements for compliance with applicable legislation (including anti-corruption laws), support and improvement of socio-economic well-being of enterprises' employees, including avoidance of discrimination on any grounds, requirements regarding occupational health and safety. Along with measures aimed at supporting and enhancing socio-

economic well-being of local communities, observing their legal rights, such requirements reflect integration of social component in the process of forest management decision making, which, along with preservation and improvement of the environment, is a priority area in the context of sustainable forest management. Thus, targeting forest enterprises to comply with requirements of FSC NFSS for Ukraine will contribute to mitigating global threats, including those related with climate change, and will create opportunities to support their economic potential and ability to meet public needs for forest resources and services over short and long run.

## **Providing access to ecosystem services finance: from theory to practice**

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Forest and natural resources could play a major role in fighting climate change, preserving water resources, halting loss of biodiversity and generally preserving those ecosystem services that are benefiting human beings.

The creation of financial rewarding systems (payment for ecosystem services) that improves the management of natural resources and forests and creates incentives for land owners and land managers has been under investigation for the last 10 or more years.

This research presents real ongoing ecosystem services projects that generate financial benefits for natural resource managers. Case studies of both public and private land owners are sourced in North Italy and involve tourist areas, conservation areas, fast growing planted forests, semi natural mountain areas, riverine forests.

The analysis entails: type of activities that generate positive impacts on the ecosystems, type of buyers, importance of decision factors (e.g. proximity to project, portfolio approach, demand oriented land managers, etc.), buyers' expectations, communication and marketing, quality certification system and grouping systems (FSC<sup>®</sup>), technology and transparency.

## Outlines for new forest policy instruments set: integrating payments for ecosystem services, forest certification and social innovations

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**Key words:** national forest policy, forest ecosystem services, institutional mechanisms.

To correspond societal expectations new forest policy should be developed and implemented taking especial attention to integration ecosystem services (ES) in forest management decision-making. Among major scientific problems regarding research on ES is the investigation of trade-offs within implementation of multi-purpose forestry on the basis of ES bundles and developing an efficient institutional mechanism of payment for ES.

The EU Biodiversity Strategy to 2020 (Target 2, Action 5) (2011) claims that: “Member States [...] will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020”.

In US, direct payments and rapidly developing ES markets have been coming into use in recent years. The experience of British Columbia, Canada gives an effective example of carbon markets functioning at the regional level. Considering resemblance of natural conditions and socio-economic peculiarities of post-socialist economy particularly worth attention are projects regarding valuation and integration of ES into decision making implemented WWF in Bulgaria and Romania. The most common international ES markets are: carbon markets, wetland mitigation banks, water quality markets, biodiversity markets. Their differences and current prospects or development at national and regional levels should be analyzed with focus on Ukrainian prospects.

The success story of forest certification as policy instrument can serve as a good example. Forest ecosystem certification may be considered as a logical step up from the traditional forest certification. Both approaches have much in common, yet substantial differences arise in particular regarding the process of informing. Potential limitations and barriers as well as uncertainty regarding the effectiveness of forest ecosystem certification for the development of sustainable forestry remain. The strategic aim is to develop novel instruments for the certificate holders that would allow them to access emerging ecosystem service markets, serving as stimuli for responsible forest use, maintenance and strengthening of ecosystem services. Also the public forest sector, which is currently ignoring social innovation, should utilize it

by involving all relevant stakeholders in designing appropriate and innovative governance schemes, strategies and programs.

## Strengthening the sustainability and adaptive capacity of forest management under FSC certification of forestry enterprises

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**Key words:** forestry, certification, adaptive management, Ukraine.

FSC certification is a voluntary process, where the compliance of the forestry enterprise activity with the established requirements (standards) is confirmed. The mentioned standards are based on the principles of sustainable forest management and combine economic, ecological and social aspects of forest management. Within the conditions of the rapid transformation of the environment and socio-economic relations in post-Soviet countries, the adaptive forestry is becoming increasingly important.

The research of URIFFM Forest Monitoring and Certification Laboratory and NEPCon's experience of practical implementation of certification requirements in forestry enterprises in Ukraine and other post-Soviet countries indicate that FSC certification is a significant driving force and instrument for the practical implementation of sustainable forest management and strengthening of adaptive forest management ability. The orientation of the forest enterprise on the principles of sustainable forest management is carried out by directing its activities according to FSC criteria and indicators regarding: compliance with the legislation and FSC principles; ensuring the realization of legal rights and obligations for owners and users; support of local population and workers; rational use of environmental forest functions; environmental impact; planning of forestry activities; monitoring and evaluation; support of HCVFs.

Adaptive forest management is based on a systemic approach that involves a preliminary assessment of the possible impact of forest management measures, monitoring and evaluating of actual changes, and adjustment of planned measures considering the feedback. All mentioned components of adaptive forest management shall be carried out in accordance with the FSC requirements. The analysis of the implementation of adaptive forest management elements in certified enterprises has shown that such management is implemented by forest enterprises, but for the purpose of more effective implementation it is necessary to provide training for the enterprises' staff, to establish cooperation with forest inventory and forest management planning and to promptly improve the national regulatory and legislative base taking into account the environmental changes which affect the forest conditions, as well as the dynamics of socio-economic relations.



## Forest management certification as a tool to promote sustainable forestry: standards development and research needs

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**Key words:** forest management certification standards, research needs.

Responsible forest management plays a major role in mitigating stress factors coming along with climate change as well as human pressure on forests. Through specific rules that cover ecological aspects of management, standards for forest management can address some of the challenges that people and climate change poses.

FSC standards provide specific guidance to maintain and enhance resilience of forest ecosystems and to reduce negative impacts of forest management interventions, and how the FSC standards are elaborated: National FSC working groups consisting of scientists, forest practitioners, ecologists and other stakeholders agree on indicators for each of the FSC global criteria of they deem appropriate for the forest management conditions in their countries. This results in standards which are adapted to different sizes of forest management operations and other national specific socio-economic criteria, as well as for specific ecological and geographical conditions. Our procedures of standard setting capable for the different stakeholders jointly agree on rules for responsible forest management that cover social and economic issues as well as ecological interventions can prove beneficial in support of climate change mitigation and adaptation strategies. National indicators, by responding to the global Principles and Criteria, result in forest management requirements for the protection of High Conservation Value areas, promotion of species diversity, and minimal soil disturbance as a result of reduced impact logging practices.

There is research needs and research challenges on how forest management certification interventions impact on forest ecology, on silviculture and management decisions, on economic effects for forest owners as well as on other socio-economic effects for any stakeholder. As forest management certification is a complex process, it is challenging to precisely evaluating how certification schemes impact those various dimensions. As FSC is not a research organization itself, the one of objective is to invite researchers and practitioners to identify strength and weaknesses of certification and therewith informing standard development groups to further strengthen certification standard requirements for responsible forest management.

## FSC Ukraine response to challenges in forest management of Ukraine

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**Key words:** Forest Stewardship Council, standard, certification, forestry.

Negative trends that have emerged in relation to forestry and forest management in Ukraine require an adequate response from Forest Stewardship Council® (FSC®) - an international forest certification scheme that cultivates strict and balanced requirements for responsible forestry management.

Weakening of forest stands due to climate change, destructive natural phenomena predetermine their large-scale dieback and damage by pests and diseases. Sanitary measures in the form of sanitary selective and clear felling do not improve the situation but escalate the issues of their legality and silvicultural expediency, as well as observance of the principle of non-exhaustion of forest resources use. Lack of forest policy and sectoral development strategy, a rented exhausting model of economic relations in the system "owner-user" of forests, inertial mechanisms of forestry functioning do not allow to respond adequately to the current challenges. As a result, there is an increase of contradictions in achieving the opposite interests related to forests – on one hand, an increasing demand for harvesting more and more wood for securing needs of processing industry, on the other hand, a requirement to better secure ecosystem services, and consequently – emergence of additional environmental restrictions for forest use. At the same time, these processes take place simultaneously with deterioration of forest industry's productive potential linked not only with extended, but also with simple reproduction of forest resources.

We foresee the following directions of FSC activity in Ukraine:

- Work with authorities and other stakeholders aimed at formation of state forest policy, based on balance of ecological, social and economic goals benefitting general society, and improvement of legislation in order to overcome the disproportions in functioning of forest industry;

- Replacement of interim standards of certification bodies by a single standard of responsible forest management in Ukraine based on new FSC principles and criteria and containing such innovations as introduction of anti-corruption policy by certificate holders, differentiation of indicators based on the "Scale, Intensity and Risk" concept, and also introduction of additional development tools such as adaptive forest management, certification of non-timber forest products and ecosystem services;

- Transformation of certification bodies' activity into risk-oriented audit, when planning and conducting conformity assessment will be carried out with a focus on

those aspects of enterprises' activities that may lead to emergence or development of negative social, environmental and economic consequences of significant magnitude;

- Strengthening stakeholder's involvement in certification process to provide assistance to auditors, promote openness and transparency of forestry enterprises;

- Promoting principles of sustainable forest management as a methodological basis for formation of a new social agreement on forests, and promotion of ideology of responsible consumption of forest-based renewable resources.

## Forest certification in different national institutional contexts: a comparative analysis of non-conformities identified across European countries

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**Key words:** forest certification; legal framework; corporate social responsibility.

The implementation of responsible forest management relies on institutions that set the rules of the game. At the European level, there is a very diverse setting of the national regulatory frameworks regarding forest management. In some countries, the policy instruments are focused on command and control instruments which mainly impose the obligation that forest owners implement a forest management plan, designed according to imposed technical requirements. Other countries emphasize more the use of economic instruments (such as subsidies) or voluntary instruments (such as certification schemes) to motivate the responsible use of forest resources.

Forest certification is a voluntary tool used as a market instrument to provide a guarantee to the consumers that the timber production is done in agreement with an international standard. On the European market there are two voluntary schemes, Forest Stewardship Council (FSC®) and Programme for the Endorsement of Forest Certification (PEFC™). Both systems rely on third-party audit for the verification of the compliance with the requirements of the standards.

The aim of this research is to make a comparative analysis of the identified non-conformities in different countries by using a standard classification system. Non-conformities are used under the FSC certification and represent a deviation from the standard that needs to be improved in a timeframe. The identified non-conformities are publicly available for each certificate holder on the FSC website. Thus, reports from 14 countries were checked for the last 5 years. The non-conformities were coded based on four domains (Forest management issues, Environmental issues, Social issues and Administrative issues). Under each domain specific categories were created to allow for a better comparison of the non-conformity.

The results of this analysis show that clear patterns of non-conformities can be identified between “western” countries and former socialist countries. For example, most common non-conformities in Nordic countries are related to high conservation values identification, representative ecosystems, FSC procedure/trainings. In former socialist countries like Bulgaria, Poland, Romania the

most common non-conformities are related to health and safety equipment, felling techniques and quality of harvesting. Non-conformities from Nordic and central-west countries represent in most of the cases only an infringement of voluntary requirements while in former socialist countries represent, in addition, an infringement of regulatory requirements. The analysis shows the potential use of FSC reports for assessing the main problems that the implementation of forest management brings in practice, from an institutional perspective.

## Charcoal supply chain transaction verification

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**Key words:** FSC, charcoal, transaction verification.

Transaction verification is the act of certification bodies and/or Accreditation Services International (ASI) verifying that an FSC® output sales claim made by an FSC certificate holder is both accurate and matches an FSC input purchase claim by a trading partner.

This opportunity was introduced in the revised Chain-of-Custody standard (FSC-STD-40-001 V3-0). The new criterion for transaction verification is to ensure that FSC is enabled to systematically have transactions between trading partners that trade high-risk product types, species, or from high risk regions, which limits the amount of inaccurate transactions.

There are currently three options for verification. The verification can be done via the Online Claims Platform (OCP), where certificate holders will register, connect with suppliers, enter relevant data from their invoice directly to the platform (no financial information required), and the transaction is automatically verified once the suppliers validate their claim.

A second option includes the OCP where the certificate holder will also register, connect with suppliers and enter relevant data from their invoice directly to the platform but verification of transactions is completed by ASI instead of automatically.

Alternatively, certificate holders can choose to fill in a downloadable spreadsheet template with relevant transactional data and send that on to their certification bodies, or they can opt to do an on-site audit where transaction information is collected manually by the auditor for ASI to verify.

Among the reasons for charcoal supply chain transaction verification were that supposed FSC-certified charcoal might be sourced from illegally harvested forests and not from where the charcoal is claimed to originate. There were also assertions that charcoal was being purchased from countries where there are no FSC-certified charcoal producers or forests, being repackaged in European countries and then sold on as FSC-certified charcoal produced in Europe.

Traditional wood anatomy testing can provide information on family, genus, species of lump charcoal and briquette charcoal products (origin can be deduced based on

species). FSC Network Partners and retailers submitted charcoal samples from more than 100 bags of charcoal from brands sold on the European market.

Given that Ukraine is a big exporter of charcoal to Europe, transaction verification is important to support basic trust to the Ukrainian charcoal producers in the charcoal supply chain. As a result of the transaction verification in 2017 year, some FSC-certified companies in Ukraine had their certificates immediately terminated or suspended after transaction verification.

Transaction verification permits systematic analysis information obtained from the trade reported by certificate holders and take transparent decisions in the case of suspicion if a non-certified material may be sold as certified.

## The adaptation of requirements of NEPCon Global Non Timber Forest Product Certification Addendum to forestry in Ukraine

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**Key words:** certification, non-timber forest product.

Global Non Timber Forest Product Certification Addendum (effective from: 19 December 2014) consists of 10 principles, 29 criteria and 43 indicators.

Principle 1 specifies the requirements according to: implementation of the applicable legislation in the context of the use of non-timber forest products (NTFPs); observance of requirements of international biodiversity conservation agreements.

The provisions on cooperation with local communities in the field of NTFPs' marketing and use of local knowledge are considered in Principle 2.

The priority should be given to: NTFPs' harvesters from local communities; observance of the safety rules of them; assessment of social impact (Principle 4).

The process of long-term forest management encouraging; the use of advanced technology for NTFPs' harvesting and processing; the harvesting impact on the forest diversity are given in Principle 5.

Minimizing the impact on forest management regulation and NTFPs' harvesting; maintenance of the natural composition and structure of the populations of target NTFP species and properties of high conservation value forests (HCVF); preservation of NTFPs' resources for local communities are stated in Principle 6.

Requirements for the development of a management plan and also issues related to the NTFPs' harvesters are discussed in Principle 7.

Monitoring changes in conditions associated with NTFP species populations; socio-economic aspects of the use and procurement of NTFPs are required by Principle 8.

The administration of the forest management unit (FMU) should give the status of socially important forests for local communities to HCVF, in which NTFP species grow (Principle 9).

Intensive management or cultivation of NTFPs-understory in natural forests should not be affected to rights of local communities, reduce water quality or adversely impact soil fertility (Principle 10).

Below are some approaches that will allow adapting some surpluses to the forest management system in Ukraine.



The administration of FMU provides jobs for representatives of local communities (4.1.NTFP.1) and establishes a contractual relationship with them (2.2.NTFP.2).

Data on the area and volume of NTFPs' harvest should be included in the process of forest management planning (4.4.NTFP.1).

Market analysis and potential buyers indicate which certification systems should be used in addition to FSC certification (5.2.NTFP.2).

Maintenance of viable populations of target NTFP species (5.6.NTFP.2) regards the conformity of the harvesting methods of these types of resources (6.3.NTFP.2).

The above requirements of Global Non Timber Forest Product Certification Addendum will be taken into account in the final draft of the National Forest Stewardship Standard for Ukraine in 2018.

## Financing and taxation of the forestry sector. Role of state and local communities

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**Key words:** forestry sector, State Fund for Development of the Forestry Sector.

Incoherence and absent financing of the forestry sector from the state budget, legislative changes that hamper forest product sales, changes in the taxation system that not only produce adverse effect on the forestry sector but also expose whole enterprises to the danger of shutdown necessitate creation of an integral system of the government support for Ukraine's forestry sector. Undoubtedly it requires amendment of the Budget Code, Tax Code, Forest Code and other legislative and regulatory acts of Ukraine. Obviously, the required amendments must be comprehensive.

The key elements of these amendments were implemented in the Decree 381/2017 of the President of Ukraine of 21 November 2017. The point was to create a forestry sector financing fund on basis of computations from rent payments, half of which would be remitted to the consolidated budget and the other half (50%) to a specific-purpose fund of the state budget. This fund will be used to finance forestry, scientific research, protection and preservation of forests, the forest ranger service, forestry investment projects, reforestation and afforestation projects. In February 2018, the authors presented these proposals at a field meeting of the Agricultural Committee in Lviv.

The aforementioned systemic solution has received support and it was included to a package of draft laws developed by the Verkhovna Rada Agricultural Committee jointly with research institutions and forestry experts and registered with the Verkhovna Rada of Ukraine:

1. Draft law 8238 from 05.04.2018 about amending the Forest Code of Ukraine (to improve the mechanism of financing the forestry sector);
2. Draft law 8239 from 05.04.2018 about amending the Budget Code of Ukraine (to improve the mechanism of financing the forestry sector);
3. Draft law 8240 from 05.04.2018 about amending paragraph 256.3, Article 256 of the Tax Code of Ukraine (regarding financing of the forestry sector);
4. Draft law 8241 from 05.04.2018 about amending certain legislative acts of Ukraine to ensure efficiency of the forestry sector and improve protection of forests.

The aim of this legislative initiative to provide comprehensive solution to the problem of financing development of the forestry sector. In particular, besides creation of the State Fund for Development of the Forestry Sector, it envisages redistribution of a portion of revenues from rent payments for special use of forest

resources (concerning final felling) to the budgets of bodies of local self-government to enhance their fiscal potential.

The proposed financial model by this legislative initiative is more balanced, not only due offering a solution to increase financial capabilities of local communities, but also creating a financial foundation for a reform and development of Ukraine's forestry sector.

## Environmental requirements for the forest management standard and their contest in Ukrainian forestry enterprises

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**Key words:** Forest Management Standard, environmental requirements.

Principle 6 of the FSC's Forest Management Standard states that the Organization shall maintain, conserve and/or restore ecosystem services and environmental values of the Management Unit, and shall avoid, repair or mitigate negative environmental impacts.

Investigations were conducted at forest enterprises of Ukraine, which are supervised by three certification bodies (NEPCoN, SGS, "Forest Certification").

Not all enterprises have a full assessment of environmental values and monitoring with an indication of the necessary conservation measures in the management plan. The identification and recording procedures for registering rare and threatened species and mapping their habitats are not fully implemented.

The support of ecological functions and useful properties of the forest should also take place through the promotion of the reforestation process by natural means and the formation of mixed forests.

The enterprises take into account the results of the natural regeneration survey on the harvested sites, planted forests and native tree species of local origin.

In the enterprises subject to the State Agency of Forest Resources of Ukraine, there was no marked directional replacement of natural forests on the plantation.

In plain areas, final and sanitary clear cuttings dominates in areas and volumes of timber harvesting. The application of selective and gradual cutting systems is not given sufficient attention.

Foresters are finding it difficult to apply methods for identifying key habitats, their conservation and monitoring. There are complications with the allocation of key biotopes, their conservation and monitoring.

Sometimes, foresters fulfill this requirement at their own risk by ways: leaving the undergrowth of oak and birch trees on the harvested sites, groups of trees (especially around small reservoirs). Foresters do not realize that key elements should be indicated on technological cards.

Identification of key elements of foreststand that support biodiversity in forest ecosystems ("old trees", "trees with hollows", "dried up standing trees", "high hemp" and other) has not been widespread.

On the harvested sites key elements like as "seed-trees of economic-valuable species", "next tree generation" and "undergrowth" are excluded from the felling process.

Key elements such as "dry trees" and "trees with nests" were not selected at all. Dried up standing trees do not remain, as foresters consider them as emergency trees.

The fulfillment of the key requirements of principle 6 of the FSC's FM Standard has a formal character, especially with regard to minimizing the environmental impact, implying the natural dynamics of forest development, and biodiversity conservation.

## Comparative characteristics of the requirement of the FSC standard and the legislation of Ukraine regarding the assessment of environmental impact

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**Key words:** FSC Standard, Ukrainian legislation, environmental impact assessment.

Assessment environmental impacts (AEI) is part of FSC standards used in Ukraine. AEI is mentioned in the following principles of the current standard: 6. Environmental Impact; 7. Planned activities in forest management; 8. Monitoring and assessment.

The Law of Ukraine "On Environmental Impact Assessment" (dated 23.05.17, No. 2059-VIII), which came into force on 18.12.2017, establishes the legal and organizational principles of environmental impact assessment, aimed at prevention of environmental damage, ensuring environmental safety, environmental protection, rational use and reconstitution of natural resources. The Law also states that the AEI is mandatory in the decision-making process of implementation of planned activities.

A comparative matrix with the indication of the key elements of the AEI was developed in order to find out the consistency of the FSC standard with the current legislation of Ukraine regarding of the AEI. As a result of the comparison, it has been established that the current FSC standards does not contradict the Law of Ukraine "On Environmental Impact Assessment". However, there are requirements of the FSC standards, which partially exceed the requirements of the current legislation, namely:

- AEI on sites and registration of corresponding documentation in an arbitrary form (criterion 6.1) (requirements of the FSC standard oblige the AEI to be carried out on sites, and according to Legislation – in general, by type of forest management activities);
- Conducting the AEI after the end of the forest management activities. Enterprises need to collect information on the environmental and social impacts of logging and other forest management activities (criterion 8.2) (the requirements of the FSC standard clearly state the necessity of the AEI after the completion of forest management activities, but there is no such requirement in the legislation, however, in the AEI conclusions of the SE "Kostopilske FD" and the SE "Rafalivske FD" such item is indicated, and the act drawn up on the results of the assessment must be submitted to the Ministry of Ecology and Natural Resources of Ukraine within a month).

In conclusion, by comparing the requirements of Ukrainian legislation and the FSC standard for AEI, it can be stated that for enterprises, which are certificate the holders, the procedure for AEI is more understandable, requires less time spent on its implementation, and makes procedures much easier, as well as drafting of the AEI Report in accordance with the legislation of Ukraine.

## Status of fiscal regulation in forest economy of Ukraine

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**Keywords:** fiscal regulation, forestry, forest resources, tax burden.

An important component of economic regulation of balanced and non-exhaustive forest use is the mechanism of fiscal regulation. The main instruments of fiscal adjustment are revenues and expenditures, which are budgetary and tax constituents. Most developed countries in the system of anti-crisis economic regulation use instruments of fiscal regulation not only for solving fiscal objectives, but also for urgent tasks of social development, redistribution of budget revenues between the state, economic actors and the population.

The methodical approach to assessing the effectiveness of the functioning of the fiscal regulation mechanism in ensuring a balanced forestry development has been applied, which includes a set of tools, namely: the level of tax deductions, fiscal sufficiency, tax burden and the intensity of forest regeneration processes. The system of these indicators makes it possible to determine the adequacy of fiscal regulation in the forestry sector not only in relation to the interests of individual economic agents (forest enterprises - in terms of receiving profits) but also the state as a whole, its compliance with the priority interests of the state ecological, economic and social policy, as well as efficiency use of forest resources, resource conservation, reforestation and, in general, the provision of balanced forestry development.

The tendencies of the dynamics of the main indicators of the state of fiscal regulation of the Regional Departments of Forest and Hunting Farms of Ukraine (OLUMM) and the comparative analysis of natural zones with clearly distinguishable regional differences are carried out. Thus, the lowest fiscal efficiency was detected in Zhytomyr ONGMG at a fairly high level of forest resource availability, and the highest in Kirovograd, due to significant differences in financing of enterprises. The indicator of fiscal impact in Zhytomyr Oblast is quite high, and since 2014 it has a tendency to increase. In the Kyiv region, the area of leading leading felling is smaller, the intensity of the forest reproduction is 0.12-0.19, which suggests a more effective provision of forest reproduction. Despite the different level of forest resources, the intensity of forest reproduction in Zhytomyr and Ivano-Frankivsk regions is almost the same and has a moderate upward trend. The indicator of the tax burden per 1 ha of land exploited in Zhytomyr region is 7.5 times higher compared with Kirovograd region, while in Kyiv it is 2.7 times compared with Ivano-Frankivsk. Such differences are caused by different amounts of rent payment for special use of

forest resources, as well as heterogeneity of natural and economic conditions within administrative areas. The necessity of improvement of fiscal regulation tools in the forestry sector has been proved in such directions as improving the transfer mechanism of the current tax system and expanding the list of local taxes and fees legally established in the Tax Code of Ukraine.

On the basis of proposed estimation system of the mechanism of fiscal regulation in forestry, the convenience of taking into account the different management efficiency of individual enterprises and regional administrations, as well as regional peculiarities in the process of improvement of the relevant instruments, as well as the necessity of forest policy development at the regional level has been substantiated. When taxing forest enterprises, it is suggested to weigh the following factors, such as natural zones, and adjust in the direction of reducing the tax burden on enterprises where the worst climatic conditions.



THEORY AND PRACTICE OF ADAPTIVE FOREST  
MANAGEMENT

## East European Mid-Latitude Forests: Challenges of transition to sustainable forest management

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**Key words:** East European Mid-latitude forests, climate change, transition to adaptive risk resilient forest management.

Substantial part of the Mid-latitude ecotone forests of the Eurasian continent is located in the xeric belt where the actual evapotranspiration on average exceeds the amount of available water. Most probable climatic projections (based on SRES and RCP Scenarios) for the East European part of the ecotone's territory (including countries situated in territories of the former USSR - Belarus, Ukraine, Moldova and European part of Russia) predict the substantial increase of temperature mostly during the growth period and different by direction but relatively small changes in precipitation which increases mainly in winter. It makes water stress a major driver of substantial risk for the forest ecosystems. Over the region, the stress increases from north to south and from north-west to south-east. A recent study of the impact of climate change on vulnerability of Ukrainian forests (Shvidenko, Buksha, Krakovska 2018) showed that for IPCC Scenario A1B (~RCP6.0) major part of the country will likely have an arid climate that would be not suitable for main forest forming tree species (pine, oak, spruce, birch), and critical conditions of very dry steppe and semi-deserts will be typical in the southern part of the country by end of this century. Recent years have been characterizing by severe intensification of pathological processes and increased tree mortality in forests of the East European countries, particularly in Ukraine. While direct reasons of that are different (insects and pathogens, change of hydrological regimes, insufficient wood tending etc.), there are enough evidences to hypothesize that climate change has already initiated the complicated interaction of environmental change as well as increased the extent and severity of disturbances and pathological processes in the forest ecosystems. Such conditions require urgent transition to adaptive, risk resilient sustainable forest management. Overall, this is an extremely complicated problem, which requires *inter alia* 1) understanding by societies and governments the particularly important role of forest ecosystems in current and future wellbeing of the nations;

2) implementation of appropriate state forest policies: 3) need of new knowledge and information, which would be able to provide early detection of negative changes in forest ecosystems and recognize major drivers of that; 4) intensification of integrated research on vulnerability of forests in a fast changing environment; 5) development of a new paradigm, methods and tools of forest management on a landscape-ecosystem basis etc. The presentation considers underlying scientific, social, economic and institutional aspects of the problems mentioned above.

## Close to nature forestry as a foundation for sustainable forest management

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**Key words:** close to nature forestry, sustainable development.

Currently, forestry in Ukraine face a range of problems that hamper reforming of forest sector and require urgent solutions. First of all, they are associated with excessive use of clear cuttings.

Conducting clearcutting resulted in a sharp decrease of the area of uneven-age forest stand and increase in the area of even-age planted forest stand that require much more intensive treatment and, in comparison with natural forest stand characterized by a simplified structure, reduced biodiversity, and lower biotic resistance.

In addition, in the forest fund of Ukraine we have significant areas of stand of vegetative origin and derivative woodlands which need to be replaced by indigenous forest stand. Due to global climate changes, environmental pollution and anthropogenic pressures vitality and biotic resistance of woodlands decrease, first of all vitality and resistance of planted forest stand. The processes of forest stand aging and degradation are intensified in the forest stand where the main felling is prohibited by normative legal acts.

Solving these problems, which is very relevant for Ukrainian forestry, requires changes in forest management system and is generally based on the principles of close to nature forestry that involves the transition from a clearcutting forest management system to a selective close to nature system - the cultivation of uneven-aged mixed forest stand with a multi-level vertically and horizontally closed structure based on natural seed regeneration.

In Ukraine, the introduction of close to nature forestry is an especially appropriate for the Carpathian region. This is facilitated by the successful natural regeneration and shadow endurance of the common here tree species - beech, spruce, and fir.

However, the transition to a close to nature forestry foresee the presence of woodlands that are characterized by the following features: uneven-age composition, usually a mixed natural composition and complex spatial structure of forest stand and the permanent presence of the processes of natural regeneration. Such areas area are rare in the forest fund of Ukraine. Forests of Ukraine, as a rule, are intensively managed, converted into even-aged, quite often homogeneous forest stands. They should be recomposed accordingly to close to nature forest management system.

Depending on the condition of the forest area and silvicultural situation on it, tree species composition and the age of the stands different approaches of close to the nature forestry interventions different approaches are used for their re-formation:

a selection of single trees or individual biogroups, tending cuttings, selective sanitary cutting, etc. It is also necessary to define the "trees of the future" and to determine the silviculturally reasonable intensity of the techniques of reforming cuttings. It should be appropriate for providing sufficient light power for the emergence, growth and development of self-seeding and regrowth of tree species. The stage of reforming of forest stand requires a lot of effort, costs, time and its implementation faces a number of difficulties and problems:

1. Significant duration of reformation of forest stand (70-80 years);
2. Large area of even-aged stand;
3. Irregular fruiting (seeding) of the main forest species;
4. The absence of highly skilled personnel;
5. Insufficient development of forest transport networks etc.

However, in spite of the difficulties in the forests of Ukraine, experimental testing of reforming cuttings has already begun.

In particular, in the forests of the Carpathian region, methods and technologies for carrying out the reformation cuttings are being worked out (developed) in about 200 experimental forest plots.

The experience shows that in comparison with the existing clearcutting forest management system, the introduction of a selective, close to nature forestry in Ukraine will enable us to increase the forest management efficiency both in ecological, social and economic terms.

## Challenges for transition to integrated forest fire management in Ukraine

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**Key words:** fire management, wildfire, Ukraine, integrated system, forests.

After 1991, the basic principle of fire management system in Ukraine in comparison with the Soviet Union period has not changed significantly. The main approach of fire management is quick and full extinguishing of all fires. Commonly shared paradigm among foresters of Ukraine is that fires are unacceptable event in forests as negative factor. And it is wrong paradigm because pine forests is fire driven ecosystem and fires played important role in spreading pine across its current natural range. Controlled use of fire should be important part of management in particularly protected forests.

Until now fire management system was based on: 1) personal responsibility of head of State forest enterprise for fires prevention and administrative and financial charge for cases of wildfires in their forests; 2) foresters are fully responsible for wildfires; 3) forest enterprises must determine the required amount of funding and find resources for the fire management in forests themselves.

This policy to some extent was successful as fire management in forests, which belong to the State Forest Resources Agency of Ukraine, organized in more effective way than in agroforests, military's forests, communal forests and other where amount and areas of fires were much higher. On the other hand, such approach more typical for USSR, when the result must be achieved "at any price".

Laying down all responsibility for such a complex ecological and social phenomena as fires on foresters - push forestry enterprises not to reflect part of small and medium-sized forest fires in their statistics. Only large fires, which attracted the attention of the media and demanding high costs for suppression, were reflected. As a result, the national fire statistics looks relatively good and the Government of Ukraine has been considering fire situation as normal and has no reasons to increase funding for personal fire protection, their training, renovation of fire equipment and annual fire prevention measures, and eventually only reduce and in the end cancel funding of fire management.

Over the past decade, the forest fire prevent system lost such an effective tool as a fire management plan, which has helping to reduce occurrence of fires in long-term perspectives. As a result, in many cases fire brigades suppress fires in same places every year with maximum concentration of ignition sources instead of implementation of long-term prevention measures. Most of forest enterprises do not use fire weather index for arranging proper level of preparedness for current day. The result of this is increase the area and frequency of large fires. Sad

leadership in this keeps the Chernobyl Exclusion Zone - in 1992 fires burned near 17,000 hectares, and in 2015 - 14,800 hectares.

Among fire prevention tools most widely foresters use firebreaks - even there is no clear evidence of how many fires firebreaks prevented. The use of new technologies - video surveillance cameras and drones for fire reconnaissance has greatly enhanced the effectiveness of fast response and tactics.

Analysis of fire suppression tactics shown that the forest firefighters effectively extinguishing small and medium fires up to 5-10 ha. At the same time, they are not properly trained for responding to large fires – emergencies. First of all, this is due to absence of professional, theoretically and practically trained and experienced incident commanders able to lead suppression of large forest fires in Ukraine. Also, this is due to absence of large incident command system, rules of personnel safety provision, effective system of radio communication, fire cash with reserves, proper interagency communication system.

In developed countries, where the fire situation recently become serious national challenge, transition to new paradigm is going on - integrated fire management system, which involves the use of traditional fire suppression and fire safety methods and participation of the local population, local authorities, industry and new technologies. In other words fire problems daily under attention not only forest fire brigades, but visitors of forests, local authorities and enterprises. And this concerns both joint activities in fire management and joint financing of fire-prevention and fire suppression measures.

Summarizing we need to stress that in the context of reducing of forest resilience under climate change, when it is already clear that the fire situation will be just worsening, Ukraine should to move toward developing and implementation of integrated fire management system. This is possible through the development and adoption of fire policy at the national and regional levels and the involvement of all stakeholders in its implementation.

## Douglas fir - perspective tree species for Ukrainian forests

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**Key words:** Douglas fir, forest productivity, forest ecology, silviculture.

The Douglas fir grows under a wide variety of climatic conditions: from a maritime climate on the coastal regions of the Pacific Northwest to a continental one in the central Rocky Mountains. Generally, Douglas fir is considered a moderate light-demanding species, tolerating a light shelter in its youth.

Both in the natural range and outside of it, Douglas fir is considered a fast-growing and of high productivity tree species; it reaches maximum 99.4 m in height in the natural range (Oregon State, U.S.A) and 66.4 m (Scotland) in Europe. The volume growth of Douglas fir can reach 17-22 cu.m/ha/yr in the natural range (coast Douglas fir) and more than 20 cu.m/ha/yr in various European countries. Thus, Douglas fir is more productive than any of the native tree species.

Douglas fir is more resistant to drought than Norway spruce and silver fir, making possible its use in the hilly areas, in pedunculate oak and European beech stands. This fact was confirmed in central and western Europe and is extremely important in the context of potential climate changes, limiting the current range of Norway spruce.

The Douglas fir stands are in Ukraine very rare. Their total area covers on 1.1.2011 only about 4,4 thous. ha. It is just 0.04% of the total forest area of Ukraine. The Douglas fir part in stand composition makes mostly one unit (namely, from 5.0 to 14.9 percent of the total stand volume) – on 65.2 percent of areas. The forests with the advantage in their stand composition of Douglas fir occupy only 638.0 hectares. The pure Douglas fir stands take in Ukraine only 41.0 ha.

Overall in Ukraine dominate young stands of Douglas fir. Their area account 3093.9 ha. The lowest area amount to mature and overmature stands – only 139.0 ha. The oldest Douglas fir planting is 170 years old and is located in Rahkiv forest enterprise in Sakarpatska Oblast.

The silviculture in Douglas fir stands should be based on the principles of continuous cover forest management. In the future this tree species will play an important role contributing to the aesthetic and economic value of the Ukrainians forests.

FSC Ukraine does not permit to make use of alternative tree species like Douglas fir for instance. This should be reviewed as an option for a moderate percentage of Douglas fir is within FSC rules in other countries.



## Methodical principles of establishing forest-seed zones of Ukraine

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**Key words:** forest seed production, forest–seed zoning, genetic resources of tree species, populations, geographic variation.

Forest-seed zoning is an important component of the successful forest management, as it ensures the compliance of genetically determined intraspecific forms of woody species with the natural conditions of their cultivation in the process of artificial reforestation and afforestation.

The purpose is to develop the methodical basis of the unified forest-seed zoning on the territory of Ukraine as one of the important constituents of the fundamental framework of rational science-based forest management.

The current scheme of forest-seed zoning is characterized by a low level of detailed information on the geographical and altitude-zonal variability of forest species.

Also, its provisions are not sufficiently effective with regard to maintaining the genetic purity and the relative stability of the most valuable populations.

It is expedient to use physiogeographical zoning of the territory of Ukraine as a cartographic basis to set apart basic zoning units.

Each structural element of forest-seed zoning is territorially separated integral unit that has intrinsic organic unity and, at the same time, specific ecological, physiogeographic and genetic features and properties, which is set apart on the methodological principles of unification. Above-mentioned collectively provide the realization of potential opportunities for the development of forests on the basis of their artificial regeneration, afforestation, and natural regeneration as key components of a sustainable multifunctional forest management system.

We propose to adopt the following categories as separate territorial-hierarchical units of zoning: subdistrict, district, region, providing the status of the basic unit of forest-seed zoning for the subdistrict. The territorial boundaries of the subdistricts are determined on the basis of the study of physiogeographical features of the differentiation of the territory, in particular, its geological structure, the nature of the distribution of forest vegetation at the level of associations and groups of associations, as well as qualitative and quantitative parameters of stands of dominant species.

In order to show the role of forest vegetation in the ecosystems of the region, as well as the nature of its distribution and the degree of genetic transformation of forest ecosystems, it is proposed to introduce three categories of subdistricts that will reflect their different status in the processes of preservation, reproduction and enrichment of forest genetic resources: "donor", "ordinary", and "recipient", and, as for the specified categories of subdistricts, specific rules should apply concerning

the use and movement of all kinds of reproductive material within their borders and between separate subdistricts.

Current forest-seed zoning is based on methodological principles that are not adapted to the conditions of Ukraine and don't provide sufficient support for maintaining the biological stability of woody species, as well as forest ecosystems as a whole. The proposed scheme of forest-seed zoning allows for its unification and regulating the rules for the movement of seeds and other types of generative material between the territorial units of zoning, thus ensuring the preservation and protection of the gene pool of especially valuable populations, as well as the effective use of the generative potential of the best populations, which will improve the selection traits of the next generations of forests. Setting apart unified zoning units of different status and rank levels will reflect in a more objective manner the patterns of the population structure of woody species in accordance with the principle of the unity of the composition of phytocoenosis and the environment of their functioning, taking into account the degree of breeding value and the level of genetic transformation of forest ecosystems.

## Spatio-temporal analysis of illegal amber mining in Ukraine using remote sensing

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**Key words:** Illegal amber mining, dNBR, satellite images.

Ukraine is one of the leaders of amber reserves in the Europe. Ukraine's amber deposits are concentrated in the northwest, stretching through three regions: Zhytomyr, Rivne and Volyn, close to the Belarus-Ukraine border. Unfortunately, in recent years, there has been an increase in illegal amber mining activities in the Ukrainian.

To assess the area of illegal amber mining and its dynamics for each forest enterprise we combined official data of the State Agency of Forest Resources of Ukraine in GIS file format and multispectral satellite imagery. We incorporated a set of available historical satellite images provided by several missions of Landsat (TM, ETM+, OLI) and Sentinel 2 sensor.

Our research was based on analysis of time series of satellite images accelerated by cloud platform Google Earth Engine. Perimeters of disturbed areas were mapped using dNBR (delta Normalized Burn Ratio). The dNBR values are calculated as a difference of NBR index characterizing state of the area before and after amber mining. Applying dNBR allowed us reclassifying mapped area as a gradient representing intensity of disturbances using four levels: low, moderate-low, moderate-high and high.

The mapping procedure could be described as follows: 1) search for a year when disturbance of forest area firstly was identified; 2) filtering images for a summer season one year before with cloud coverage less than 50 %; 3) following that filtering rule, selection of images for every year in time lag starting from year, when mining was identified and finishing with 2017; 4) calculation of *dNBR* values; 5) reclassification of dNBR rasters using site specific threshold (usually in a range of 0.10–0.15); 6) annual mining area calculating.

We have analyzed 11 forest enterprises starting of the year illegal mining was identified for the first time to 2017. The total area of disturbances was estimated as 2530 ha. The analysis of mining intensity levels allowed us to state that illegal amber mining in recent years has increased on the territory of four forest enterprises. Another four forest enterprises has experienced the situation when amber mining has stopped or increased not significantly. The intensity of amber mining for rest three forest enterprises has decreased or stopped.

The technique of evaluation of forest damage caused by illegal amber mining has proved its effectiveness for the purposes of planning different measures taken for conservation, protection and reproduction of forests.

## Software solution for internal control of conformance with Forest Stewardship Council Principles and Criteria

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**Key words:** Computer software, Forest Stewardship Council Principles and Criteria, regulatory documents, SD NULES of Ukraine "Boyarka FRS".

Computer software «Software solution for internal control of conformance with Forest Stewardship Council Principles and Criteria» has been developed by a scientific team of Separated division of the National University of Life and Environmental Sciences of Ukraine "Boyarka forest research station" (further referred to as SD NULES of UKRAINE "Boyarka FRS"). The copyright for the software product is registered by Ministry of Economic Development and Trade of Ukraine (certificate of registration of copyright for work No. 81013, dated 16.08.2018).

*Software description.* The software provides for three levels of information access. The "administrator" level, which is assigned to the person who is responsible for forest certification at the enterprise, it is possible to view and change all available documental information that is in the software product. Creating this profile is mainly aimed at general monitoring of state and relevance of documents related to forest certification at the enterprise. The "responsible employees" level allows viewing and uploading information for those Criteria, that are within responsibility sphere of a certain employee (lead accountant, lead engineer, labor safety engineer etc.). The "administrator" level allows to assign enterprise employees responsible for each FSC Principle and Criterion. The "guest" level is provided for certification bodies' employees, this level allows viewing and downloading all the Principles-related documents available in the system. After authorization, a user obtains comprehensive information on state of regulatory documents that have been uploaded. For better usability, the following colors are used for denoting information state: green – up-to-date information, red – expiring documents, and black – inapplicability of a certain Criterion or Principle. For uploading information to the program, firstly it is necessary to choose a Criterion. Further, upload a copy of a certain document (in pdf, docx, xlsx, jpg, pptx and other formats), and indicate its expiry date. A user may add a note to the selected Criterion when necessary. Previously uploaded documents can be viewed, downloaded and deleted when necessary.

For certified forestry enterprises it is very important to organize their activity in such a way that would enable confirming their FSC-certified status during annual audits. However, due to high responsibility, certificate holders face a considerable amount of work that creates an additional pressure on their employees. Availability of an automated system for information collection and processing will enable forestry enterprises' employees to secure timely control over availability and relevance of forest certification-related documents that in turn will prevent violations of Forest Stewardship Council's international requirements.

## Old Growth Forests: an important example of the High Conservation Value Forests in Ukraine

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**Key words:** Old Growth Forests, High Conservation Values, Criteria and Indicators, identification, FSC.

Small patches of old-growth (primeval) forests have been conserved in different places across Europe, but exceptional large concentration of them can be found within the Carpathian mountain range, including the Ukrainian part of it. However, a big share of these old-growth forests (OGF) in Ukraine is located outside existing protected areas and therefore could be an object of both legal and illegal timber harvesting.

In the draft of National Forest Stewardship Standard for Ukraine, OGFs belong to the Category 3 (rare, endangered or extirpating ecosystems and habitats) of the High Conservation Values (Principle 9); they are also one of the best candidates for Representative Sample Areas (Principle 6).

History of the identification and conservation of OGFs in the region:

- 2006-10 – pilot application of the OGF concept within the HCVF identification;
- 2008-12 – pilot field works on the OGF identification in the Ukrainian Carpathians;
- 2012 – harmonized C&I for OGF identification in Maramuresh part of the Carpathians (RO / UA) developed,
- 2012 - now – large-scale field identification in the Carpathians and Polissia;
- 2014 – the OGF C&I above used as a basis for the Virgin Forest C&I by the Carpathian Convention: [http://www.carpathianconvention.org/tl\\_files/carpathiancon/Downloads/03%20Meetings%20and%20Events/COP/2014\\_COP4\\_Mikulov/Follow%20Up/DOC13\\_Criteria\\_Indicators\\_virginforests\\_FINAL\\_26SEP.pdf](http://www.carpathianconvention.org/tl_files/carpathiancon/Downloads/03%20Meetings%20and%20Events/COP/2014_COP4_Mikulov/Follow%20Up/DOC13_Criteria_Indicators_virginforests_FINAL_26SEP.pdf);
- 2017 – framework Law on the Protection of Virgin, Quasi-Virgin (OGF), and Natural Forests approved in Ukraine: <http://zakon.rada.gov.ua/laws/show/2063-19>;
- 2018: incorporation of the C&I and the Methodology into the Ukrainian national legislation: <http://zakon.rada.gov.ua/laws/show/z0707-18>.

Criteria and Indicators in brief: Minimal area (20 ha); Form (plot /massif width, regardless of its length, cannot be less than 200 m); Species composition according to the native forest type; Stand structure (mosaic, vertical and horizontal); relevant presence of Dead wood and Veteran trees; Human interventions are negligible.

Identification methodology comprises 3 stages:

- Preparatory: plots of potential virgin or old-growth forests are selected using forest management database;
- Field identification: each selected parcel is inspected for compliance to the C&I listed above at representative inventory points;
- Final: results of the field work are analyzed, status of each plot is identified, and the GIS-associated database compiled.

As of 01.01.2018, more than 90 thousand ha of OGFs in the Ukrainian Carpathians were identified in the field altogether by various organizations and projects. Map of the plots identified and their descriptions can be found at: <http://gis-wwf.com.ua/> available for forestry practitioners, nature conservationists, FSC auditors, and broad public.

## Tree inventory and 3d modeling with the using of modern methods

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**Keywords:** remote methods, tree inventory, UAV, research of trees, GPS technologies.

The use of remote sensing methods for land surface sounding with further data processing in GIS, computer simulation programs and GPS technologies have already been successfully approbated in different fields. That is why investigation of the potential of modern methods research is up-to-date and important in terms of practical application and requires further development.

The investigation was conducted from 2016 to 2018, the evidence was obtained from Berezhany Castle Park (Ternopil region, Ukraine) by means of a field study and a fly-over aimed at area photographing by a quadrotor [Phantom 4](#). The information about the location of every tree was obtained with the help of Garmin GPS Map 64S with further updating in geographic information system ArcGis 9.2 based on the orthophotomap, which was obtained by means of a quadrotor Phantom 4. After this, a geo information database of trees and bushes, which included the location of trees combined with the information about the species composition, phytosanitary and basic taxation characteristics of plants, was created.

Visualization of the created database of trees and bushes based on the digital model of the area provided the possibility to develop a three-dimensional model of the area in Realtime Landscaping Architect 2016 program. As a result, a mock-up area with model trees and bushes was created, which provides the opportunity to introduce new approaches to complex evaluation of landscaping and planning patterns of the park area in a computer program, simulate time changes and transformations as a result of cuttings as well as to introduce landscaping design methods and their visualization.

The conducted research shows that the use of unmanned aerial vehicle aimed at remote surveying of park and garden objects is promising due to its advantages as compared to traditional methods of aero-satellite surveying, namely they include the ability to avoid the influence of cloud cover, shade and distortion that are typical of aero-satellite surveying; better detalization of the investigated objects, which is important for creation of a cartographic basis and for taking measurements according to an orthophotomap; affordable flights, which are easy to retake and repeat. The use of GPS inventory with further data processing in GIS and computer simulation aimed at investigating park objects provides the possibility to simplify and lower the price of field studies, improve the accuracy and quality of the obtained materials.

## Features of primary production modeling of trees and stands

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**Key words:** stemwood, primary production, current growth, modelling.

The study of stemwood primary production of trees and stands provides evaluation of its current volume growth considering base density of wood.

Namely current volume increment of trees stemwood and stands in their weight units are considered to be their annual production.

The current increment, being a biological phenomenon, occurs as a result of complicated biogeochemical processes: photosynthesis, respiration, mineral substances cycle. It is characterized by difference of absolute values of any mensuration parameter of a tree or of a whole stand for a certain period of time. The current volume increment is the one of the main parameters that defines specifics of wood accumulation and forest productivity overall. It is largely dependent on biological features of tree species, climate, timeliness and quality of silvicultural activities, and other important factors.

Evaluation of stemwood primary production for trees and current volume increment (absolute and relative) for trees and stands requires development of mathematical dependencies based on analysis of tightness and shape of statistical link of these indices with regard to main mensuration parameters (age ( $a$ ), diameter at breast height (DBH,  $d$ ), height ( $h$ ), periodical radial increment ( $Z_r^{np}$ ) and absolute current volume increment ( $Z_m^{mn}$ )).

When conducting regression analysis of stemwood primary production, we used single and multi-variable models that included mensuration parameters being easily defined in field conditions (age, DBH and height) or obtained from simple computations (periodical radial and absolute current volume increments). Models were evaluated by their confidence level and determination factor considering the number of observations. Regarding determination factors values and significance levels, we chose the model that adequately defines the dependent variable.

We propose to conduct the assessment of the primary production of trees and stands stemwood with the following methods. The first method intends direct modelling of primary production. For each model tree or stand primary production shall be determined through indicators of base density by age classes and types of forest growing conditions.

The second method requires computing stemwood primary production by modelling current volume increment, considering an average base wood density of trunks:

$$\rho_{rds} = Z_v^{nm} \cdot \rho_d$$

where  $\rho_{rds}$  – primary stemwood production of trees or stands,  $\text{kg} \cdot \text{year}^{-1}$ ;

$Z$  – current increment of stemwood volume of trees or stands,  $\text{m}^3 \cdot \text{year}^{-1}$ ;

$\rho^d$  – average base wood density of stemwood of trees or stands,  $\text{kg} \cdot (\text{m}^3)^{-1}$ .



The base wood density that is considered in computation substantially influences stemwood primary production parameters. Primary production of stemwood depends on mensuration parameters (age, DBH, height, periodical radial tree increment) and on forest growing conditions.

It has been found that stemwood primary production increases in two directions – with increasing tree diameter either periodical increment at breast height. Obtaining the modelling outputs for stemwood primary production dynamics will allow to assess the main ecological functions of forests.

## STUDENTS' ABSTRACT

## Analysis of the fulfillment of requirements of FSC standards in forestry enterprises of Carpathian region

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**Keywords:** forest certification, non-conformance, principle, report.

Forest certification is assessment of compliance of the forest management system, that was established by international requirements for the forestry on the basis of sustainable development. In Ukraine forest certification is carried out according to the FSC scheme, which is designed to provide economical, ecological and socially balanced forest management through the implementation of relevant generally accepted and reliable standards. Scheme based on third-part annual audit for verification of the compliance with the requirements: principle-criteria-indicator.

Forestry enterprises of the Carpathian region were selected for analysis, which was audited in 2016 and 2017. In all, 42 public reports were processed. According to the results of audits in 2016, 154 conditions were recorded, and in 2017 – only 69. This significant discrepancy in the number of non-conformances due to the fact that only 52% of reports for 2017 were available at the time of evaluation.

At the same time, there is a general trend where the largest share of remarks falls to principles 4, 6 and 8 - 79% in 2016 and 61% in 2017.

Thus, the non-conformances to principle 4 are related to the requirements of occupational safety and health and are manifested in insufficient number of personal protective equipment of workers at felling areas, also they are at unsatisfactory technical condition. These issues are most sensitive to subcontractors. Social impact of forestry activities to local communities are not always counted and estimated.

The comments to principle 6 related mainly to the imperfect practice of minimizing the negative impact of logging to the environment (trailing by the water flows, spilling of petroleum, oils and lubricants, clogging), the difficulties arise in leaving trees and valuable forest components for biodiversity conservation, the system of protection of rare and endangered species is limited to existing objects of the nature reserve fund.

Monitoring and evaluation (principle 8) is limited to the collection and analysis of information flows that cover the economic sphere of activity. The environmental and social aspects of monitoring are not given proper attention, this, in turn, leads to non-conformances about the limited public access to the monitoring results.

Most of the non-conformities are not critical and do not result to suspension of the certificate. At the same time, a significant number of non-conformance indicate that the forest management system requires the implementation of system and integrated solutions related to compliance with forest certification requirements.

## Calculation of depreciation charges for an unmanned aerial vehicle DJI Phantom 4 PRO

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**Keywords:** economic rationale, depreciation, cost analysis, fixed capital, unmanned aerial vehicles, forestry.

Unmanned aerial vehicles open new possibilities when applies in forest inventory or in daily operations of forestry enterprises. Developing economic rationale for application of a new approach, technique and technology in forest sector requires cost analysis to be conducted. Among the cost components a significant role belongs to depreciation of fixed capital, whose calculation was defined as a main aim of our study. It will enable clear planning of useful exploitation period for the fixed capital object as well as establishing share in total cost of operation.

On an example of Separated Division of the National University of Life and Environmental Sciences of Ukraine “Boyarka Forest Research Station”, we substantiated depreciation charges for DJI Phantom 4 PRO quadcopter. SD NULES of Ukraine owns a DJI Phantom 3 UAV, which is an older model in a rather successful lineup of Phantom quadcopters. Since UAV’s technical features are sufficient for the envisaged application, it is possible to claim that obsolescence does not influence length of its useful exploitation period. Non-intensive exploitation of the fixed capital object enables setting a prolonged exploitation term. According to the current Ukrainian legislation, the quadcopter belongs to 4<sup>th</sup> group (9<sup>th</sup> subgroup) of fixed capital, therefore depreciation charges can be calculated using even and industrial methods for the period of 10 years.

The following calculations are conducted using an even method utilizing the following input data: initial price of a fixed capital object ( $B_a$ , equals 49470 UAH as of 01.09.2018 according to DJI official distributor in Ukraine) and depreciation factor for a certain period of time ( $H_a$ ). For a one-year period, depreciation charge is then calculated as follows:

$$P_a = H_a \cdot B_a = 0,1 \cdot 49470 = 4947 \text{ UAH}$$

Monthly depreciation charge is then equal:

$$M_a = \frac{P_a}{12} = \frac{4947}{12} = 412,25 \text{ UAH}$$

The obtained result enables us to conduct further cost analysis, which is one of the tasks of the forthcoming Bachelor’s thesis project. It shall be noted that application of industrial method of depreciation charges calculation seems to be more suitable for the existing exploitation pattern of UAVs in SD NULES of Ukraine “Boyarka FRS”, however, there is a complication linked with exact measurement of flying hours of the drone. Once this problem is solved, depreciation charges for this fixed capital object will be calculated in a more consistent way.

## Ways of raising tolerance to pathogen of *Fraxinus excelsior* L. using biotechnology methods

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**Key words:** *Fraxinus excelsior* L., die-back, resistance, microclonal propagation.

Common ash (*Fraxinus excelsior* L.) is one of the most abundant and useful species of this genera in temperate Europe (Pautasso M. et.al., 2013; Davydenko K., Meshkova V., 2014), including Ukraine (Gordienko et.al., 1992), providing both ecological and forest benefits. Also, it is famous for its diversity of ornamental cultivar.

In the present state of the art, forest restoration of stands with the use of valuable tree plant species is an actual task of forestry. One of these species is Common Ash (*Fraxinus excelsior* L.). However, the main limiting factor of distribution and cultivation in the modern period is the Ash die-back.

Ash dieback caused by *H. fraxineus* was firstly found in forest stands and forest shelter belts in the eastern Ukraine in 2011 (Davydenko K., Meshkova V., 2014).

According to literature, first symptoms of the intensive ash die-back forest stands has been found in Europe. The first manifestations affect were recorded in northern Europe (the Baltic states), later the processes were recorded in Poland, Sweden, Norway and other countries (Matsyah I., 2014). In recent years, in the western of Ukraine (Davydenko K. et.al., 2013) this affect was observed, also have been noted the ash die-back in clean and mixed stands, is appeared as result of increasing in the volume of sanitation cuttings (Matsyah I., 2014).

In this case, the significance of vegetative reproduction of plants in vitro, getting better plant materis, with fully preservation valuable signs of woody plant were increase. The solution of reproduction problem of ash and getting improvement plant material in way of resistant, is possible with providing modern biotechnology achievements, one of which is micropropagation in vitro.

Unconditionally, this method is technologically more complex than traditional preservation, requires the appropriate equipment, reagents, stuff and special skills. However, sometimes it is almost the only one way to preserve resistant to pathogens species, which is represented by a small number of plant individuals or unique genotypes.

The first attempts to microclonal propagation of *F. esce/sior* were started about 30 years (Preece et al., 1989; Bates et al., 1992; Chalupa 1983, 1987, 1990). In spite of this, micropropagation methods of multiplication *F. excelsior* have not been developed enough. Publications that describe the individual stage of *F. excelsior* cultivation *in vitro* do not allow the development of a complete technology for the accelerated reproduction of valuable, resistant plants (Mitras et al., 2009).

Latvian researchers studied organogenesis in *F. excelsior* in vitro using mature zygotic embryos (Kuusiene S., Mockeliunaite R., 2004). Bulgarian and Greek researchers studied the influence of the nutrient medium on the root formation of embryos of *F. excelsior* (Iliev I. et al., 2010). French scientists conducted a comparative analysis of two European types of Ash (common and narrow) to determine better sprouting and further development. (Raquin C. et al., 2002). According to scientists from different countries, the selection for stability resistant trees is much more important than the selection for productivity, because in case of the disappearance of certain forest tree species and even separate genotypes, high performance indicators of the remaining trees will have no longer matter.

## Dynamics of mean site index classes by groups of forest-forming tree species in Communal Enterprise “Sviatoshyn Forest-Park Economy”

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**Key words:** forest stand, productivity, site index class, mean value, dynamics.

According to Prof. Orlov, site index class is a basic mensurational index that indicates productivity of forest stands and is determined using stand origin, age and mean height. The main aim of our research was to track the dynamics of mean site index classes by groups of forest-forming tree species at Communal Enterprise “Sviatoshyn Forest-Park Economy” during a 41-year period from 1969 to 2010. This will enable general assessment of productivity of forest stands at the enterprise. For this purpose, we have calculated mean values of site index classes weighted by occupied area. The results of analysis of the mentioned information are presented below.

When tracking dynamics of mean site index classes during the specified time frame, it is possible to observe an increasing trend for coniferous group of forest-forming tree species from I,2 in 1969 to I<sup>3</sup>,8 in 2010. A similar trend characterizes hardwood broadleaved stands of SE “Sviatoshyn FPE” with an increase of the analyzed mensurational parameter from II,8 to I,2 over the specified period. In contrast, mean site index of softwood broadleaved group of forest-forming species has not demonstrated a notable increase, and is fluctuating within I site index class, which is also quite a high value. There are several reasons for such situation with the latter analyzed tree species group, the most notable of which is comparatively low significance of softwood broadleaves due to their low area share (around 300 ha). Another reason is orientation of the enterprise’s activities towards securing and enhancing protective, recreational and other useful environmental functions that are of high importance in urban and sub-urban forests, rather than prioritizing timber production. The presented analysis allows us to conclude that SE “Sviatoshyn FPE” conducts economic activity in forests in a proper way, increasingly high level of productivity of stands of the analyzed tree species groups creates preconditions for proper performance of functions important for urban inhabitants, particularly oxygen-productive and carbon-sequestrative.

## General approaches to analysis of social aspects of forest certification

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**Key words:** forest certification, social aspects, analysis, approach.

Achieving sustainable forest management allows to claim existence of a balance of environmental, economic and social interests in accordance with the international standards of forest certification. Forest Stewardship Council sets preconditions for development and approval of forest management standards that are based on internationally recognized FSC Principles and Criteria. When assessing forest management system against FSC Principles and Criteria, various aspects are assessed, namely: forest harvesting, reforestation, biodiversity conservation, labor protection, social policy, interaction with stakeholders, financial sustainability etc. Socially beneficial forest management allows local population, employees of an enterprise and society in general to enjoy long-term benefits, as well as creates powerful incentives for people to preserve and manage forest resources on the basis of long-term plans.

The main aim of our research is to analyze social aspects of forest certification at State Enterprise “Smila Forest Economy”. Prior to conducting data search and analysis it is necessary to outline a general background. When analyzing social aspects of forest certification, the following of them can be distinguished:

- The organization is obliged to comply with all applicable legislation and regulations;
- According to the rights to work (as defined in the ILO Declaration), an enterprise should take care of the social and economic development of its employees;
- Under the established rights of local communities, the enterprise shall promote their development;
- The enterprise shall pay proper attention to questions of occupational health and safety;
- For purposes of economic development, the enterprise shall provide competitive salaries to the employees, as well as it shall be consistent in paying all the foreseen taxes and fees to budgets at different levels.

Analysis of the outlined aspects of forest certification will help quantify its positive impact within the social sphere, which will be beneficial for the state, local communities and enterprise employees. Currently we have analyzed public reports on forest certification audits and have not found any non-conformances related to the outlined social aspects, neither we have found any evidence on presence of occupational injuries or salary arrears listed in forms of statistical reporting of the enterprise. These facts prove that SE “Smila FE” puts a substantial effort into conducting socially beneficial forest management and confirming its FSC-certified status.



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