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Environmental consequences of the adverse impact of unauthorized amber mining on forest areas of Zhytomyr region

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Abstract. Amber mining has already led to a regional environmental disaster. According to official data, over a thousand hectares of land, which are mainly located in the central Polissia region (Zhytomyr region), have suffered very severe damage and need to be restored. The environmental significance of such territories has been lost, and further use for forestry or agriculture is very risky. To develop the norms of anthropogenic loads on landscapes, it is mandatory to investigate anthropogenic transformation by identifying their current ecological state, establishing the dependence of changes on the intensity of anthropogenic loads individually for each natural region. The source materials for obtaining results are field research materials, tax descriptions of plantings, satellite and aerial photographs, as well as laying temporary test areas according to the generally accepted method in forestry. As a result of unauthorized amber mining in Zhytomyr region, the anthropogenic load on forestry landscapes is rapidly increasing, which causes irreparable damage, leads to an environmental and economic crisis of the region, an imbalance in the social situation of the region residents, significant losses in the field of forestry, and creates grounds for related environmental issues. There are considerable changes in the structure and mineral composition of the soil layer of forest lands, the herbaceous ground vegetation and understorey are completely or partially destroyed, the undergrowth undergoes a considerable transformation of growing conditions and anthropogenic pressure. Violation of the ecological balance of the forest at various stages of biological development can lead to irreversible consequences in the forestry sector. The results obtained are promising for further development of the method for ecological and economic estimation of the damage caused, which results in illegal amber mining

Keywords: dendro-reclamation, amber, forest areas, erosion, ecology

Introduction

Ukraine is distinguished by the richness of mineral resources, the development of which inevitably disrupts the existing ecosystems. In recent years, the problem of restoring considerable land areas damaged as a result of unauthorized amber mining in the Polissia amber-bearing district has become

acute. According to official data, over a thousand hectares of land have suffered very severe damage and need to be restored. The environmental significance of such territories has been lost, and further use for forestry or agriculture is very risky. The extraction of amber using motorized pumps destroys

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the soil structure and leads to abrupt deterioration of its water-physical properties. The difficulty of restoring such territories is related not only to financing, but also to the fact that there is no experience in dendro-reclamation of land with similar damage in the world practice. Therefore, a comprehensive assessment of the damage and its impact on all components of the ecosystem, specifically tree stands, is essential. Forest dendro-reclamation, as a relatively cheap and quite effective way of rehabilitating lands damaged by industry, has become widespread in the forest zone of Europe, Russia, and North America. During forest dendro-reclamation of disturbed lands, much attention is paid to the selection of an assortment of tree and bush species, the main element of the types of projected artificial forest stands.

Analysis of recent studies and publications Central (Zhytomyr) Polissia is one of the most wooded regions of Ukraine. The land fund of Zhytomyr region is 2,982.7 thousand hectares. In its composition, agricultural land has the highest specific weight – more than half (53.9%, or 1,608.5 thousand hectares) (Trembitskyi et al., 2011). More than a third of the land is made up of forests and forest areas covered with forest vegetation. Only 166.7 thousand hectares of land in the region are in their natural state: swamps, lakes, rivers, open lands.

Erosion processes are progressing on the territory of the region, the areas of eroded and erosion-dangerous lands are constantly growing. Erosion processes are widespread on 104.8 thousand hectares of agricultural land, which is 3.5% of the region's territory and 6.5% of the farmland area (Trembitskyi et al., 2011).

Forest vegetation in the past, a fairly humid and mild climate, a positive balance of moisture in the soil, a light mechanical composition and the lack of carbonation of the rocks led to the emergence of sod-podzolic (ungleyed and gleyed) soils, mainly of a light mechanical composition, in Polissia, namely in its central part (sandy, clayed-sandy, sandy-loam and sandy-light loamy) (Hooke et al., 1958). Sod-podzolic soils of Polissia are characterized by some negative features: acidic reaction, unsaturation of bases, scarcity of humus, the gross amount of nutrients (nitrogen, phosphate, potassium) and trace elements (Huck et al., 1958). The lack of any chemical elements in the soil causes their lack in plants.

The forest cover of the territory of Central Polissia increases from the southern regions to the northern ones from 5% to 50% and averages 33.3% (Pylpyenko et al., 2010). Among all types of forests in the territory of Central Polissia, suboral type forests are most common, which are mainly confined to sod-weak-podzolic and sod-medium-podzolic clayed-sandy and sandy soils of varying degrees of moisture (Lavrinenko, 1954). In fresh subors, pine is in optimal conditions for its development and produces the best quality timber (Kucheriavyi et al., 2006).

Amber manifestations within the forest part of the Zhytomyr region, discovered by scientists and locals, belong to the borders of the Zhytomyr Polissia. In its geological structure, the main place is occupied by Precambrian rocks covered by anthropogenic deposits (Vyshnivskyi & Kushnir, 2007). Considering the relatively small distance between the Klesivske deposit and the discovered areas of amber deposits, where it is currently being illegally mined in Olevskyi and Korostenykyi districts, as well as the similarity of the geomorphological and soil conditions of the territories, these areas should be considered a continuation of the Klesivske deposit. The lower layer of quartz sands of the intermountain formation of the Kharkiv series of the Oligocene is considered the most amber-bearing. It is represented by fine- and medium-grained sands of mainly greenish-grey colour with Glauconite, the content of which reaches 5%. The thickness of the layer of water-saturated sand is from one to five meters. The average amber content in sands of this type is 57 km³ (Shcherbak & Hoshovskyi, 2006).

Recently, the greatest activity of unauthorized amber mining on forest lands was observed within Olevskyi and Ovrutskyi districts of Zhytomyr region, Rokytnivskyi, Dubrovytskyi, Volodymyrets'kyi, Zarichnenskyi and Sarneskyi districts of Rivne region and Ratnivskyi and Liubeshivskyi districts of Volyn region. In addition, considering the geography of deposits, several other areas of the listed regions, as well as the territory of the Kyiv region, fall into a kind of risk zone. In fact, unauthorized amber mining covers almost the entire north-western part of Ukraine with an area over 14,600 km² (Kovalevsky & Legky, 2018; Nadtochii, 2007; Vyshnivskyi & Kushnir, 2007).

Amber mining is carried out by manual and hydro-mechanical methods (pump method, pumping). The latter currently prevails and has more catastrophic consequences for the environment. The

hydro-mechanical method of extraction consists in washing away the soil with a jet of water under high pressure up to 6-10 meters deep (Kovalevsky & Legky, 2018; Nadtochii & Myslyva, 2007, 2015; Slobodian, 2009). Extraction in this way destroys the fertile soil layer in the place of the probable occurrence of minerals because during “erosion” the humus layer is mixed with the main mass of underlying sandy and sandy-loam rocks. It takes decades to restore the fertile layer. During extraction by the pump method, the root system of trees is destroyed, which leads to the destruction of tens and hundreds of hectares of forest. Considerable damage to woody vegetation by such amber mining is explained by the fact that unauthorized development is mainly carried out in closed and semi-closed areas: forests, shrubs, forest belts, remote from settlements, in off-road conditions, which does not allow ensuring proper protection of deposits and manifestations (Nadtochii & Myslyva, 2007; Nadtochii & Myslyva, 2015; Slobodian, 2009).

However, the issue of reclamation and den-dro-reclamation of forest lands affected by unauthorized amber mining in the territory of Ukrainian Polissia, specifically in Zhytomyr region, is new and understudied. The first scientific papers on this issue appeared only five years ago, their main topics are satellite monitoring of affected areas (Slobodian, 2009) and assessment of environmental consequences and economic damage (Dorenko, 1979; Vovk et al., 2008; Nadtochii & Myslyva, 2015) caused by amber mining. In the studies of scientists, the authors of this paper found no analogues of a comprehensive approach to the assessment and restoration of forest areas disturbed as a result of amber mining in the Ukrainian Polissia.

Quite interesting today are the scientific studies of M. Kazimir and T. Bedernichek “Reclamation of Lands Disturbed Due to Amber Mining in Polissia: Problems and Prospects” (Kazimir & Bedernichek, 2017) and P. Nadtochii “Ecological and economic assessment of the impact of activities related to illegal amber mining on the environment of Zhytomyr region” (Nadtochii, 2015).

The scientific papers of S. Kovalevskiy and V. Legky “Integral assessment of anthropogenic transformation of forest landscapes of the Dubrovytskyi district as a result of unauthorized amber mining” and “Typological evaluation of forest areas of the Dubrovytskyi Forestry, disturbed as a result of

unauthorized amber mining” highlight the results of the study of forest stands of the Dubrovytskyi Forestry damaged as a result of illegal amber mining (Kovalevsky & Legky, 2017; Kovalevsky & Legky, 2018).

The purpose of this study lies in identifying the environmental consequences of the adverse impact of unauthorized amber mining on the land of the Forest Fund of the Zhytomyr region, which was covered with woody vegetation.

Materials and Methods

Research was conducted during 2018-2020 on the territory of the forest fund of the Zhytomyr Regional Department of Forestry and Hunting. According to the results of the reconnaissance of the damage on the territory of the mentioned enterprises, three state enterprises and seven forestry enterprises as part of them have been identified for further work: SE “Bilokorovytske Forestry” (Zamyslovytske, Ozerianske, Tepenytske, Poyaskiv forestries), SE “Olevske Forestry” (Yurivske and Kamianske forestries), SE “Slovechanske Forestry” (Syrnytsia and Mozhariv forestries). In the future, temporary experimental plots were laid out on the territory of blocks 20 and 21 of the Poiaskivske forestry, block 27 of the Mozharivske Forestry and block 29 of the Syrnytske forestry. Temporary experimental plots were laid in places of the most intense damage to sites due to amber mining, and in adjacent areas that were not adversely affected.

The source materials for this paper included field research materials, inventory descriptions of tree stands, satellite and aerial photographs, data from specialized literature, and orders of state authorities of Ukraine (Yanchuk et al., 2017). The study was conducted per generally accepted guidelines in forestry (Gordienko et al., 2000). The technology of the created forest cultivars, the conduct of economic activities in them was restored based on archival data and forest management materials and clarified during the survey in nature.

Experimental plots were laid in places characteristic of the sites. The experimental area was linked to the quarterly network. In nature, experimental plots were limited by visors, and pits (30×30×30 cm) were dug at the corners, and earth was left at a distance of 30-35 cm. The age of individual woody plants was determined according to the data of inventory descriptions, and if there were no such – visually, according to the general condition of plants, inventory

indicators, conditions of local growth. Measurements of the principal inventory indicators of trees were conducted according to the generally accepted method (Anuchin, 1982). The type of forest vegetation conditions was determined according to the forest typological classification of Alekseev-Pogrebniak (Pogrebniak, 1968) considering the indicators of forest types, soil, and relief. The volumetric mass was determined according to the pycnometric method in twofold repetition, the *pH* of the salt extract was determined by the potentiometric method, the hydrolytic acidity was determined according to Kappen, the amount of absorbed bases was determined by Kappen-Gilkovits, and the humus content was determined according to Turin. Soil analyses were performed in threefold repetition, with a permissible deviation from the arithmetic mean of no more than $\pm 5\%$ (Arinushkina, 1970).

Results and Discussion

Mass amber mining in the Zhytomyr region began somewhat later than in the neighbouring Volyn and Rivne regions. This was one of the prerequisites for the fact that the total area of damaged territories and forestry land is less than in neighbouring regions.

Areas of forest stands that require dendro-reclamation were identified on the territory of three enterprises. The most disturbed areas (336.60 ha) are on the territory of the "Bilokorovytske Forestry", "Olevske Forestry" (30.70 ha) and "Slovechanske Forestry" (2.15 ha). According to the results of the damage analysis, seven forestries have been identified for further research on the territory of the mentioned enterprises: SE "Bilokorovytske Forestry" (Zamyslovytske, Ozerianske, Tepenytske, Poyaskivske forestries), SE "Olevske Forestry" (Yurivske and Kamianske forestries), SE "Slovechanske Forestry" (Syrnytske and Mozharivske forestries). In the future, temporary experimental plots were laid out on the territory of blocks 20 and 21 of the Poiaskivske forestry, block 27 of the Mozharivske Forestry and block 29 of the Syrnytske forestry.

On the territory of the SE "Belokorovytske Forestry", the largest area of damaged land falls on blocks 20, 21, 22, and 25 of the Poiaskivske forestry, blocks 60 and 64 of the Yurivske forestry of the SE "Olevske Forestry", block 29 of the Syrnytske forestry of the SE "Slovechanske Forestry". Forest management data and visual inspection of disturbed areas indicate that, as a result of amber mining,

mainly medieval stands of *Pinus sylvestris* L., sometimes with an admixture of *Quercus robur* L., as well as young *Betula pendula* Roth, and maturing stands of *Alnus glutinosa* (L.) Gaertn were destroyed. In the vast majority of cases, forest stands were completely cut down, and in some cases burned together with the under-canopy cover. Part of the tree stands, specifically young *Betula pendula* Roth., died after flooding the top layer of soil with pulp from sandy horizons due to hydraulic washing from motor pumps. In many areas, washing operations led to a violation of the groundwater level.

As a result of the survey of sites, several types of soil cover violations were found. These are channels for water supply to hydraulic pumps, several types of craters, pits from primary and secondary manual digging, and so-called mining pits with reinforced walls.

Temporary experimental plots were laid in places of the most intense damage to sites due to amber mining, and in adjacent areas that were not adversely affected. Only on the territory of the Mozharivske forestry, experimental plots for comparison were laid out in relatively slightly disturbed areas.

Given the fact that, according to geologists, only about 20-30% of amber is extracted from the sub-surface by pumping, there is an elevated risk of repeated violations of the territory.

In the practice of local foresters, there have already been cases when areas prepared or already planted with forest cultivars were repeatedly disturbed. In addition, considering the already explored density of amber deposits, there is a significant probability of expansion of disturbed areas in the future.

Agrochemical indicators of soils, namely their chemical composition and physical and mechanical properties, often play a decisive role in the choice of tree species and the technology of creating tree stands. Since considerable areas of the surface of the territory under study within the boundaries of the lands of SE "Bilokorovytske Forestry" during illegal extraction of amber by the hydromechanical method are covered with a layer of overburden, the thickness of which reaches 0.9 m, there is a need to investigate the indicated potential substrate. In general, the overburden rocks that comprise the washed layer – quartz, quartz-glaucomite, Lower Cretaceous and Tertiary quartz sands, as well as Quaternary sandy-clayed deposits, are characterized by the corresponding indicators (Table 1).

Table 1. Composition and agrochemical properties of overburden on the territory of SE “Bilokorovytske Forestry” (2019 research)

Indicators	Overburden rocks		
	quartz-glaucinite sand	quartz sand	sandy loam soil
Mineralogical composition	quartz, glauconite, feldspars, phosphate, calcium, gypsum, pyrite, montmorillonite, hydromica, kaolinite	quartz, feldspars, micas, hydromica, montmorillonite	quartz, feldspars, micas, hydromica, chlorite, kaolinite, montmorillonite
Dry residue, %	0.1–0.4	0.04–0.05	0.002–0.04
pH of water	5.4–6.8	4.1–5.7	6.3–6.5
Sum of absorbed bases mg-eq·(100 g) ⁻¹	7–11	0–0.3	2.0–6.2
fraction < 0.01 mm, %	10	7.5–9.3	10.5
Humus, %	0.3–0.7	0.2–0.5	1.5–3.9
Mobile phosphorus, mg-eq·(100 g) ⁻¹	14	2.5	7.5
Mobile potassium, mg-eq·(100 g) ⁻¹	10	2.5	5.0

The complex total interaction of abiotic and anthropogenic factors, which are differently balanced in the territories under study, leads to the formation of different properties of disturbed land plots. As a rule, highly disturbed lands are covered with a layer of quartz sand. Areas formed by quartz-glaucinite sands are more favourable for plant growth. According to the results of the tests, it was found that they contain a considerable amount of nutrients, specifically calcium, potassium, phosphorus, manganese, sulphur, and trace elements. The pH index of sands containing glauconite is close to neutral, and this can explain the decrease in acidity in areas where

pumping of acidified water took place in horizons containing glauconite.

After illegal amber mining by hydro-mechanical method, disturbed forest lands are mainly represented by substrates composed of a mixture of fine-grained quartz sands. The main indicators of overburden that limit or sharply reduce the efficiency of biological development of land include acidity, nutrient content, and water content. The results of studies of the agrochemical properties of sandy substrates at the TEPs within the blocks 19, 20, 21, 22 of the Poiaskivske forestry of the SE “Bilokorovytske Forestry” are presented in Table 2.

Table 2. Agrochemical properties of substrates with an admixture of overburden on the TEPs, covered with self-seeding, within the boundaries of the Poiaskivske forestry of the SE “Bilokorovytske Forestry” (overburden layer 0-40 cm)

No.	Species	Age, years	Months	Agrochemical properties							
				pH (KCl)	humus, %	mobile nitrogen, mg·(100 g) ⁻¹	P ₂ O ₅ , mg-eq·(100 g) ⁻¹	K ₂ O, mg·(100 g) ⁻¹	S*	H*	V*
1	Ps, Bp	5	V	3.96	0.20	2.19	6.2	8.5	0.67	1.86	26.5
			VII	4.13	0.21	1.64	7.7	10.7	1.04	1.86	49.8
			IX	4.15	0.19	1.49	6.9	10.9	1.18	1.48	44.4
2	Ps, Bp, Pt	3–4	V	4.01	0.18	1.04	7.5	14.5	0.40	1.64	19.6
			VII	4.16	0.24	2.79	9.2	9.0	1.55	1.64	48.6
			IX	4.04	0.24	1.42	7.9	14.0	0.61	1.64	27.1

Table 2, Continued

No.	Species	Age, years	Months	Agrochemical properties							
				pH (KCl)	humus, %	mobile nitrogen, mg·(100 g) ⁻¹	P ₂ O ₅ , mg·eq·(100 g) ⁻¹	K ₂ O, mg·(100 g) ⁻¹	S*	H*	V*
4	Bp	3-4	V	3.82	0.18	1.68	6.6	8.5	0.45	1.64	20.4
			VII	3.76	0.18	1.47	7.0	13.5	0.99	3.45	22.3
			IX	3.84	0.22	1.82	7.4	12.0	0.55	1.97	21.8
5	Bp, Ag, Ps	2-4	V	4.49	0.22	2.78	9.0	12.0	2.67	1.15	69.3
			VII	4.39	0.22	1.77	9.0	14.5	1.73	1.15	60.1
			IX	4.25	0.20	2.01	6.3	10.5	1.37	1.31	51.0
6	Bp, Ps, Pt	2-3	V	4.20	0.14	1.14	5.2	13.5	1.37	1.31	51.0
			VII	4.24	0.22	2.66	5.6	15.5	0.98	1.15	46.0
			IX	4.21	0.22	1.26	5.0	14.5	1.17	1.15	50.4
7	Ps Bp	2-4	V	4.19	0.22	1.89	6.0	9.0	0.42	1.31	24.2
			VII	4.09	0.24	3.10	8.2	11.4	0.61	1.31	31.8
			IX	4.06	0.20	1.16	4.0	10.0	0.61	1.48	29.2

H* is the hydrolytic acidity, mg-EQ per 100 g substrate;

V* is the degree of saturation of the substrate with bases;

Ps is *Pinus sylvestris* L.;

Bp is *Betula pendula* Roth.;

Pt is *Populus tremula* L.;

Ag is *Alnus glutinosa* (L.) Gaerth.

According to the degree of acidity, the substrates under study are highly acidic. The pH response is within 2.76-4.49. Zonal soils are characterized by a low content of organic matter. According to the present study, the humus content in all the areas under study covered with a layer of overburden is extremely low and amounts to 0.14-0.24%. However, this fact indicates the presence of a humus-forming process and its connection with the functioning and development of biota. Overburden rocks in the study area contain a small amount of nitrogen, and therefore the content of its available form is estimated as very low. Almost all mobile nitrogen in the areas under study is in the ammonia form, since nitrate is prone to either rapid absorption by plant roots, or leaching into deeper layers, or transformation. The amount of available nitrogen (Table 2) indicates only the nature of its circulation in continuous cycles between vegetation and the substrate.

There are no substantial seasonal changes in the content of mobile nitrogen in anthropogenic washing substrates. In almost all the areas under study, there are two periods during the year, quite sharply

separated from each other: the period of predominant consumption, which coincides in time with the season of active vegetation, and the period of filling the labile fund, which covers the cold season. There-with, the formation of long-term reserves (humus reserves) almost does not occur. The content of mobile nitrogen in anthropogenic substrates may only be sufficient to meet the current needs of biota, but it may not be in reserve.

Agrochemical analysis of anthropogenic substrates allowed establishing that the content of available phosphorus (P₂O₅) during the entire growing season was 4.0-9.2 mg·(100 g)⁻¹, with some tendency to increase until the end of July. According to the degree of supply with available phosphorus (P₂O₅), the substrates under study also belong to the poor.

According to these indicators, they are inferior to zonal soils, where the P₂O₅ content ranges within 9.3-14.7 mg·(100 g)⁻¹ of soil. The amount of exchangeable potassium (K₂O) in the substrates of the experimental plots for the entire growing season was at 8.5-15.5 mg·(100 g)⁻¹ of the substrate, which

corresponds to the content of exchangeable potassium in zonal soils, where its amount ranges within 10.7-14.5 mg·(100 g)⁻¹ of soil. At plots No. 2 and 3, a decrease in the content of K₂O was observed in June, compared to the presence in May, and then it increases again until the end of September. In all other areas, the maximum content of metabolic potassium in substrates occurs in July. The highest K₂O content is observed during the growing season at plot No. 6, where its amount ranges within 13.5-15.5 mg·(100 g)⁻¹ of the substrate. Determining the degree of soil saturation with bases, along with determining the pH of the salt extract, hydrolytic acidity and the amount of exchangeable bases is one of the key methods of researching acidic soils for liming. On land plots No. 1, 2, 3, 4, 6, 7, the substrates under study belong to Group I according to the need for lime, since the degree of their saturation with

bases is 50% or less. Group II includes substrates at Plot No. 5, the degree of their saturation with bases is within 51.0-69.3%. These substrates require less lime. Thus, the data of the presented studies indicate the peculiarity of agrochemical properties of substrates. However, these substrates are non-toxic and because of their agrochemical properties, are quite suitable for the growth of both local and introduced woody plant species.

As a result of hydraulic washing, deep layers of soil are brought to the surface of the plots, and the upper layer of zonal soil is buried under a layer of up to 0.9 m. This affects the physical properties of overburden rocks, depending on the types of their substrate (Table 3). As a result of strong mixing, when using the hydro-mechanical method of amber extraction, all layers are mixed and, as a result, the humus layer is inferior in many respects to quartz sand.

Table 3. Physical properties of overburden on the territory of “Bilokorovytske Forestry”

Substrate type	Specific gravity, g·(cm ³) ⁻¹	Volumetric mass, g·(cm ³) ⁻¹	Hygroscopic humidity, %	Porosity coefficient	Filtration coefficient, m·(day) ⁻¹	Total porosity of the substrate, %
Humus layer of the soil	2.66	1.50	2.20	0.785	1.32	43.6
Quartz sand	2.65	1.55	0.80	0.724	1.61	41.5
Quartz sand with admixtures of glauconite and kaolin	2.65	1.40	4.60	0.893	1.37	47.1

Mineral nutrition is of significant importance for the physiology of the tree, since its normal growth requires a sufficient supply of certain mineral elements. At certain stages of growth and development, plants experience unique needs for elements of mineral nutrition, and therefore knowledge of the dynamics of consumption and redistribution of nutrients in the first years of plant life serves as the biological basis for agricultural technology of their cultivation.

The share of disturbed land is rather considerable and is growing every day. This indicator points to the considerable losses of wood raw materials, non-wood resources of the forest, understorey, undergrowth, and ground vegetation. At the same time, these losses increase the class of fire danger in damaged areas, which can lead to inevitable consequences. Disturbed forest areas are a source of forest pests and fungal diseases. The negative trend

that has developed in the forest massifs of individual forest farms renders forest certification impossible, which would otherwise allow the enterprise to move to a new level of management.

Conclusions

The massive spread of amber mining in recent years has socio-economic, legal, and geological prerequisites and entails environmental, social, and economic consequences. Mining is carried out by manual and hydro-mechanical methods, the latter currently prevails and is more catastrophic for the ecology of the region.

A catastrophic environmental situation is inherent in the centres of mass amber mining, which is the driving force for the imbalance of all ecological indicators of the area, the emergence of side environmental problems and can lead to irreversible consequences. The forest ecosystem is adversely affected at various stages of its development. Forest stands suffer from changes in the hydrological system of the region, which are associated with illegal extraction, which, in turn, can lead to an increase in the volume of lost timber. Having analysed the total

anthropogenic load on forest landscape systems, the authors of this paper found that most of the territory under study is characterized by substantial anthropogenic transformation. Within the area under study, powerful foci of unsatisfactory ecological state were formed due to unauthorized amber mining. Currently, there is a trend of rapid growth in the share of land converted as a result of illegal mining.

The main reasons for the negative changes in the region are the lack of a single ecologically balanced system of rational nature management and ignoring the parameters of permissible standards of load on landscape systems, the lack of relevant legislative acts on the regulation of illegal amber mining, the inaction of law enforcement agencies, the obstruction of the activities of forestry workers, the difficult socio-economic situation of the local population.

Further research is to establish the features and ways of stimulating natural vegetation renewal in areas degraded due to illegal amber mining, to investigate the influence of abiotic environmental factors on the processes of vegetation renewal, to develop a method for ecological and economic estimation of damage caused to forests as a result of unauthorized amber mining.

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Екологічні наслідки негативного впливу несанкціонованого видобутку бурштину на лісові ділянки Житомирщини

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Анотація. Видобуток бурштину вже призвів до екологічної катастрофи регіонального масштабу. За офіційними даними, понад тисяча гектарів земель, які переважно розташовані на території Центрального поліського регіону (Житомирська область), зазнали дуже сильних ушкоджень і потребують відновлення. Природоохоронне значення таких територій втрачено, а подальше використання для ведення лісового чи сільського господарства є дуже ризикованим. Для розроблення норм антропогенних навантажень на ландшафти обов'язковим є дослідження антропогенної трансформації шляхом виявлення їх сучасного екологічного стану, встановлення залежності змін від інтенсивності антропогенних навантажень індивідуально для кожного природного регіону. Вихідними матеріалами для отримання результатів є матеріали польових досліджень, таксаційні описи насаджень, супутникові та аерофотознімки, а також закладання тимчасових пробних площ за загальноприйнятою у лісовому господарстві методикою. Унаслідок несанкціонованого видобутку бурштину на території Житомирщини стрімко зростає антропогенне навантаження на лісгосподарські ландшафти, що завдає їм непоправимої шкоди, призводить до екологічної та економічної кризи району, дисбалансу соціального становища жителів району, значних збитків у сфері лісового господарства, створює підґрунтя для виникнення супутніх екологічних проблем. Відбуваються значні перетворення у структурі та мінеральному складі шару ґрунту лісових земель, повністю або частково знищується живий надґрунтовий покрив і підлісок, підріст зазнає значного перетворення умов місцезростання та антропогенного тиску. Порушення екологічної рівноваги лісу на різних етапах біологічного розвитку, може призвести до незворотних наслідків у лісгосподарській галузі. Отримані результати є перспективними для подальшого розроблення власної методики еколого-економічної оцінки заподіяної шкоди, наслідком яких є незаконний видобуток бурштину

Ключові слова: дендрорекультивація, бурштин, лісові ділянки, ерозія, екологія