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CURRENT CHALLENGES FOR THE CONSERVATION AND RESTORATION OF FOREST ECOSYSTEMS IN UKRAINE

Ukraine's forests play a key role in maintaining ecological balance, regulating the climate and preserving biodiversity. However, today the forestry sector faces unprecedented challenges caused by the russia's military aggression, climate change and the need to reform the management system. Over the past decade, there has been a negative trend of declining forest areas: if in 2014 the forest area was approximately 10.4 million hectares, then as of 2024 this figure decreased to 10.185 million hectares [1]. Such dynamics pose a direct threat to biodiversity conservation, as forests provide habitats for over 80% of terrestrial flora and fauna species and perform critical ecosystem functions, including climate and hydrological balance regulation [1].

The war has been the most destructive factor for forest ecosystems. Since 24 February 2022, about 30% of Ukraine's forests have suffered varying degrees of damage as a result of hostilities. The total area of forests affected by the war is estimated at 3 million hectares [2]. Particularly critical damage has been caused to the nature reserve fund (NRF) sites. As of March 2024, 45 NRF sites under the jurisdiction of the State Enterprise "Forests of Ukraine," totalling 36,441 hectares, have been negatively affected [3]. For just six of these sites, the calculated losses amounted to over 817 million hryvnia [2]. The main factors contributing to the destruction were active ground combat operations, aerial bombing, the construction of fortifications, and the widespread contamination of territories with explosive objects.

In addition to the physical destruction of trees, combat operations cause long-term chemical contamination of forest soils. In areas where explosions and destruction of equipment have occurred, high concentrations of heavy metals, fuel and lubricant residues, and specific toxic compounds – detonation products such as residues of TNT, hexogen, octogen and rocket fuel components – have been recorded [2]. This poses a threat not only to biodiversity but also to public health due to toxins entering the groundwater. Forest fires in radioactively contaminated areas are particularly dangerous. In 2022, rocket and bomb attacks on the Drevliansky Nature Reserve resulted in the destruction of over 2,100 hectares of forest by fire [2]. The damage exceeded 14.5 billion hryvnias and created a threat of secondary radioactive contamination due to the atmospheric release of isotopes from combustion products [2].

Landmines remain a critical problem. Approximately 0.5 million hectares of forest in the controlled territory require demining and, taking occupied territories into account, up to 2.2 million hectares may be contaminated [4]. Illegal amber mining remains a separate challenge for the forests of Polissia, leading to the complete degradation of ecosystems. A striking example is the destruction of the landscapes of the "Rechytsa" hydrological reserve (Zhytomyr region), where more than 80% of the territory has been damaged by illegal mining [5]. The washing away

of the fertile soil layer and the disruption of the hydrological regime in such areas make natural forest restoration impossible and require costly recultivation [5].

The response to these systemic challenges was the implementation of the State Forest Management Strategy until 2035, which aims to increase forest cover to 18% and total timber reserves to 2.5 billion m³ [1]. An important step was the division of functions in the industry: the Ministry of Environment formulates policy, the State Forestry Agency implements it and exercises control, and the economic function is consolidated in the State Enterprise "Forests of Ukraine". The government has decided to transform the State Forestry Agency into a joint-stock company (with the state retaining 100% of the shares) to improve corporate governance [4].

Ensuring transparency and combating illegal logging is being achieved through digital transformation. The introduction of electronic logging tickets and certificates of origin for timber has become a key tool. A significant step in the digitalization of control is the introduction of GPS monitoring of the movement of specialized vehicles [4]. Equipping vehicles with GPS trackers allows real-time tracking of vehicle movements, recording of stop times and locations, and monitoring of fuel consumption. This approach enables the detection of suspicious activity in forest areas and minimizes the risk of illegal timber exports. Currently, functionality is being developed that combines GPS monitoring with the e-Naryad system for comprehensive tracking of equipment operation, with the prospect of extending this requirement to all forest users.

Despite the war, the President's "Green Country" program and forest restoration are continuing. In 2023, 35.2 thousand hectares of forest will be restored [4]. A key element of the restoration strategy is the development of a network of forest seed and selection centres (FSSCs). The transition to growing planting material with a closed root system significantly improves crop quality and survival rates. As of early 2024, four powerful centres (in particular, in the Lviv, Zhytomyr, Khmelnytskyi, and Kirovohrad regions) with a capacity of over 10 million seedlings per year are already operating within the State Enterprise "Forests of Ukraine" [4]. Increasing capacity to 25 million seedlings in 2024 will provide the industry with high-quality material for the Green Country program and the rapid restoration of tree stands destroyed by the war. There are also plans to establish laboratories for genetic research and the biological protection of forests.

An essential tool for confirming the sustainability of forest management is certification according to FSC and PEFC standards. As of early 2024, 4.65 million hectares of forest had FSC certification. The standards require companies to interact with stakeholders and preserve exceptional environmental values. In addition to timber, it is important to develop secondary forest use (harvesting berries, mushrooms, and medicinal raw materials). Analysis shows an increase in the volume of non-wood products harvested, indicating diversification of forestry activities. A promising direction here is the creation of cooperatives and the use of GIS technologies for resource monitoring.

It has been established that ensuring the environmental sustainability of regions requires a transition from extensive forest use to scientifically based forest resource regeneration. A key tool is the implementation of large-scale initiatives, such as the Green Country program, which aims to plant a billion trees. The effectiveness of restoration measures critically depends on a comprehensive

approach: a combination of artificial and natural restoration, strengthened protection of nature reserve areas (especially in the Carpathians and Polissia), and the priority use of autochthonous plant species adapted to local conditions.

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