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The Challenge of Mobilizing the Unused Wood Stock Reserve to Foster a Sustainable and Prosperous Hungarian Forest Industry

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Woody biomass is a key raw material of the circular bioeconomy, and its use can contribute considerably to achieving sustainability goals and carbon neutrality. The use of timber can foster climate change mitigation through long-term carbon storage and through the substitution of fossil products and fossil fuels. Sustainable forest management is meant to balance the contradictory goals of economic efficiency and nature conservation with careful planning and foresight. Consequently, it is important to assess the amount of timber that can be harvested without compromising sustainability. In our study, we examined the amount of wood stock accumulated in overmature stands in Hungary. Overmature stands are defined as those stands where the actual age of the stand is over its cutting age prescribed by the Forest Authority. 11.5 % of the standing volume in Hungary is overmature, and the wood stock of overmature stands has increased by more than 250 % in the last 40 y. Our results point out that a significant surplus of timber ripe for cutting is stored in overmature stands. The importance of this unused wood stock reserve is enormous, as it is a basis for meeting the growing timber demand in a sustainable way. In our study, we present the most important characteristics of the overmature black locust (*Robinia pseudoacacia*), which stands as a representative example. The authors conclude that the mobilization of the unused wood stock reserve and the utilization of the additional harvest possibility will be among the most important challenges of the Hungarian forest industry in the upcoming decades. The harvesting potential could be unlocked by professional integration and technical assistance provided to forest managers and wood industry enterprises based on GIS applications. Geographically explicit information on the amount and value of wood stocks available for harvest could be a basis for creating a new type of entrepreneurial culture and new ways of providing forest-related services.

1. Introduction

It is widely known that forests and trees are important for biodiversity conservation, ecosystem stability and even for human well-being (Kanniah and Ho, 2017). However, in addition to providing many ecosystem services, forests also provide timber which is a key raw material of the circular bioeconomy targeted by EU policy (Verkerk et al., 2022). Obtaining lignocellulosic materials for energy production is becoming a challenge in many parts of the world. Even non-forestry raw materials and agricultural wastes are used for energy production (Suárez-Rivero et al., 2021). Standing volume of woody biomass in forests, as well as harvested wood products (Király et al., 2022), are important carbon pools accountable under the United Nations Framework Convention on Climate Change (UNFCCC) (Király et al., 2022) supported by (IPCC 2006). The forest industry can contribute significantly to climate mitigation pathways in order to achieve carbon neutrality targets set by the Green Deal (Lerink et al., 2023).
Borovics et al. (2023) show that a significant unused wood stock reserve exists in Hungary. According to their results, even without new afforestation, more timber becomes available for harvest annually up to 2100 than the level of the average harvests of the 2017-2021 historical years (Borovics et al., 2023). According to their study, up to 2050 in Hungary, an additional 4.059 Mm^3 of timber is projected to become available for harvest as a maximum.

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In Hungary more than 40 % of the forests have a plantation-like composition of non-native tree species like black locust (*Robinia pseudoacacia*) and pine species (*Pinus sylvestris* and *Pinus nigra*). Black locust is the tree species occupying the largest area in Hungarian forests with an area ratio of 24 % (NFK, 2023). In recent decades, afforestation has typically been carried out under unfavourable and degraded site conditions. In artificially drained semi-desert habitats occurring in Hungary, in many cases, only the introduced black locust can be used for successful afforestation.

Black locust is a fast-growing, nitrogen-fixing, drought-tolerant tree species. Due to its adaptability to various sites and climates and attributable to its valuable and resistant wood and excellent nectar production, it has a key role in the field of plantation forestry worldwide (Ábri and Csajbók, 2023). The importance of black locusts in the Hungarian wood market is considerable, as it represents 1.4 Mm^3 of the 7.5 Mm^3 annual gross timber production (NFK, 2023). The industrial timber ratio of the extracted black locust timber is around 20 %, and this amount (approximately 230,000 m^3 annually) represents 8 % of the total domestic industrial timber production. At the same time, the role of the species is decisive in the firewood market since around 27 % of the annual net firewood production (approximately 900,000 m^3) is black locust. In addition to the traditional areas of use, in recent years, black locust has gained increasing importance as an energy woody plantation due to its fast-growing nature and relatively easy and cost-effective regeneration (Szmorad and Tímár, 2014).

According to recent economic analyses, black locusts are still net profitable on the weakest site conditions as a single agricultural plant (taking woody and non-woody crops into account) if the rotation cycle is reduced to 20 years (Nagy, 2013). However, the 30–35–40-year rotation cycle makes the cultivation of black locusts unprofitable under weak site conditions. Under good site conditions, it is worth increasing the cutting age, as extra-sized logs can be produced, which compensates for the longer rotation period and for the longer investment cycle (Kottek et al., 2023).

The goal of our study was to assess the characteristics of overmature black locust stands as it is one of the economically most important tree species in Hungary, and according to Borovics et al. (2023), a significant unused wood stock reserve of the species has been accumulated in the last decades. The total amount of overmature black locust wood stock has been examined by Borovics et al. (2023). However, the distribution of overmature stands among yield classes, nature conservation categories and management systems have not been studied yet. In addition to the above-mentioned characteristics, we also intended to examine the number of years with which the age of the stand is over its prescribed cutting age in order to define the degree of overmaturity. This assessment could serve as a basis to plan measures in order to unlock harvest potentials of overmature black locust stands.

2. Methodology

Our study is based on the National Forestry Database (NFD) as the data source (Tobisch and Kottek, 2013). The NFD stores data on each forest stand (also called forest subcompartment). Data collection is based on field surveys conducted as part of the forest management planning activity. On each stand, digital maps and more than 300 raw and derived data are available (Kottek et al., 2023). Each forest stand is surveyed every 10 years. Between two field surveys, a yield table-based increment estimation is used. In the NFD, the cutting age prescribed by the Forest Authority is stored for each forest stand, as well as the actual age of the stand.

We defined stands as overmature if the actual age of the stand was over its cutting age prescribed by the Forest Authority. In this study, we queried the standing volume of overmature black locust stands based on the following criteria.

$$Overmature = true, \text{ if } CuttingAge < Age, \tag{1}$$

$$Overmature = false, \text{ if } CuttingAge \geq Age, \tag{2}$$

The overmature stands were then subdivided by ownership, nature protection status, management system, yield class and cutting age indicator based on the NFD data. In Hungary, four different forest management systems can be applied: rotation forest management, continuous cover management, non-production forest management, and transitional forest management (Hungarian Forest Act, 2023). In the case of the rotation forest management system, stands are felled and regenerated following a temporal and spatial cycle. In the case of continuous cover forest management, no final cutting resulting in regeneration obligation takes place. Thus, continuous cover forests have no cutting age, and consequently, they are excluded from this study. Transitional forest management means the transition from rotation forest management to continuous cover forest management. In transitional forests, the Forest Authority prescribes a cutting age for each stand. In the case of non-production forest management, no timber management takes place, logging can only be carried out for experimental purposes or for the sake of forest protection, nature conservation, public welfare, forest regeneration or other public interest.

3. Results and Discussion

Black locust, Turkey oak (*Quercus cerris*) and hybrid poplars have the largest share in the Hungarian overmature wood stock. Black locust occupies 37 % of the area of overmature stands and gives 24 % of the overmature wood stock (Figure 1).

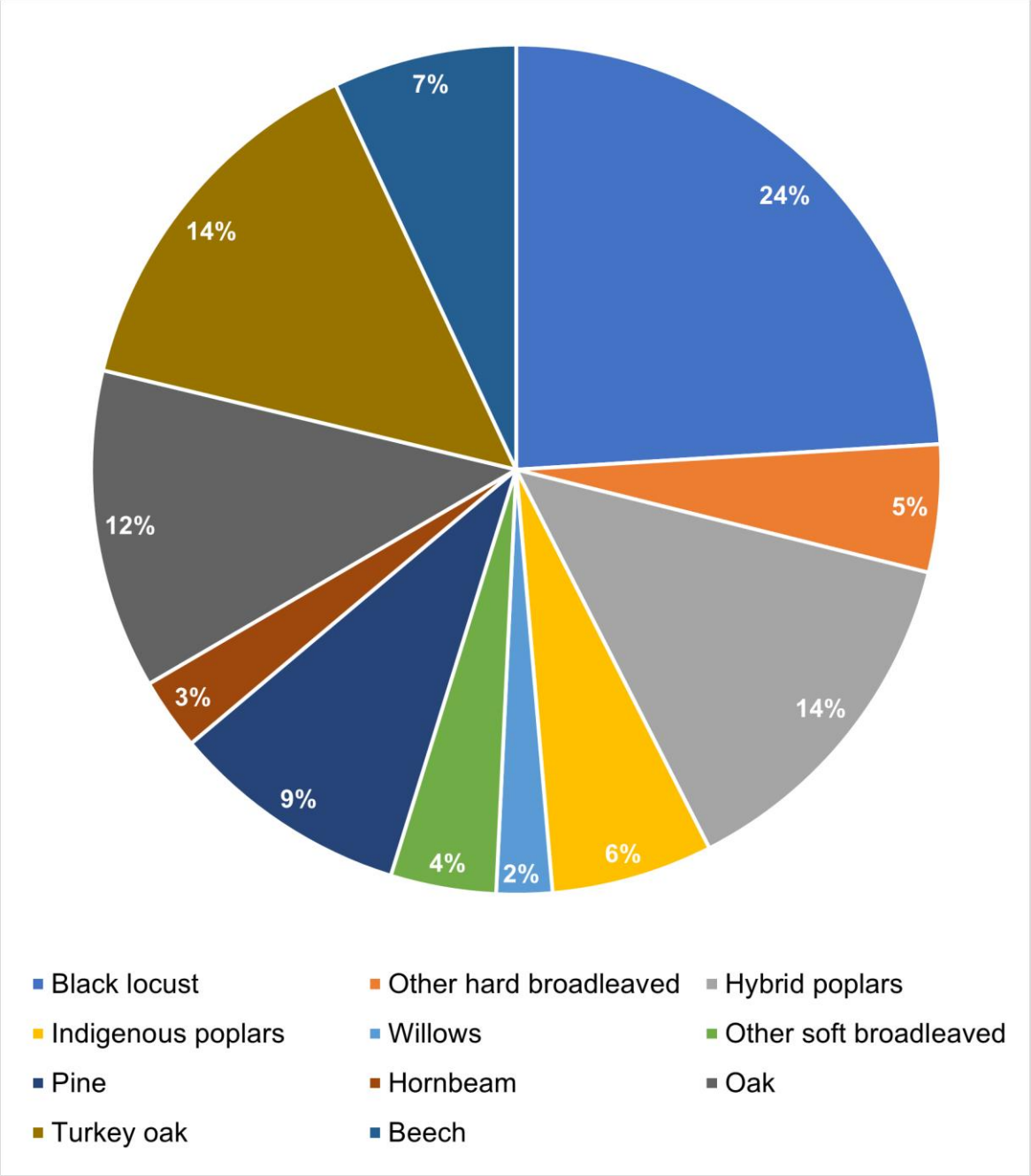

Figure 1: Standing volume of overmature forest stands in Hungary grouped by tree species group as of the 2021 state of the NFD

According to our results, the majority (87 %) of privately owned overmature black locust stock is not under nature protection (Figure 2). In the case of state-owned forests, 37 % of the overmature black locust standing volume is under nature protection, and 3 % is strictly protected, while the share of the wood stock of Natura 2000 sites is 37 % (Figure 2).

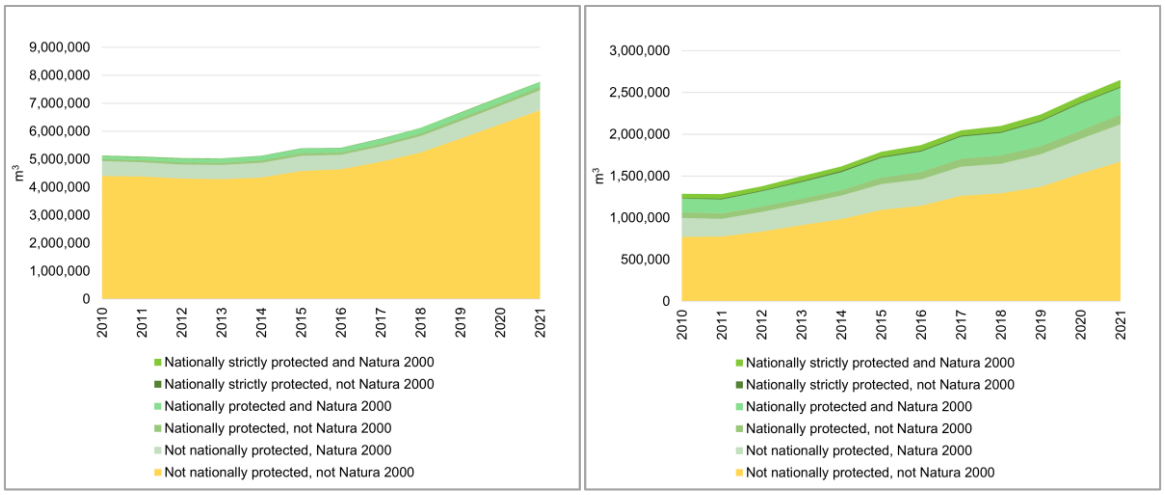

Figure 2: Standing volume of overmature private (a) and state-owned (b) black locust stands by protection status

As regards the management system, it can be stated that almost all overmature black locust stands are under rotation forest management. In the state-owned subgroup, only 1 % of the standing volume is under transitional forest management (Figure 3).

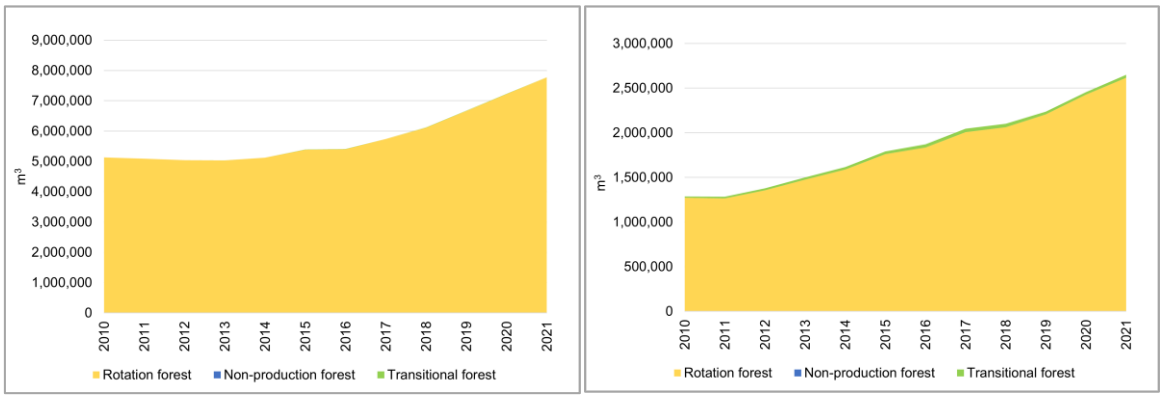

Figure 3: Standing volume of overmature private (a) and state-owned (b) black locust stands by management system

Figure 4: Standing volume of overmature private (a) and state-owned (b) black locust stands by yield class (yield class 1 is the most productive yield class, and yield class 6 is the less productive yield class)

When grouping overmature black locust stock by yield class, it can be stated that in 2021, only 0.3 % of the private overmature standing volume was in yield class 1 (which is the most productive one), while most of the standing volume was in yield class 4 and 5 (30 % and 28 % respectively; see Figure 4). In the case of state-owned forests, 1 % of the stock was in the most productive yield class, and 60 % of the standing volume was in yield class 4–5 (Figure 4). This means that it is more likely that a black locust stand in the less productive yield classes is not harvested and becomes overmature, this tendency can be well explained by economic reasons. The cutting age indicator of a forest stand shows the number of years with which the age of the stand is over its prescribed cutting age. According to our results, in private overmature black locust forests, 52 % of the stock is only 1–5 years overaged, while in state-owned forests, this category makes up 65 % of the wood stock (Figure 5). In these cases, it is probable that the harvest of the stand is postponed but not given up and will take place in some years. However, in private forests, 15 % of the standing volume is 16–30 y overaged, while in state-owned forests, only 7 % of the wood stock is in this category. This means that in private forests, more excessively overmature wood stock is accumulated than in state-owned forests. This can be explained by the fact that in private forests, a significant part of the forest area, nearly 340,000 ha, is unmanaged due to a fragmented property structure (Borovics et al. 2023).

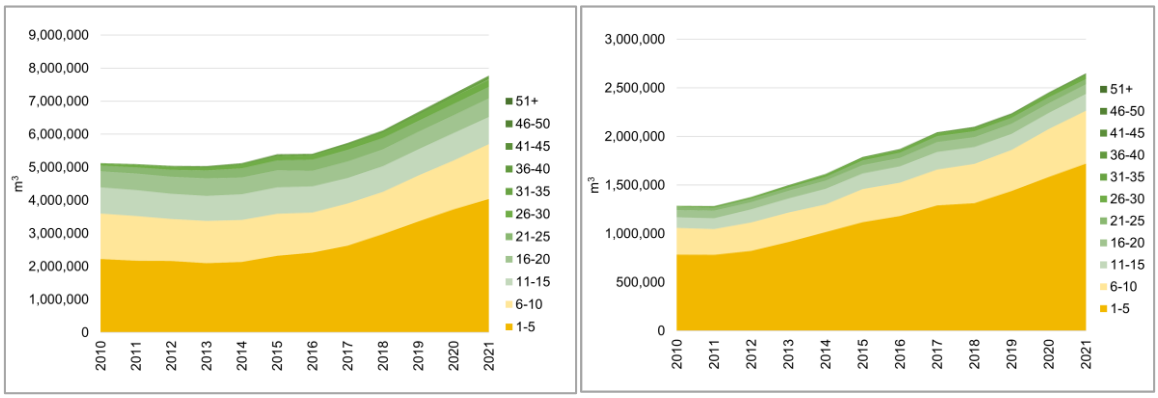

Figure 5: Standing volume of overmature private (a) and state-owned (b) black locust stands by cutting age indicator (cutting age indicator shows the number of years with which the age of the stand is over its prescribed cutting age)

4. Conclusions

In our study, we assessed the distribution of overmature black locust stands among yield classes, nature conservation categories and management systems. We also examined the cutting age indicator of the overmature black locust stands, i.e., the number of years with which the age of the stand is over its prescribed cutting age. This made it possible to define the degree of overmaturity of the unused black locust wood stock. According to our study 23 % of the overmature black locust stands are 11–35 y overaged. Due to the unsettled and fragmented property structure, many privately owned black locust stands are unmanaged in Hungary, which leads to a significant amount of wood stock ripe for cutting being unharvested. If the current conditions and practices continue, large amounts of unharvested timber will undergo significant quality deterioration and will no longer be suitable for industrial purposes. The importance of the unmanaged overmature black locust forests is high, as they represent an unused wood stock reserve, which could be available under a growing timber demand if the property relations were settled. Thus, we can conclude that the mobilization of the unused wood stock reserve and the utilization of the additional harvest possibility will be among the most important challenges of the Hungarian forest industry in the upcoming decades. The harvesting potential could be unlocked by professional integration and technical assistance provided to forest managers and wood industry enterprises based on GIS applications. Geographically explicit information on the amount and value of wood stocks available for harvest could be a basis for creating a new type of entrepreneurial culture and new ways of providing forest-related services.

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