

## OAK FORESTS OF THE LEFT-BANK FOREST-STEPPE ZONE OF UKRAINE AND THEIR NATURAL REGENERATION

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The natural range of pedunculate oak (*Quercus robur* L.) covers entire Western Europe with the exception of most of the Iberian Peninsula and Scandinavia, Central Europe, Turkey, the Republics of Belarus, Lithuania, Latvia, Estonia, Ukraine and much of the territory of the European part of Russia [7].

Pedunculate oak grow on 28% (1.7 million hectares) of forest area and are one of the main forest-forming species in Ukraine [4]. The area of oak stands within the Left-bank Forest-Steppe zone of Ukraine was 284 000 ha according to forest inventory materials (as of 2016). Oak is one of the most valuable species performing important ecological and protective functions [10]. Its timber is superior to all tree species in strength, color, texture, and capability of taking a polish.

The area with pedunculate oak prevailing in the composition (at least 50%) amounted to 232 000 ha, representing almost 82% of the total area of oak stands in the study area. The oak forests were dominated by natural stands of vegetative origin, with an area of 57%; the proportion of planted stands with pedunculate oak in composition was 36%. Natural forests of seed origin were only 7%. The area of natural stands, where oak was predominant, amounted to more than 154 000 ha, and the area of planted forests with the predominance of oak was almost 78 000 ha.

There was a decrease in the total area of oak forests as of 2016 in comparison with the data of preliminary forest inventory. Despite the increase by one thousand ha in the area of planted oak stands to 101 000 ha, the area of natural stands of seed origin decreased by 8 000 ha to 183 000 ha. In total, the area of oak forests decreased by almost 7 000 ha (Table 1). However, the total standing volume has increased by almost 4.5 million m<sup>3</sup> owing to an increase in the average age of stands, regardless of the origin.

The oak forests of the Left-bank Forest-Steppe zone have a great typological diversity since pedunculate oak grows in 67 forest types in the plains of Ukraine. However, 82% of oak forests are grow within the following four main forest types: fresh fertile maple-lime oak forest, dry fertile maple-lime oak forest, fresh fairly fertile lime-oak-pine forest, and

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fresh fairly fertile maple-lime oak forest. The smallest areas of stands with oak are concentrated in damp and wet fertile and fairly fertile sites.

Table 1

**Changes in areas and volumes of oak stands within the Left-bank Forest-Steppe zone, Ukraine, in terms of origin, for the period 2001–2016**

Origin of oak stands	As of 2001		As of 2016		Changes	
	Area (thousand ha)	Volume (million m <sup>3</sup> )	Area (thousand ha)	Volume (million m <sup>3</sup> )	Area (thousand ha)	Volume (million m <sup>3</sup> )
Vegetative	173	43.6	163	43.5	-10	-0.1
Natural seed	18	4.8	20	5.7	+2	+0.9
Planted seed	100	17.7	101	21.5	+1	+3.7
Total oak stands	291	66.1	284.1	70.7	-7	+4.5

The oak forests within the Left-bank Forest-Steppe zone (northeastern part of Ukraine), occupying an area of 284 000 ha, have uneven distribution both within «age classes» and across age groups. The distribution of oak stand areas by age groups is heterogeneous and has certain characteristics depending on the origin.

The largest part of the area is occupied by stands of age groups of 41–80 and 81–120 years – 45 and 44% of the total area, respectively. Age groups of ≤ 40 and ≥ 121 years have the smallest percentage – 7% and 4% respectively.

One of the important aspects of the management in oak forests during their regeneration, both in Ukraine and in other European countries, is the use of natural reproduction of oak and other valuable species because the stands of natural seed origin are biologically more resistant to negative environmental factors, diseases and pests. The stands are longer-lived; they reach a greater height and have a better quality of wood in comparison with coppice stands and planted forests. Also, they are centers of the gene resource for local populations of pedunculate oak. Natural oak reproduction consists of young oak seedlings of natural seed origin. Identification of peculiarities of the advance reproduction as well as analysis of its quantity and quality will promote the development of appropriate activities for the seed regeneration of high-yielding, biologically resistant natural oak stands. It will allow predicting their further development and preserving genetic potential. This problem becomes significant due to the current gradual warming and aridization of climate and the dynamic increase in the area of the nature reserve fund, the majority of which are tree stands with oak in their composition [1; 2; 3; 11].

The success rate of natural oak regeneration depends on many factors such as the number of oaks in the stand and their age, the relative density of stocking, the acorn yield, sufficient heat, moisture, and light, and the development of shrub and grass layers [1; 2; 5; 8; 9].

The results of our studies show that the highest amount of natural regeneration of pedunculate oak (about 10–11 thousand stems ha<sup>-1</sup>) appears after the harvest year under the canopy of open (the relative density of stocking is 0.6–0.7) old (140–190 years of age) oak stands with more than 70% of oak in the composition.

By age, natural oak regeneration under the canopy of oak stands belongs predominantly to the categories of young seedlings (plants of the first year of life) and 2–3-year-old regeneration, accounting for 10–100% and 4–85% of the total oak regeneration, respectively.

The number of older regeneration is significantly lower (10–40%) due to severe damage caused by powdery mildew (*Microspheera alphitoides* Gr. Et Maubl.) and transformation to stump plants. Their particularity is a saber-shaped bending on the stem of the plant with or without signs of the presence of a main stem in previous years. This indicates that growth has stopped due to mechanical damage or poor lighting.

By height, almost all oak regeneration – more than 94% of the total – is in the small-sized category (up to 0.5m high).

The analysis of the quantity and quality of oak regeneration, its height and age structures indicates that the regeneration success rate is «insufficient» or «poor» (the number of healthy regeneration in terms of 4–8-year-old large-sized individuals does not exceed 3 thousand stems ha<sup>-1</sup>) by the regeneration success scale [6, p. 142].

The absence of regeneration indicates a sharp reduction in the area of oak forests in the future. Eliminating the negative factors affecting the natural regeneration and implementing activities to promote reproduction in the oak forests of the region are priority tasks for foresters and scientists. Old (mature and overmature) oak stands, which create the most favorable conditions for the emergence and development of natural regeneration, occupy only 4% of the total area of oak forests in the region. Management interventions should aim to optimize the age structure of oak forests and grow forests of natural seed origin to apply the principles of sustainable forest management.

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