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## Representation of the genus *Larix* Mill. in the protected areas of Ukrainian Polissia

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**Abstract.** *Larix decidua* Mill. may become more important than *Picea abies* (L.) Karst for reforestation and restoration of the natural balance, and therefore it is necessary to investigate this species. Therefore, the purpose of this study was to conduct an inventory of *Larix* taxa in the protected areas of the mixed forest zone of Ukrainian Polissia, to analyse their distribution, age structure, and use. Research methods used: route, analytical, comparative analysis, systematisation. It was found that 5 species, one variety and two hybrids of larch grow in the protected areas of the mixed forest zone of Ukraine. It was established that *L. decidua* is the most widespread – it grows in parks-monuments of landscape art, natural monuments, protected tracts, reserves in pure mixed plantings, alleys, row plantings, groups and as a solitaire tree. *L. sibirica*, *L. kaempferi* grow as solitaire trees and in groups of 3 to 10 specimens in 9 and 10 protected objects, respectively. *L. gmelinii* is present in two arboretums, *L. laricina* – in one. *Larix decidua* var. *polonica* (Racib. ex Wóycicki) Ostenf. & Syrach is not widespread, represented in groups in 6 parks-monuments of landscape art and Bereznivskyi denrorark. *Larix* × *eurolepis* A. Henry. is widespread in pure and mixed stands, grows in an alley in the Slavianskyi park-monument of landscape art, in groups – in the Lisova Aleia Botanical Reserve, Bereznivskyi denrorark, and in mixed stands of the Riznolissia General Zoological Reserve. The age structure is quite diverse, represented by *L. decidua*, *L. sibirica*, *L. decidua* var. *polonica* aged from 100 to 200 years. Other species, varieties, and hybrids are

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represented by specimens aged from 3 years (*L. xeurolepis*) to 80 years (*L. kaempferi*). 69.2% of larch stands are in good condition, 28.9% are in satisfactory condition, and only 1.9% are in poor condition. The results of the research can be used in the further creation of pure and mixed stands, alleys, etc. in the mixed forest zone

**Keywords:** larch; species; park-monument of landscape art; natural monument; arboretum

## Introduction

In recent years, there has been considerable attention paid to reforestation for carbon sequestration and biodiversity conservation. European larch (*Larix decidua* Mill.) is one of the most important coniferous species in Europe in economic terms. It is expected that with the decline of *Picea abies* (L.) Karst., this species may become more important for reforestation and restoration of the natural balance by sequestering CO<sub>2</sub>. K.F. Suzuki *et al.* (2021) found that the use of introduced species for natural forest regeneration is controversial, but that the use of these species, if they are already present in the ecosystem, can lead to overall benefits for nature and society. V.A. Usoltsev *et al.* (2021) developed a pseudo-allometric model of the biomass structure of larch trees (*Larix* spp.) growing in Eurasia to create prerequisites for predicting changes in the biomass structure of *Larix* spp. trees under the influence of modern climate change. They found that a 1°C increase in temperature with constant precipitation caused a decrease in the aboveground surface, trunk, leaves, and branches of uniform and same-age larch trees. An increase in precipitation of 100 mm at a constant temperature level leads to a decrease in aboveground and stem biomass and an increase in leaves and branches. S. Jansen & T. Geburek (2016) were the first to investigate the artificial spread of European larch in Europe from the 17<sup>th</sup> to the mid-20<sup>th</sup> century. They found that during this period, larch genetic resources were displaced with varying intensity. Specifically, plant material from the Alps was transferred

outside their natural range throughout Europe, while genetic resources originating in the Sudetenland were mainly distributed in northeastern Germany, northwestern Poland, and outside the Sudetenland. Polish larch is mainly distributed within Poland itself. Genetic resources from the Carpathian Mountains (Tatras, eastern and southern Carpathians) have not been spread over long distances. The local larch populations in the Alps and Poland were hardly affected by allochthonous plant material, while the natural gene pool of larch in the Sudetenland and Carpathians was considerably influenced by alpine plants. According to C. Wu *et al.* (2021), under current climatic conditions, the areas for the spread of *L. kaempferi* are concentrated in Europe and Central and North Asia (especially Japan and Korea), as well as in North America. Globally, about 33.75% of suitable areas are located in China. Modelling future climate change shows that suitable areas are shrinking and shifting to the north of Asia, Europe, and China. *L. kaempferi* may adapt or move to higher latitudes/altitudes, which will affect its productivity. N. Bhusal *et al.* (2020) note that due to climate change, the frequency and severity of droughts will increase, so drought tolerance of tree species should be considered when creating tree stands. They note that Japanese larch is more stable and hardier in morphological and physiological reactions, as well as in the plant's relationship with water, than *Prunus sargentii*, and therefore Japanese larch will be more suitable for stands in regions with water shortages.

S.O. Belelya (2013) investigated the spread of larch in Ukraine. The author found that the largest number of stands with a predominance of larch is concentrated in the western region of Ukraine (49% of larch stands are in Lviv region, 26% – in Ternopil region, 6% – in Ivano-Frankivsk region, 3% – in Rivne region, and 1.5% – in Volyn region). Moreover, mixed stands are 4-8 times more numerous than pure larch stands. V. Zaika *et al.* (2016) investigated the growth and formation of 12-109-year-old stands of *L. decidua* Mill. in different growing conditions of the Kremenets hills. It was found that on relatively poor soils with average moisture, Scots pine is not inferior to European larch in terms of growth intensity. In the protected areas, the distribution of larch was studied in the Steppe zone, in the Forest-Steppe zone, in the broadleaf forest zone, in the Ukrainian Polissia, in the Ukrainian Carpathians – S.Yu. Popovich *et al.* (2020; 2022). The authors have analysed the species composition of dendrozoexotes, including the representation of larch species, varieties, and hybrids in the protected areas of Ukraine. Categorical and regional representativeness, as well as representation of species of age-old larch were considered. The distribution of unique trees in the protected

areas of Ukrainian Polissia, including *L. decidua* Mill. (Dzyba, 2021), taxonomic and ecological structures of potentially old, old, centuries-old, and ancient trees, including: *L. decidua* Mill., *Larix decidua* var. *polonica*, *Larix sibirica* Ledeb. (Dzyba, 2022). Given the numerous studies on larch, the relevance of the subject under study is confirmed. The purpose of this study was to investigate the representation, use, status, biometric indicators, and age structure of *Larix* genus *taxa* in the protected areas of Ukrainian Polissia.

Objectives: to make an inventory of *Larix taxa* in the protected areas of Ukrainian Polissia and distribute them by age; to determine quantitative and qualitative indicators of larch species, varieties, and hybrids, to identify types of stands created with the participation of larch.

## Materials and Methods

The research was conducted during 2014-2021 in parks-monuments of landscape art, reserved areas, nature reserves, national nature parks, dendrological parks, botanical garden, natural monuments, arboretums of the Hamarnia Landscape Reserve and Shatsk National Nature Park. During the field surveys, the condition of larch trees was assessed (Table 1).

**Table 1.** Assessing the condition of woody plants

Condition of woody plant	Characteristics of tree condition
Good	The trees are healthy, normally developed, needles are dense, evenly distributed on the branches, of normal size and colour, there are no signs of disease and pests, wounds, damage to the trunk and skeletal branches, or hollows
Satisfactory	The trees are healthy, but with signs of stunted growth, with an unevenly developed crown, few needles on the branches, minor mechanical damage and small hollows
Unsatisfactory	The trees are very weakened, trunks are curved, crowns are poorly developed, there are dry branches, the growth of annual shoots is insignificant, trunks are mechanically damaged, presence of hollows

**Source:** Order of the State Committee for Construction, Architecture and Housing Policy of Ukraine No. 134 (2001)

The DBH (diameter at breast height) (1.3 m) was measured with a tree caliper, and the height was measured with a Suunto

PM-5/1250 altimeter. The age structure was established according to the archive materials and inventory description and divided into age

groups: 1-20 years and 21-40 years (young), 41-60 years (middle-aged), 61-80 years (pre-mature), 81 to 100 years (potentially old), from 100 to 200 years (old), from 200 to 800 years (centuries-old). The names of the taxa of the genus *Larix* were specified according to the international classification The World Flora Online (WFO) (n.d.). Species of the *Larix* genus were verified for pertinence to The International Union for Conservation of Nature (IUCN) (IUCN, 2023). The study was conducted in compliance with the Convention on Biological Diversity (1992).

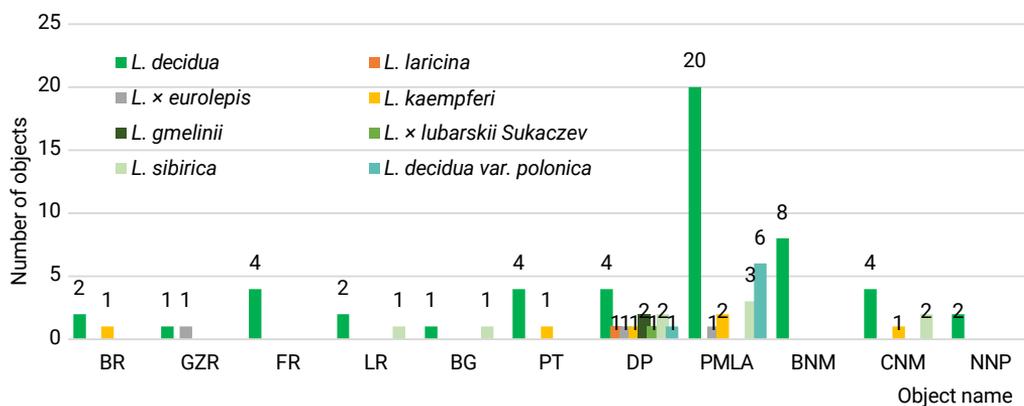
## Results and Discussion

The genus *Larix* L. is represented in the world by three North American species (*Larix laricina* (Du Roi) K. Koch., *Larix lyallii* Parl., *Larix occidentalis* Nutt.) and six Euro-Asian species (*Larix decidua* Mill., *Larix sibirica* Ledeb., *Larix gmelinii* (Rupr.) Kuzen., *Larix kaempferi* (Lamb.) Carr., *Larix potaninii* Batalin., *Larix griffithii* Hook.f.), as well as varieties and hybrids.

In the protected areas of Ukrainian Polissia grow 5 species (*L. decidua* Mill., *L. kaempferi* (Lamb.) Carrière., *L. sibirica* Ledeb., *L. gmelinii* (Rupr.) Kuzen., *L. laricina* (Du Roi) K.Koch.), one variety (*L. decidua* var.

*polonica*) and two hybrids (*Larix*×*eurolepis* A.Henry, *Larix*×*lubarskii* Sukaczew.) in 20 parks-monuments of landscape art (PMLA), four dendrological parks (DP), two national nature parks (NNP) of Shatsk and Kivertsi, and the botanical garden (BG) of Polissia National University, 12 natural monuments (NM), six reserves (two botanical reserves (BR), a general zoological reserve (GZR), a forest reserve (FR), a landscape reserve (LR)), and four protected tracts (PT) (Fig. 1). *L. decidua*, *L. kaempferi*, *L. sibirica*, *L. gmelinii*, *L. laricina* are classified as Least Concern, *L. decidua* var. *polonica* is classified as Endangered in the IUCN Red List. All representatives of the *Larix* genus grow in groups and as solitaire trees in the Bereznivskiyi Dendropark. They are 40 years old and were grown from seeds. The largest number of specimens (30) is represented by *L. decidua*, which is in good condition. The average diameter is  $34.8 \pm 2.0$  cm and the height is  $15.9 \pm 0.5$  m.

There are also seven specimens of *L. sibirica* growing in Bereznivskiyi DP, their diameter ranges from 16 to 38 cm, height – from 13 to 26 m, the condition of the plants is good and satisfactory (Table 2).



**Figure 1.** *Larix* species in protected areas of Ukrainian Polissia

Source: compiled by the authors of this study

**Table 2.** Characteristics of *Larix* L. species in man-made protected areas Ukrainian Polissia

Reserved area	Number of specimens, pcs/area, ha	Age, years	Height, m	Diameter, cm	Condition
Dubechnenskyi PMLA	5/-	60	18.5, 15.5, 16.5, 12.5, 11	21, 18, 25, 14, 16	s
Bairak PMLA	4; 1 <sup>1</sup> ; 2 <sup>2</sup> ; 3 <sup>3</sup> /-	45	(14, 16, 12), 14 <sup>1</sup> ; (16, 12) <sup>2</sup> ; (16, 12, 14) <sup>4</sup>	(29, 23, 24), 28 <sup>1</sup> ; (38, 22) <sup>2</sup> ; (23, 24, 28) <sup>4</sup>	g
Litynskyi PMLA	20; 13 <sup>1</sup> /-	140	31.7±0.1; 32.0±0.2	57.9±2.9; 59.9±1.8	g
Sadyba Lypynskoho PMLA	1/-	130	20	44	s
Novostavskyi Dendropark PMLA	2, 2 <sup>4</sup> /-	58	16, 24, (23, 24) <sup>4</sup>	12, 24, (18, 18) <sup>4</sup>	s
Zirnenskyi PMLA	1; 1 <sup>1</sup> /-	125	30.5; 30 <sup>1</sup>	80; 56 <sup>1</sup>	g
Tuchynskyi PMLA	2/-	209; 6	22.5; 2.2	90; 0.4	g
Vilkhivskyi PMLA	2+7/-	150	24, 32+35, 32.5, 35, 32.5, 32	70, 94+58, 42, 74, 56, 42	g
Horodnytskyi PMLA	10+7, 3 <sup>2</sup> /-	130, 66, 18	26.6±0.2; 25, 26, 24, 25.5, 26, 24, 24.5, (10, 11, 11) <sup>2</sup>	50.2±3.2, 40, 32, 26, 44, 40, 38, 28 (12, 10, 12) <sup>2</sup>	g
Horodnianskyi PMLA	5/-	55	14, 16, 20, 25.5, 23	23, 18, 16, 24, 22	s
Vahanytskyi PMLA	1/-	120	26	80	g
Lyzohubivskyi PMLA	2/-	130	30, 32	62, 72	g
Miskyi Sad PMLA	1/	60	14	30	g
Vozdvyzhenskyi PMLA	1/-	120	21	47	g
Kochubeivskyi PMLA	5/-	120	30, 37, 38, 35, 34	47, 74, 62, 45, 41	g
Polonskyi PMLA	16, 2 <sup>1</sup> /-	140	28.6±1.2, (33, 29) <sup>1</sup>	76.5±7.1, (104, 90) <sup>1</sup>	g
Shatskyi NNP (arboretum)	2/-	50	14.5, 14	21, 23	g
Hamarnia LR (arboretum)	2, 7 <sup>4</sup> /-	40	18, 18, (12, 13, 12.5, 12, 20, 22, 19) <sup>4</sup>	28, 30, (16, 21, 14, 11, 20, 24, 18, ) <sup>4</sup>	g, s
Rokytnivskyi Dendropark CNM	3, 5 <sup>2</sup> , 2 <sup>4</sup> /-	59	20, 19.5, 15, 16 (22.5, 17.5, 21.5, 22, 21) <sup>2</sup> , (22, 21.5) <sup>4</sup>	45, 38, 20, 22 (55, 40, 58, 40, 46) <sup>2</sup> , (36, 32) <sup>4</sup>	g, s
Sarnenskyi arboretum CNM	7, 6 <sup>4</sup> /-	57	27, 24, 24.5; 26.5; 27.5, 26, 27.5 (17, 12.5, 12, 11, 9, 11) <sup>4</sup>	24, 12; 14, 20; 22; 16; 20; (26, 20, 12, 10, 12, 12) <sup>4</sup>	3
Vysotskyi Dendropark CNM	1/-	55	11.5	24	g
Bilskyi Dendropark CNM	7/-	53	10, 10, 11.5, 12.5, 13.5, 13, 12.5	16, 19, 22, 24, 26, 13, 13	g
Alley of European Larch BNM	30/0.2	90	31.4±0.9	44.6±1.9	g, s, u
Modryna BNM (Mosyr Forestry)	>30/0.5	65	31.3±0.2	41.7±2.0	g
Modryna BNM (Horodnytsia)	>30/36	200	51.1±0.5	84.9±2.5	g, s
Modryna BNM (Dubechnivske Forestry)	7/-	98	31, 32, 30, 30, 30, 31, 32.5	44, 36, 38, 38, 37, 39, 66	g, s
Dereva Ekzoty BNM	>30/3.2	78	28.4±0.4	32.0±1.2	g, s
Smereka BNM	2/-	110	24.5; 21.5	80; 50	g
Modrynovi Lis BNM	>30/1.6	87	33.8±0.8	36.8±1.7	g

Table 2, Continued

Reserved area	Number of specimens, pcs/area, ha	Age, years	Height, m	Diameter, cm	Condition
Lisovyi Dendrarrii BNM	14	75	24.9±0.2	24.4±1.2	g, s
Bereznivskiy DP	30, 1 <sup>1</sup> ; 1 <sup>2</sup> ; 1 <sup>3</sup> , 6 <sup>4</sup> , 6 <sup>5</sup> , 2 <sup>6</sup> , 1 <sup>7</sup> /-	40, 40 <sup>1,2</sup> , 3, 4, 5, 6, 7	15.9±0.5, 15 <sup>1</sup> ; 10 <sup>2</sup> ; 13.5 <sup>3</sup> ; (24, 25, 22, 26, 14, 13, 21) <sup>4</sup> , (16, 17.5, 19, 18, 20, 22) <sup>5</sup> , (15) <sup>6</sup> , (9.5, 11) <sup>7</sup>	34.8±2.0, 35 <sup>1</sup> ; 15 <sup>2</sup> ; 22 <sup>3</sup> ; (37, 24, 33, 38, 28, 16, 26) <sup>4</sup> , (26, 23, 31, 27, 23, 30) <sup>5</sup> , (25) <sup>6</sup> , (15, 24) <sup>7</sup>	g, s, u
Piliava DP	17/0.3	140	34.2±0.3/31.9±0.2	63.3±3.4/53.1±1.6	g
Hladkovetskiy DP	7 <sup>5</sup> /-	63	(17, 17, 16, 17, 15) <sup>4</sup> , (17, 12, 16, 11, 16, 18, 21) <sup>5</sup>	(24, 20, 18, 21, 17) <sup>4</sup> , (28, 18, 30, 18, 22, 26, 26) <sup>5</sup>	g, s
Elita DP	1/-	36	13	18	s
Polissia National University BG	6, 1 <sup>4</sup> /-	70	18, 22, 22, 23, 10, 19	20, 26, 24, 28, 13, 21	g

**Note:** no number – *L. decidua*, 1 – *L. deciduavar. polonica*, 2 – *L. kaempferi*, 3 – *Larix×eurolepis*, 4 – *L. sibirica*, 5 – *L. gmelinii*, 6 – *L. laricina*, 7 – *Larix×lubarskii*; g – good condition, s – satisfactory condition, u – unsatisfactory condition; CNM – complex nature monument

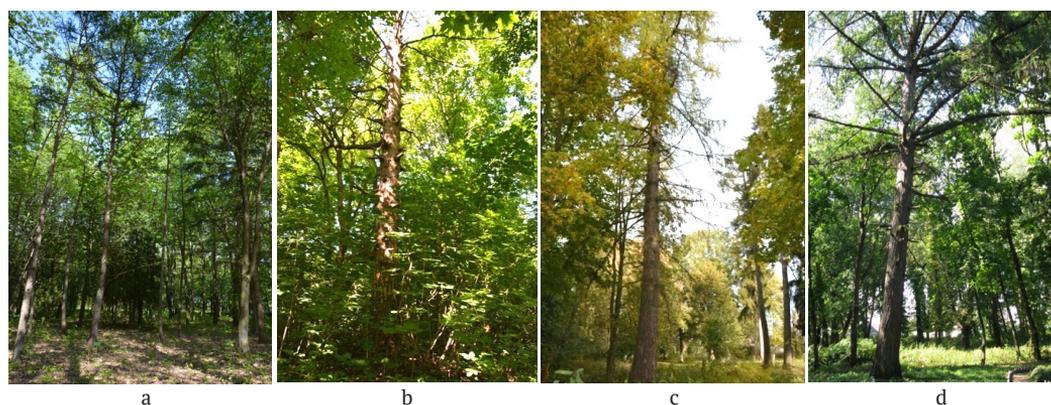
**Source:** compiled by the authors of this study

*L. gmelinii* – six specimens, 23–31 cm in diameter, 16–22 m in height, good to satisfactory condition. There is one specimen each of *L. deciduavar. polonica*, *L. kaempferi*, *Larix×eurolepis* in good condition, one specimen of *Larix×lubarskii* in satisfactory condition, two specimens of *L. laricina* in poor condition, their height is 9.5, 11 m, diameter is 15 and 24 cm (Table 2). Therewith, *L. laricina*, *Larix×lubarskii* in Ukrainian Polissia is found only in the Bereznivskiy dendropark. *L. gmelinii* is represented in two dendroparks: Bereznivskiy and Hladkovetskiy. There are 11 specimens of 63-year-old *L. gmelinii* growing in Hladkovetskiy DP, seven of which are in good to satisfactory condition (two have broken tops), their diameter ranges from 18 to 30 cm, height – from 11 to 21 m (Table 2), four specimens are dry.

According to F.R.A. Widagdo *et al.* (2020), the area of *Larix gmelinii* stands in northeastern China has increased significantly following a massive reforestation programme initiated by the Chinese central government to provide biomass for global carbon emissions reduction and industrial sectors. According to the authors, a combination of *L. gmelinii* and *L. kaempferi* can achieve better growth and create ornamental stands in protected areas, and the latter species

has been spreading in protected areas of Ukrainian Polissia for the last 30 years.

Of the five identified species growing in natural and man-made protected areas of Ukrainian Polissia, *L. decidua* Mill. is the most widespread. In the PMLAs and in NMs, *L. decidua* grows mainly as a solitaire tree and in groups of 2–15 specimens. Moreover, *L. decidua* is used as an accent both in the parks created in the 19th century (Figs. 2b, 2c, 2d) and in the parks of the 20th century (Fig. 2a). Their age ranges from 45 (Bairak PMLA) to 209 years (Tuchynskiy PMLA). J. Michalczyk & M. Michalczyk (2022) note that man-made parks perform many useful functions for people and are also a centre of biodiversity. Researchers have found that the size of the park and the presence of large trees have a positive effect on the amount of biodiversity. Such areas are important for species with greater ecological plasticity and can support biodiversity in the agricultural landscape. To preserve ecologically valuable trees and reduce the adverse anthropogenic impact, it is necessary to create “wild zones” in parks (Michalczyk & Michalczyk, 2022). In the authors’ opinion, when developing the functional zoning of the PMLAs, the places where trees over 100 years old grow should be designated as reserved areas of parks.



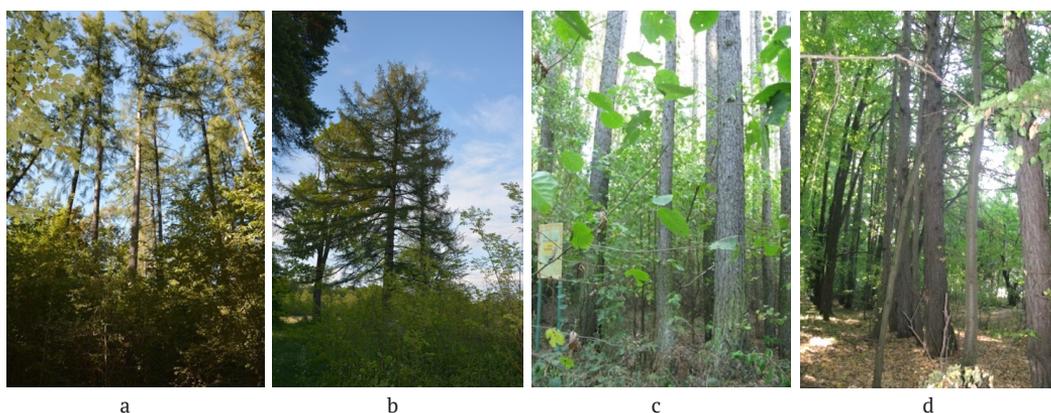
**Figure 2.** *Larix decidua* in man-made protected areas of Ukrainian Polissia

**Note:** a – Dubechnenskyi PMLA (Volyn region); b – Vahanytskyi PMLA (Chernihiv region); c – Polonskyi PMLA (Khmelnyskyi region); d – Lyzohubivskyi PMLA (Chernihiv region)

**Source:** photographs taken by the authors of this study

One of the most common of protected areas is natural monuments (NMs), where *Larix decidua* grows in groups (Modryna Botanical Nature Monument (BNM) (Dubechny Forestry), Smereka BNM (Fig. 3b), Bilskyi Dendropark BNM). In pure (Modryna BNM (Fig. 3a), Modrynovyi Lis BNM (Fig. 3c), with an area of 0.2 to 1.6 ha) and mixed stands (Alley of European Larch BNM (Fig. 3d), Dereva Ekzoty BNM, with an area of 0.2 to 3.2 ha). The Modrynovyi Lis BNM is located in Volyn region, in the Hubyn

Forestry, quarter 13, stand 19, and covers an area of 1.6 ha (Table 2). *L. kaempferi* (Rokytynivskyi Dendropark CNM) also grows in small groups (Table 2). On the territory of the Hubyn BR, there are 90-year-old monocultures of *L. decidua* (Modrynovyi Lis BNM). At 60 years old, the average height of the larch trees was 27 m, with a diameter of 32 cm. At the age of 90, the average diameter is  $36.8 \pm 1.7$  cm and the height is  $33.8 \pm 0.8$  m. The condition is good (Table 2).



**Figure 3.** *Larix decidua* in man-made areas of Ukrainian Polissia

**Note:** a – Modryna BNM (Zhytomyr region); b – Smereka BNM Sirche LR (Volyn region); c – Modrynovyi Lis BNM (Volyn region); d – Alley of European larch BNM (Volyn region)

**Source:** photographs taken by the authors of this study

In Volyn region, in Kopachiv forestry quarter 17, stand 1, a 90-year-old mixed larch-oak-hornbeam stand with the status of Alley of European larch BNM is growing on an area of 0.2 ha (Fig. 3d). The composition is dominated by *L. decidua*, which grows in a row along the road. Planting scheme row *L. decidua*, row *Q. Robur*, row *Carpinus betulus* L., row *Q. robur*, row *C. betulus*, row *Q. robur*, row spacing 2 m. There is occurrence of *Tilia cordata* Mill. In the undergrowth – *Euonymus verrucosus* Scop. The condition of *L. decidua* is good and satisfactory. Suppressed *L. decidua* grow in a satisfactory condition, or have fallen out, provided that the next row has *Q. robur*. Plants opposite to which *Q. robur* is absent are in good condition. The average diameter of *L. decidua* is  $44.6 \pm 1.9$  cm, and the average height is  $31.4 \pm 0.9$  m. The average diameter of *Q. robur* –  $37.4 \pm 1.7$  cm, height –  $27.0 \pm 0.6$  m. In the Volyn region, Dubechny forestry, quarter 40, stand 13, there is a 98-year-old mixed stand of *Pinus sylvestris* L., *Quercus robur* L. and *L. decidua* on an area of 0.2 ha. *L. decidua* grows as a group of 7 specimens (Table 2), which were assigned the status of Modryna BNM. The average diameter

of *L. decidua* is  $42.3 \pm 4.0$  cm, and the average height is  $30.8 \pm 0.3$  m. The condition is good and satisfactory. The minimum diameter of *L. decidua* is 36 cm, the maximum is 66 cm, the minimum height is 30 m, and the maximum is 32.5 m. *L. decidua* forms self-seeding in open areas at a distance of 50 m from a group of larch trees. Modryna BNM (Affiliate “Liubomyr Forestry” the State Enterprise “Forests of Ukraine”), Mosyr Forestry, quarter 14, stand 18, 0.5 ha, 65-year-old *L. decidua* in a mixed stand with *P. sylvestris*, *Q. robur* and *C. betulus*. The condition of the plants is good. In 2015, on the eastern side of the stand, in the bordering allotment where *P. sylvestris*, *Q. robur* grew, the principal felling was performed, after which *L. decidua* began to fall out, uprooted in westerly winds. In the harvested areas, *L. decidua* began to regenerate by self-seeding (Fig. 4) at a distance of 40 to 100 m to the north of the stand with *L. decidua* (Modryna BNM). The amount of self-seeding is one specimen of *L. decidua* per 3-4 m<sup>2</sup>, the self-seeding covers an area of 0.05 ha. The height of *L. decidua* varies from 0.25 cm to 2.65 m, the trunk diameter from 0.5 cm to 3 cm.



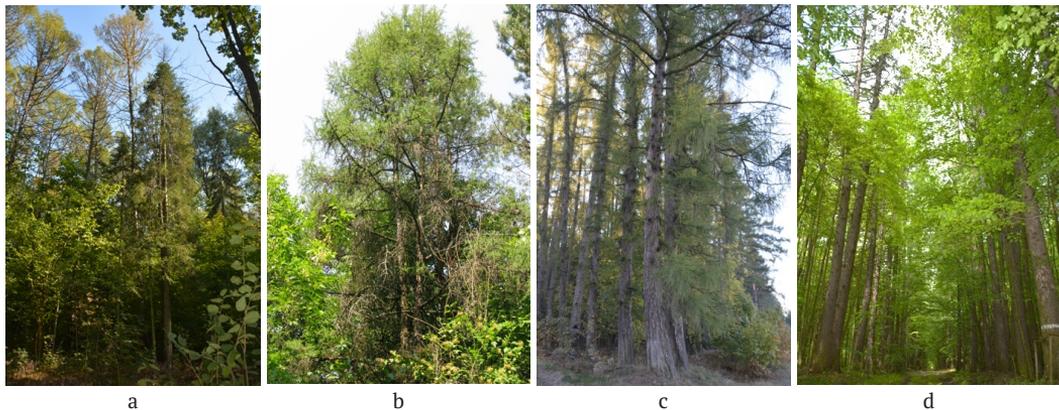
**Figure 4.** Restoration of *L. decidua* and *L. kaempferi* in the protected areas of Ukrainian Polissia (Volyn region)

**Note:** a – Modryna BNM, *L. Decidua* self-seeding; b – Riznolissia GZR, *L. Decidua*; c – Riznolissia GZR, *L. kaempferi*

**Source:** photographs taken by the authors of this study

M. Dekker *et al.* (2007) concluded that natural regeneration in gaps in Douglas-fir forest stands in the Netherlands consists mainly of *Betula pendula* (Roth.), *Pinus sylvestris* (L.), *Larix kaempferi* (Carr.) and *Pseudotsuga menziesii* (Mirb. Franco). Although these species are well-known, the autogenous development of these species in an unmanaged plant community is beyond the scope of conventional forestry experience. During the regeneration, *Betula*, *Larix*, *Pseudotsuga* will share the available light, but *Pinus* will be shaded and given its need for light, may not be able to compete. During natural regeneration at the Modryna BNM, 10-year-old *L. decidua*, *P. sylvestris*, and *B. pendula* do not compete and there is enough light at this age.

BNM of local importance Dereva Ekzoty in Chernihiv region, Radomske Forestry, quarter 62, stands 15 (2.4 ha) and 16 (0.8 ha) is represented by a 78-year-old mixed stand of *P. sylvestris*, *L. decidua*, *Abies alba* Mill. *Picea abies* Karst. and *Q. robur*, where *L. decidua*, *A. alba* are exotic plants for this region (Fig. 5a). The condition of *L. decidua* is good and satisfactory, and the condition of *A. alba* is satisfactory and unsatisfactory; there are dry plants and only a few specimens in good condition. The average diameter of *L. decidua* is  $32.0 \pm 1.2$  cm, and the average height is  $28.4 \pm 0.4$  m (Table 2). The average diameter of *A. alba* is  $15.8 \pm 1.1$  cm, and the average height is  $13.5 \pm 0.8$  m. Biometric parameters and condition of *L. decidua* are much better than those of *A. alba*.



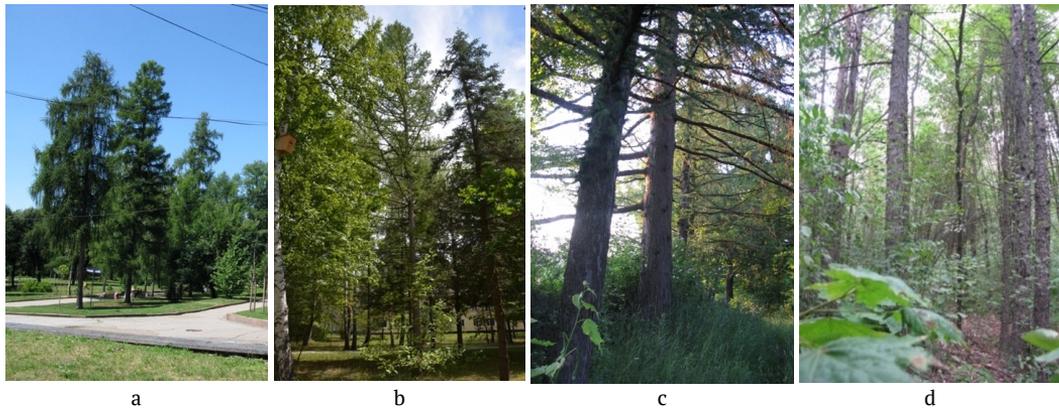
**Figure 5.** *Larix decidua* in natural and man-made protected areas of Ukrainian Polissia  
**Note:** a – BNM Dereva Ekzoty (Chernihiv region); b – CNM Bilskyi Dendropark (Rivne region); c – Piliava DP (Rivne region) (Zhytomyr region); d – Tsumanska Pushcha PT (Rivne region)  
**Source:** photographs taken by the authors of this study

In 1951, a group of 6 specimens of *L. decidua* and one specimen of *Larix sibirica* Ledeb were planted in the Polissia National University BG. *L. decidua* that have survived to date are in good condition (Table 2). In the Piliava Dendropark, quarter 63, stand 16, 140-year-old

*L. decidua* grows on an area of 0.3 ha (Fig. 5c), the average height is  $31.9 \pm 0.2$  m, the average diameter is  $53.1 \pm 1.6$  m. The condition of *L. decidua* is good. *L. decidua* was planted in historical parks during the 20<sup>th</sup> and 21<sup>st</sup> centuries, e.g., in 1961, a forest nursery of *L. decidua* was

established in the Ivnytskyi PMLA on an area of 0.1 ha, with a planting scheme of 1×1 m. Currently, the diameter of 60-year-old *L. decidua* ranges from 14 cm to 36 cm, the height from 17 to 22 m, and the condition of the plants is good and satisfactory. In 1968, there were 13 European and Siberian larch trees in Yuri Gagarin Park PMLA, and now there are two 90-year-old European and Siberian larch trees and five 25-year-

old *L. decidua* trees. Plant condition – good. The 90-year-old *Larix sibirica* is 52 cm in diameter and 17 m high (Fig. 6a). There is one 8-year-old specimen of *L. decidua* growing in the Horodot-skyi PMLA. An alley with *L. kaempferi* has been created in the Slovianskyi PMLA. *L. kaempferi* is 20 years old. Plant condition – good. *L. decidua*, *L. gmelinii* are part of the collection of arbore-tums and dendrological parks (Figs. 6b, 6d).



**Figure 6.** *Larix* species in man-made protected areas of Ukrainian Polissia

**Note:** Y. Gagarin Park PMLA, *L. sibirica* (Zhytomyr region); b – Hamarnia LR (arboretum), *L. decidua* (Zhytomyr region); c – Rokytnivskyi Dendropark CNM, *L. kaempferi* (Rivne region); d – Hladkovetskyi DP, *L. gmelinii* (Zhytomyr region)

**Source:** photographs taken by the authors of this study

In the Tsumanska Pushcha protected tracts (Kivertsivskyi NNP), Horynske Forestry (Volyn region), 70-year-old *L. decidua* grows as an alley and as a row planting along oak-pine-hornbeam-linden stands (quarter 19, stand 11) (Fig. 5d) and 80-year-old *L. decidua* – pine-birch-oak-linden stands (quarter 19, stand 12), respectively, the average height of *L. decidua* is  $33.2 \pm 0.3$  m, the average diameter is  $41.9 \pm 1.2$  cm and the average height is  $33.0 \pm 0.3$  m, the average diameter is  $37.8 \pm 1.4$  cm, respectively. In the oak-hornbeam-linden stands (quarter 19, stand 20), 70-year-old *L. decidua* have an average height of  $32.6 \pm 0.5$  m and an average diameter of  $42.9 \pm 1.9$  cm, in pine-birch-linden stands, 80-year-old *L. decidua* have an average

height of  $32.9 \pm 0.4$  m and an average diameter of  $38.2 \pm 1.5$  cm.

Modrynnyk FR (Irzhava forestry, Affiliate “Nizhyn Forestry” the State Enterprise “Forests of Ukraine”, Chernihiv region), total area 6.9 ha. In quarter 4, stand 7, there is a stand of *L. decidua* on an area of 1.2 ha (Fig. 6a), established in 1907. The stand is represented by 252 *L. decidua* trees (good condition), and there are also isolated *B. pendula* trees, *Ulmus laevis* Pall., *Acer negundo* L., *Ulmus glabra* Huds., *Quercus rubra* L., *Picea abies* Karst., *Pyrus pyraeaster* (L.) Burgsd., *Sorbus aucuparia* L., in the undergrowth - *Rubus caesius* L., *Rubus idaeus* L., *Euonymus europaea* L., *Euonymus verrucosus* Scop. L., *Chamaecytisus ruthenicus* (Fisch. ex Wol.) Klásk. Since

1968, the site has served as a permanent forest seed base. The minimum diameter of *L. decidua* is 20 cm, the maximum diameter is 76 cm, the minimum height is 29 m, and the maximum height is 36.5 m. The average height of 113-year-old *L. decidua* is  $33.0 \pm 0.8$  m, the average diameter is  $52.1 \pm 1.7$  cm (Table 3). In 1903, in quarter 17, stand 2, on the area of 5.7 ha, a stand was created where *L. decidua* dominates

(90%), *B. pendula* makes up 10% and *Q. robur*, *Q. rubra* – up to 0.5%). The 117-year-old *L. decidua* has an average height of  $38.5 \pm 0.4$  m and an average diameter of  $51.0 \pm 1.5$  cm. The condition of the plants is good (Table 3). In the undergrowth grow *S. aucuparia*, *E. europaea*, *E. verrucosus*, *Sambucus nigra* L., *Corylus avellana* L. Permanent forest seed base since 1967 and genetic reserve. Six plus trees grow on the site.

**Table 3.** Characteristics of species of the genus *Larix* L. in the natural protected areas of Ukrainian Polissia

Reserved area	Number of specimens, pcs/area, ha	Age, years	Height, m	Diameter, cm	Condition
Tsumanska Pushcha PT	43; 24, 33; 30/-	70, 80	$33.2 \pm 0.3$ ; $32.6 \pm 0.5$ ; $33.0 \pm 0.3$ ; $32.9 \pm 0.4$	$41.9.0 \pm 1.2$ ; $42.9 \pm 1.9$ , $37.8 \pm 1.4$ ; $38.2 \pm 1.5$	g
Zhukivske PT	>30/4.0	80	$32.3 \pm 0.2$	$38.7 \pm 1.1$	g, s
Papyky PT	11/-	100	$32.7 \pm 0.3$	$60.7 \pm 4.5$	g
Riznolissia GZR	>30, > 30 <sup>2</sup> /1.4; 2.9 <sup>2</sup>	55, 52	$29.1 \pm 0.4$ ; ( $26.0 \pm 0.6$ ) <sup>2</sup>	$39.5 \pm 1.7$ ( $36.1 \pm 1.6$ ) <sup>2</sup>	g
Hubyn BR	>30/-	100	$35.9 \pm 0.5$	$50.0 \pm 2.1$	g
Lisova Aleia BR	20/2.3	90/23	$31.6 \pm 0.6/14$	$40.0 \pm 2.6/18$	g
Modrynyk FR	>30/1.2; 5.7	113; 117	$33.0 \pm 0.8$ $38.5 \pm 0.4$	$52.1 \pm 1.7$ $51.0 \pm 1.5$	g

**Note:** no number – *L. decidua* Mill., 2 – *L. kaempferi*; g – good condition, s – satisfactory condition  
**Source:** compiled by the authors of this study

The Lisova Aleia BR is located in the Volyn region, Moshchanytsia Forestry, quarters 46, 50, 51, on an area of 110.4 ha. The 90-year-old *L. decidua* grows in a pine stand along the Lutsk–Rivne Road in quarter 51, stand 21, with an area of 3.0 ha (Fig. 6d). The condition of *L. decidua* is good. The average height is  $31.6 \pm 0.6$  m, and the average diameter is  $40.0 \pm 2.6$  cm (Table 3). In quarter 51, stand 9, a mixed stand was created on an area of 2.3 ha, including *Pinus sylvestris* L., *L. decidua*, *L. kaempferi*, *Q. rubra*, *B. pendula*, *C. betulus*, the latter two species of natural origin. 23-year-old *L. decidua*, *L. kaempferi* are in good condition, bear fruit, their diameter is 14–18 cm, height is 13–14.5 m, and diameter 10–23 cm, height 13–14 m, respectively.

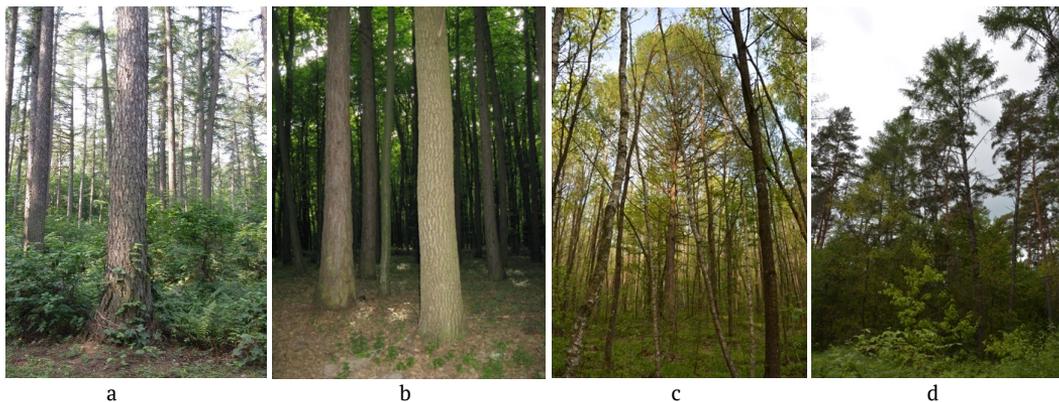
On the territory of the Hubyn BR, quarter 18, stands 1 and 2, there is a 100-year-old stand of *L. decidua*. The average diameter of *L. decidua* is  $50.0 \pm 2.1$  cm, height –  $35.9 \pm 0.5$  m. Condition – good. In the Hubyn BR, quarter 12, stand 25, self-seeding of three *L. decidua* 70–100 cm tall was detected.

In 2015, mixed larch-oak-pine cultures were established in the Radomska Dacha PT with 2-year-old seedlings in quarter 80, stand 9 (according to the scheme: 2 rows of *L. decidua*, 1 row of *Q. robur*, 3 rows of *P. sylvestris*, 1 row of *Q. robur*, 2 rows of *L. decidua*). The distance between the rows is 2.5–3 m. The condition of the plants is good. In quarter 74, stand 7, on an area of 2.1 ha, 5 rows of *P. sylvestris*, 1 row of

*Q. robur*, 3 rows of *L. kaempferi* and *L. decidua* were planted in 2012. The condition of the plants is good. Yu. Debrynyuk & M. Beleya (2017) note that in 1-2-year-old forest cultures, European larch (1.5-2.1 times) and broadleaf larch (3.1 times) have a significant advantage in height compared to Scots pine. In 3-year-old crops, the advantage of European larch over Scots pine in terms of average height is 1.5 times, and the maximum is 1.7 times. The protected tracts of local importance Papyky is located in Moshchanytsia Forestry in quarters 27-36 on an area of 606 ha. The 100-year-old *L. decidua* grows in quarter 34, stand 8 and in quarter 29, stand 22 as an alley along the forest road in the amount of 7 and 4 specimens, respectively (Table 3).

The Zhukivske PT covers an area of 4.6 ha in Smorzhivske Forestry quarter 3, stands 2, 3, 7, 34. The 80-year-old *L. decidua* grows in mixed larch-oak-hornbeam stands on the area of 1.5 and 2.5 ha (stands 2 and 7) (Fig. 7b). The plants were planted as follows: row

*L. decidua*, row *C. betulus*, row *Q. robur*, row *C. betulus*, row *L. decidua*. The average height of *L. decidua* is  $32.3 \pm 0.2$  m, the average diameter is  $38.7 \pm 1.1$  cm (Table 3), the average height of *Q. robur* is  $30.3 \pm 0.5$  m, the average diameter is  $36.1 \pm 1.5$  cm, the average height of *C. betulus* is  $19.5 \pm 0.5$  m, the average diameter is  $19.5 \pm 2.1$  cm. The condition of *L. decidua* is good. Today, an accurate estimation of the growth of forest ecosystems is essential for understanding carbon sequestration and achieving carbon neutrality goals. However, the key environmental factors that influence volume growth differ across scales and functional plant types. H. Tian *et al.* (2022) note that altitude has a positive effect on stock growth in *Larix* forests, but a negative effect on stock growth in *Quercus* forests. Similarly, the impact of other environmental factors on stock growth varies depending on the origin of the stands (man-made and natural) and the functional types of plants (*Larix* vs. *Quercus*).



**Figure 7.** Species of the genus *Larix* in the natural protected areas of Ukrainian Polissia

**Note:** a – Modrynnyk FR, *L. decidua* (Chernihiv region); b – Smorzhivske PT, *L. decidua* (Rivne region); c – Riznolissia GZR, *L. kaempferi* (Volyn region); d – Lisova Aleia BR, *L. decidua* (Volyn region)

**Source:** photographs taken by the authors of this study

Riznolissia GZR covers an area of 128 ha, *L. decidua* and *L. kaempferi* grow in quarter 32 on two objects in stand 19 on an area of 1.4 ha. This is a mixed larch-oak-willow-birch forest,

dominated by *L. decidua*. The average diameter of *L. decidua* is  $39.5 \pm 1.7$  cm, the average height is  $29.1 \pm 0.4$  m (Table 3), the average diameter of *Q. robur* is  $31.3 \pm 1.8$  cm, the average height is

26.6 ± 0.5 m, the average diameter of *Alnus glutinosa* (L.) Gaerth. is 30.8 ± 5.8 cm, the average height is 25.7 ± 0.5 m. The condition of *L. decidua* is good. Specimens of *L. kaempferi* occur on the site. Propagated by self-sowing. A group of self-sowing *L. decidua* plants consisting of seven specimens on an area of 4 m<sup>2</sup> aged 4–5–7 years was found. Their heights are 1 m, 1 m, 1 m, 2 m, 3.5 m, 3.5 m, 4.5 m. In stand 16, on an area of 2.9 ha, *L. kaempferi* makes up 5% of the mixed oak-birch-alder stand (Fig. 7c). The average diameter of *L. kaempferi* is 36.1 ± 1.6 cm, the average height is 26.0 ± 0.6 m, the average diameter of *Q. robur* is 22.5 ± 0.9 cm, the average height is 21.6 ± 0.4 m. The condition of *L. kaempferi* is good, it reproduces by self-sowing (Fig. 4c). A single specimen of 2-year-old *L. kaempferi*, 10 cm high, was found at 20 m from the mother plant. K.F. Suzuki *et al.* (2021) note that *L. kaempferi* stands can protect native species from prevailing winds and promote natural forest regeneration by improving local environmental conditions for native species in the short term. In ecosystems where introduced species have already adapted, harnessing their positive functions rather than rapidly eradicating them from the landscape can be beneficial for long-term restoration goals. F. Chen *et al.* (2015) found that the introduction of *Larix kaempferi* (Lam.) from Japan to China in the 1960s resulted in significant changes in microbial functional diversity and soil activity, as well as in soil physicochemical properties in Dalaoling National Forest Park (Hubei Province, China). The change increased with the age of the stands.

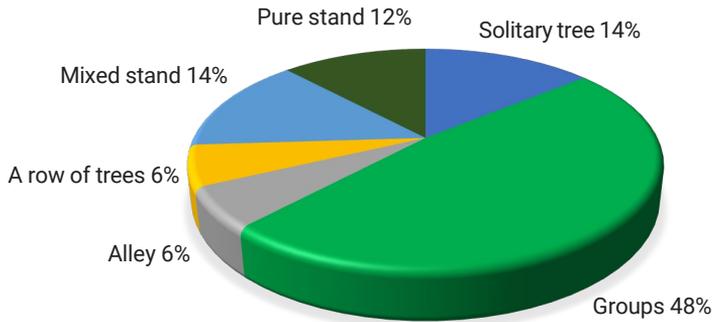
Modryna BNM covers an area of 36 ha (SE Horodnytsia Forestry), where *L. decidua* grows. There are 29 plus trees of *L. decidua*. The average height of 200-year-old *L. decidua* is 51.1 ± 0.5 m, and the average diameter is 84.9 ± 2.5 cm. *L. decidua* has a maximum diameter of 174 cm and a height of 47 m. In 1998, there was a storm on the territory of Modryna

BNM, after which some trees were broken or uprooted. As a result, sanitary felling was performed, after which self-seeding of *L. decidua* appeared. Based on dendroecological studies in mixed *Larix decidua*–*Picea abies* forests in the Tatras (Western Carpathians) over the past 200 years, they found that wind-driven windstorms prevailed in the 19<sup>th</sup> and 20<sup>th</sup> centuries, which were more extensive in the 19<sup>th</sup> century, but their frequency in the two centuries was similar. The intervals between major events were long enough to form dense stands that could be easily blown away over wide areas, but the gaps were short enough to allow light-demanding *L. decidua* to grow in stands of shade-tolerant *P. abies*. C. Wu *et al.* (2022) note that thinning measures are valuable proposals for changing forest density, can promote tree growth, and provide valuable information for assessing future forest dynamics and changes in carbon sequestration and carbon neutrality under climate change. The practice of thinning in 15 parks over 5 years in Korea has increased biodiversity in stands by preventing the spread of invasive species, resulting in a species composition similar to that of natural forests (Cho *et al.*, 2020).

The species, varieties, and hybrids of the *Larix* genus were used to create 6 types of stands in the protected areas: solitaire trees, groups, row plantings, alleys, pure and mixed stands (Fig. 8). Groups predominate (48%), with groups of one species or variety and mixed groups. The condition of the plants depends on the composition of the group. In the monogroup with *Larix decidua*, the condition of the plants is good (Litynskyi PMLA, Polonskyi PLMA, Rokytnivskyi Dendropark CNM). In the Novostavskyi Dendropark PMLA, where *Larix decidua* Mill. grows with *Juglans nigra* L., *Juglans cinerea* L., *Juglans cinerea* L. – the condition is satisfactory; *Larix sibirica* Ledeb., growing with *Quercus rubra* L. and *Betula pendula* Roth. also have a satisfactory condition (Table 1). There are 5 specimens

of *Larix decidua* in the Horodnianskyi PMLA growing in a group surrounded by *Tilia cordata*

Mill., *Picea abies* Karst., *Ulmus glabra* Huds. – in satisfactory condition, fruiting is weak.

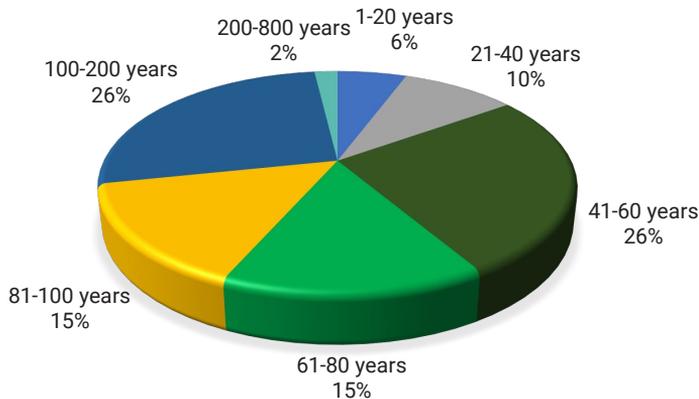


**Figure 8.** Stand types of *Larix* L. taxa

Source: compiled by the authors of this study

The age structure is mainly represented by medieval and old larch (Fig. 9). There are

slightly fewer plants of potential age and ripeness, which is 15% each.



**Figure 9.** Age structure of *Larix* L. taxa in the protected areas of Ukrainian Polissia

Source: compiled by the authors of this study

Seven species, one variety, and two hybrids grow in protected areas of Ukraine (Table 4). *Larix decidua* and *Larix sibirica* are most widespread in all natural zones of Ukraine. *Larix laricina* (Du Roi) K. Koch, *Larix×lubarskii* Sukaczew, *Larix griffithii* Hook. f. grow mainly in arboretums. *Larix kaempferi* (Lamb.) Carrière has also proved to be a good performer

in the protected areas, reaching the age of 100 years in five sites. 200-year-old representatives of *Larix decidua* grow in 5 protected areas, and 270-year-old specimens in Mala Sofivka PMLA (Vinnytsia region, Forest-Steppe zone). 250-year-old *Larix decidua* var. *polonica* in the Pidhirivtsivskyi PMLA in the Ukrainian Carpathians region.

**Table 4.** Representation of the genus *Larix* L. in the protected areas of Ukraine (number of objects)

Taxa	Zone				
	mixed forests	Forest-Steppe	Steppe	broadleaf forests	Ukrainian Carpathians
<i>Larix decidua</i> Mill.	52 (25)*	98 (45)	12 (1)	77 (24)	53 (11)
<i>Larix decidua</i> var. <i>polonica</i> .	7 (4)	10 (5)		20 (10)	17 (3)
<i>Larix kaempferi</i> (Lamb.) Carrière	7	9 (1)	5	16 (2)	11 (2)
<i>Larix</i> × <i>eurolepis</i> A. Henry	3	- (1)			- (1)
<i>Larix sibirica</i> Ledeb	9 (1)	41	8	13 (1)	9
<i>Larix gmelinii</i> (Rupr.) Kuzen.	2	10	4	2	6
<i>Larix laricina</i> (Du Roi) K. Koch	1			1	1
<i>Larix</i> × <i>lubarskii</i> Sukaczew	1				
<i>Larix griffithii</i> Hook. f.		1			1
<i>Larix occidentalis</i> Nutt.		5	1	1	1
<i>Larix czekanowskii</i> Szafer		3	1		1

Note: (\*) – trees over 100 years old are indicated in brackets

As cities grow, green spaces play a more central role in providing ecosystem services. Many ecosystem services depend on the interaction of soil-plant systems, and the type and age of plants affect the quantity and quality of services. Having investigated 41 urban parks and five non-urban forest areas in the cities of Helsinki and Lahti (Finland), G. Francini *et al.* (2021) found that urban green spaces function similarly to non-urban green spaces. Specifically, plants lead to changes in the soil environment, similar to modifications in non-urban ecosystems. The choice of plants when building or renovating parks can improve the quality and quantity of ecosystem services provided by urban green spaces. Although vegetation changes the soil of urban green spaces over time, similar to non-urban green spaces, the effect of vegetation type is greater in non-urban green spaces. Tree species that are appropriate for the area can provide greater environmental benefits by improving the physical and chemical properties and fertility of the soil and increasing carbon sequestration.

## Conclusions

Eight species, one variety, and two hybrids of larch grow in Ukraine's five protected areas. Four species (*Larix decidua*, *Larix kaempferi*, *Larix sibirica*, *Larix gmelinii*) are represented in Ukraine in the zone of mixed and broadleaved forests, Forest-Steppe, Steppe zones, in the Ukrainian Carpathians. In Ukrainian Polissia, 34% of objects with representatives of the genus *Larix* are concentrated in Volyn region, slightly less – 21.3% each in Rivne and Zhytomyr region, 17% – in Chernihiv region. *L. decidua* grows in pure stands and as a part of mixed pine-larch-fir-spruce-oak, larch-oak-alder-birch, oak-pine-hornbeam-linden, larch-oak-alder-birch, larch-oak-hornbeam, larch-pine stands. *L. decidua* has better biometric parameters and condition than *Q. robur*, *P. sylvestris*, *A. alba*, *A. glutinosa*. A total of six types of stands with larch were identified, with solitary trees and groups predominating in the PMLAs and NMs. The age structure of species, varieties, and hybrids in the mixed forest zone is represented by 26% of plants aged 41-60 and 100-200years, 15% of

potentially old (81-100years) and larch trees aged 61-80years. Only one *L. decidua*, 209 years old, grows in Tuchynskiy PMLA. Larch trees under 20 years old and 21-40 years old (*L. kaempferi* and *L. decidua*) are rare. At six objects, *L. decidua* is renewed by self-seeding. At two objects is *L. kaempferi* renewed.

The obtained results will allow comparing quantitative and qualitative indicators of *L. decidua*, *L. kaempferi*, *L. sibirica*, *L. gmelinii*, *L. laricina*, *Larix×eurolepis*, *Larix×lubarskii* success of introduction and their status in different natural zones of Ukraine. Using the obtained quality indicators of *L. decidua*, *L. kaempferi*,

*L. sibirica*, *L. gmelinii*, it will be possible to select the best specimens, considering the availability of reproduction to obtain high-quality planting material for the subsequent creation of diverse types of stands in various protected areas. Research can be aimed at creating an optimal composition of stands with *L. decidua*, *L. kaempferi*, *L. gmelinii*.

### Acknowledgements

None.

### Conflict of Interest

None.

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## Представленість роду *Larix* Mill. на заповідних територіях Українського Полісся

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**Анотація.** *Larix decidua* Mill. може стати більш важливою ніж *Picea abies* (L.) Karst для заліснення територій і відновлення природного балансу, тому необхідним є вивчення даного виду. Саме тому метою дослідження була провести інвентаризацію таксонів роду *Larix* на заповідних територіях зони мішаних лісів Українського Полісся, проаналізувати їхнє поширення, вікову структуру, застосування. Застосовано методи дослідження: маршрутні, аналітичні, порівняльного аналізу, систематизації. Встановлено, що на охоронних територіях зони мішаних лісів України зростає 5 видів, один різновид та два гібриди модрин. Визначено, що *L. decidua* набула найбільшого поширення – вона зростає у парках-пам'ятках садово-паркового мистецтва, пам'ятках природи, заповідних урочищах, заповідниках у чистих та мішаних насадженнях, алеях, рядових посадках, групах та як солітер. *L. sibirica*, *L. kaempferi* зростають як солітер та у групах від трьох до 10 екземплярів у 9 та 10 охоронних об'єктах відповідно. *L. gmelinii* є у двох дендропарках, *L. laricina* – у одному. *Larix decidua* var. *polonica* (Racib. ex Wóycicki) Ostenf. & Syrach малопоширена, представлена групами у 6 парках-пам'ятках садово-паркового мистецтва та Березнівському дендропарку. *Larix* × *eurolepis* A. Henry. набуває поширення у чистих та мішаних насадженнях, зростає в алеї у парку-пам'ятці садово-паркового мистецтва Слов'янський, у групах – у ботанічному заказнику Лісова алея, Березнівському дендропарку та у мішаних насадженнях загальнозоологічного заказника Різномісся. Вікова структура досить різноманітна, представлена *L. decidua*, *L. sibirica*, *L. decidua* var. *polonica* віком від 100 до 200 років. Інші види, різновид та гібрид представлені екземплярами віком від 3 років (*L. ×eurolepis*) до 80 років (*L. kaempferi*). 69,2 % насаджень з модрин мають добрий стан, 28,9 – задовільний і лише 1,9% – не задовільний стан. Результати досліджень можуть бути використані при подальшому створенні чистих на мішаних насаджень, алеї тощо в зоні мішаних лісів

**Ключові слова:** модрина; види; парк-пам'ятка садово-паркового мистецтва; пам'ятка природи; дендропарк