Assessment of the plantings in small towns of the Oryol region

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Abstract. The article presents the results of total plantations inventory in small towns of the Oryol region. The article studies 41 species of trees and 15 species of shrubs growing in small towns of the Oryol region. The inventory revealed a stability of 120,605 woody plants in town. The diagnosis of the vital state of trees and shrubs presents that the urban tree plantings are weakened. Based on the data obtained there are recommendations proposed for the conservation and reconstruction of tree stands, the expansion of the main assortment of tree species.

1. Introduction

The quality of the environment affects directly the health of the population. At the same time, the level of urbanization is constantly growing throughout the world, as for Russia, it makes up more than 70 %. Most of the population live in cities, the preservation of comfort in which is possible by creating and developing a landscaping system. Vegetation cover is an indicator of the state of the urban environment condition. The tree stands have the greatest importance in the regulation and maintenance of environmental quality in urban areas [1–4].

The organization of territories and spaces of cities, the rational distribution of components requires a detailed study of the assortment of woody plants, their distribution over the territory in accordance with biological, environmental and decorative qualities.

Currently, there is extensive information on the species composition, sustainability and design of tree plantations of various cities [5, 6]. As for small cities, including in the Oryol region, there is a lack of good landscaping and tree standing technology. In this regard, the topic of the study is relevant, and evaluate the current state of woody vegetation in small towns of the Oryol region to predict the fate of forest stands and the theoretical justification of measures for their conservation and reconstruction.

Tree and shrub plantings of small towns of the Oryol region, as in many other cities of our country, was formed in the postwar years. Currently, due to the lack of proper agricultural technology and age, they no longer fully perform their functions [5–7].

The purpose of this research is to study the species composition and assess the living condition of common and limited-use tree plantations in small towns of the Oryol Region (Bolkhov, Dmitrovsk-Oryol, Livny, Maloarkhangelsk, Mtsensk, Novosil).
2. Methods and materials
The study of the woody species composition in 6 cities of the Oryol region (Bolkhov, Dmitrovsk-Oryol, Livny, Maloarkhangelsk, Mtsensk, Novosil) is carried out within 2015–2018. There are route method and grid mapping method used.

As a result, 56 species were identified in small towns: 40 species (71.4 %) introduced, and 16 species (28.6 %) are wild-growing. A systematic and biomorphological analysis of tree stands was carried out [10].

Assessment of the tree stands was conducted in 2015-2018. according to the generally accepted method for diagnosing the state of trees and stands [9,11]. Assessment of the condition of shrubs was conducted according to the method [11]. Their boundaries and species affiliation were revealed when examining the plantations. The status points of individual specimens of each species were determined using visual assessment of trees and shrubs by external signs (general condition of plants, density of leaves, degree of damage to the trunk and crown, etc.). There are 56 species out of 120 605 trees and shrubs examined. The average state score for each species (Ki) and the total coefficient (Total) of the state of green spaces in the cities of the region were calculated. The obtained numerical data were processed using the STATISTICA MS EXEL 2010 packages.

The degree of gardening was assessed by remote sensing using ArcGIS and public access images, which allow obtaining objective and reliable information quite quickly and with the necessary frequency. The studied tree plantations were: green lanes along the main streets, including sections at citywide shopping and administrative centers, as well as parks and public gardens, healthcare and educational institutions of small towns of the Oryol Oblast (Bolkhov, Dmitrovsk – Oryol, Livny, Maloarkhangelsk, Mtsensk, Novosil).

3. Results
Assessment of the degree of gardening. Cities of the Oryol region founded at different times, have a different number of people and the area of landscaping. These data are presented in table 1.

| Town                | Founded in (year) | Population (2018) | Area (ha) | Green area (ha) | % |
|---------------------|-------------------|-------------------|-----------|-----------------|----|
| Bolkhov             | 1196              | 11097             | 1295.4    | 656.4           | 50.7          |
| Dmitrovsk-Orlovsky  | 1782              | 5105              | 573.1     | 168.4           | 29.4          |
| Livny               | 1586              | 47221             | 2460.1    | 349.5           | 14.2          |
| Maloarkhangelsk     | 1778              | 3872              | 395.6     | 130.8           | 33.1          |
| Mtsensk             | 1146              | 37725             | 2281.5    | 670.1           | 29.4          |
| Novosil             | 1155              | 3175              | 571.1     | 206             | 36.1          |

Most of the modern plantations are represented by trees and shrubs planted in the 20th century after the World War II. There has been no technical supply for more than 70 years, so nowadays there is a need of reconstruction.

If the city has 10 % of vegetation cover it is considered bad landscaped; a good practice of landscaping conditions requires 40–60 % of the city area [9]. Based on this, Bolkhov has good conditions for landscaping; as for Livny, it lacks the area for landscaping. Nowadays, towns develop slowly in the means of landscaping. There is no specific landscaping system, the objects are distributed randomly across territories, and there is no clear structure.

The species composition. There is a few species of woody plants used in landscaping in Oryol region (on average about 30): Bolkhov – 24 species, Dmitrovsk-Orlovsky – 22 species, Livny – 45 species, Maloarkhangelsk – 18 species, Mtsensk – 32 species, Novosil – 22 species. Similar data were obtained earlier for the city of Orel [8].

The most common woody plant species in small towns at present are: *Picea abies* (L.) Karst., *P. pungens* Engelm., *Thuja occidentalis* L. and its forms fastigiata and pyramidalis, *Populus nigra* L. and its form pyramidalis, *Belula pendula* Roth, *Tilia cordata* Mill., *Fraxinus excelsior* L., *Acer negundo* L., *Cotoneaster lucida* Schlech. t.
There are also some rare species such as *Physocarpus opulifolius* (L.) Maxim., *Sorbus aucuparia* L., *Populus alba* L., *P. razumowskiana* (Regel) Schneid., *Crataegus submollis* Sarg.

The most widely represented type is **Rosaceae** – 15 species (26.8 %), **Salicaceae** – 12 (21.4 %), **Pinaceae** – 7 (12.5 %). Moreover, the largest number of wild-growing species used in landscaping is the type of Salicaceae and Rosaceae – 8 each (25.8 %). The largest number of species contains the genera *Populus* – 9 and *Rosa* – 4. Other types are represented by 1 to 3 species. All types contain many fast-growing species with highly decorative qualities.

In fact the North America is known as a homeland of most introduced species (26.8 %) of plants, as for the few species (7.1 %) – the Far East.

Most of the identified species of woody plants are trees (73.2 %), the rest are shrubs (26.8 %). Vines are usually not used in landscaping. Currently, the average age of tree stands in small towns is 50–70 years. It should be noted that the age of tree species could be more significant, but in connection with the hostilities in the Oryol region during the Great Patriotic War, long-lived trees were practically not preserved. There is a Quercus robur L. growing in Livny, on Gorky Street. It has been growing for more than 200 years, and its height is over 25 m. Such specimens require preservation and certification.

**Landscape and architectural assessment.** The species composition is shown increasing in Orel, as for other towns, in most cities the species remain the same. Although the question of the quality of plantings was raised repeatedly, and landscape architects tried to transform common areas. For example, topiary figures appeared in the cities of Livny and Mtsensk.

Most of the studied woody plants form a thickened planting, self-renewing self-sowing or vegetative. This kind of stands require sanitary cutting and thinning, as well as sawing (pruning) in order to form a good type of landscape from trees and shrubs in alleys, borders and other stands.

In general, the compositions require a good imagination and creativeness. The features and variety of the surrounding buildings should be marked and make a good visual perception. One should remember the main functions of plantings – decorative and useful for the climate.

**Assessment of the plantings.** The visual assessment of the 120,605 trees in 30 urban plantations were made using the methodology of assessing the state of tree plantations [9], also 5 vitality classes are revealed as well (Fig. 1). Only 31.7 % of the examined trees belong to the category of **good condition**, 41.4 % – **damaged trees**: dry branches, ectoparasites (aphids, leaf beetles) etc.

The other group of **heavily damaged** trees accounts for – 19.3 %. This category is characterized by significantly dry branches, marginal and central chlorosis, in some places the death of the bark is observed. Many plants are damaged by Xanthoria parietina (L.)

The category of **drying out** includes – 6.2 %. The trees of this group have completely dry branches, there is no growth, there are numerous fruiting bodies of marsupials and basidiomycetes in trunks.

Woody plants with completely dry (without leaves, the bark exfoliates or is completely absent) make up – 1.4 %.

![Figure 1](image_url)

**Figure 1.** The percentage distribution of the studied trees of the cities of the Oryol Oblast by vitality classes (1st group – healthy, 2nd group – weakened, 3rd group – greatly weakened, 4th group – drying out, 5th group – dry).
Table 2. Average scores (Ki) of the state of tree species and the general state coefficient (K-total) of the studied green spaces of small towns in the Oryol region

| No. | Type                                                                 | Bolkhov | Dmitrovsk-Otrovsky | Livny | Mahankhangelsk | Neveil | K-total |
|-----|----------------------------------------------------------------------|---------|-------------------|-------|----------------|--------|---------|
| 1   | White birch (Betula pendula Roth.)                                    | 1.24    | 1.09              | 1.46  | 1.81           | 1.37   | 1       | 1.33 |
| 2   | Whitehorn (Crataegus submollis Sarg.)                                | –       | –                 | –     | –              | 1.27   | –       | 1.27 |
| 3   | Wallwort (Sambucus nigra L.)                                         | –       | 3.89              | –     | –              | –      | –       | 3.89 |
| 4   | Egriot (Cerasus vulgaris Mill.)                                       | 2.63    | 2.19              | –     | –              | –      | –       | 2.41 |
| 5   | Elm (Ulmus laevis Pall.)                                             | 2.57    | –                 | 2.38  | –              | –      | 1.72    | 2.22 |
| 6   | Wych-elm (Ulmus glabra Huds.)                                        | –       | 1.96              | 2.44  | 2.67           | 2.39   | 3.06    | 2.5  |
| 7   | Petiolate oak (Quercus robur L.)                                     | 1.78    | –                 | 2.69  | –              | 2.71   | –       | 2.39 |
| 8   | White spruce (Picea canadensis) (Mill. Britt.)                       | –       | –                 | –     | –              | 1.69   | –       | 1.69 |
| 9   | Blue spruce (Picea pungen Engelm.)                                   | 0.75    | 1.78              | 1.93  | 2.31           | 1.87   | 2.19    | 1.8  |
| 10  | Spruce fir (Picea abies (L.) Karst.)                                 | 0.98    | 1.8               | 1.46  | 1.69           | 1.23   | 1.62    | 1.46 |
| 11  | Common willow (Salix alba L.)                                        | 1.97    | 2.09              | 1.33  | –              | 1.83   | 1.92    | 1.83 |
| 12  | Weeping willow (Salix babylonica L.)                                 | –       | 1.02              | –     | –              | –      | –       | 1.02 |
| 13  | Brittle willow (Salix fragilis L.)                                   | 2.35    | 1.51              | –     | –              | 1.87   | 1.91    | –    |
| 14  | Siberian pea shrub (Caragana arborescens Lam.)                       | –       | 3.13              | 3.67  | –              | 3.9    | –       | 3.56 |
| 15  | Norway maple (Acer platanoides L.)                                   | 2.36    | 2.67              | 2.13  | 2.53           | 1.98   | 2.17    | 2.31 |
| 16  | Canadian maple (Acer negundo L.)                                     | 2.78    | 2.41              | 2.27  | 2.68           | 2.14   | 2.39    | 2.45 |
| 17  | Horse chestnut (Aesculus hippocastanum L.)                           | –       | 2.83              | –     | 3.27           | 2.73   | 2.94    | –    |
| 18  | Douglas fir (Pseudotsuga menziesii (Mirb.) Franco)                   | –       | 1.74              | –     | –              | –      | –       | 1.74 |
| 19  | Large-leaved linden (Tilia platyphyllos Scop.)                       | –       | 2.08              | 1.92  | –              | –      | –       | 2    |
| 20  | Small-leaved linden (Tilia cordata Mill.)                            | 1.74    | 1.84              | 2.47  | 2.31           | 1.82   | 1.59    | 1.96 |
| 21  | European larch (Larix decidua Mill.)                                 | –       | –                 | –     | 1.37           | –      | –       | 1.37 |
| 22  | Siberian larch (Larix sibirica Ledeb.)                               | –       | –                 | –     | 0.54           | –      | –       | 0.54 |
| 23  | Creeping juniper (Juniperus sabina L.)                               | –       | –                 | 1.65  | 1.42           | –      | –       | 1.54 |
| 24  | Common juniper (Juniperus communis L.)                               | –       | –                 | 1.84  | 1.27           | –      | –       | 1.55 |
| 25  | Manchurian walnut (Juglans mandshurica Maxim.)                       | –       | –                 | –     | 2.41           | –      | –       | 2.41 |
| 26  | Black locust (Robinia pseudoacacia L.)                               | –       | 2.94              | –     | –              | –      | –       | 2.94 |
| 27  | Rowan-tree (Sorbus aucuparia L.)                                     | 2.43    | 1.74              | –     | 1.48           | –      | –       | 1.88 |
| 28  | Common pine (Pinus sylvestris L.)                                    | 1.67    | 3.13              | 2.94  | 1.98           | –      | –       | 2.43 |
| 29  | Rough-bark poplar (Populus balsamifera L.)                           | –       | –                 | –     | 1.83           | –      | –       | 1.83 |
| 30  | White poplar (Populus alba L.)                                       | –       | 1.86              | –     | 1.53           | –      | –       | 1.7  |
| 31  | Berlin poplar (Populus × berolinensis (C. Koch) Dipp.)                | –       | –                 | –     | 2.31           | 1.85   | 2.08    | –    |
| 32  | Sweet poplar (Populus suaveolens Fisch.)                             | –       | –                 | –     | 2.05           | –      | –       | 2.05 |
| 33  | Canadian poplar (Populus canadensis Moench)                          | –       | 3.21              | –     | –              | 3.46   | 3.34    | –    |
| 34  | Laurifolious poplar(Populus laurifolia Ledeb.)                       | –       | 2.36              | –     | –              | –      | –       | 2.36 |
| 35  | Razumovsky poplar (Populus × razumowskiana (Regel) Schneid.)         | 1.78    | –                 | 2.85  | –              | –      | –       | 2.32 |
| 36  | Gray poplar (Populus × canescens Ait. Smith)                         | –       | 2.11              | –     | –              | –      | –       | 2.11 |
| 37  | Black poplar (Populus nigra L.)                                      | 2.18    | 2.73              | 2.16  | 2.62           | 2.83   | 2.9     | 2.57 |
| 38  | American arbor vitae (Thuja occidentalis L.)                         | 1.27    | 1.07              | 0.92  | 1.43           | 1.18   | 1.24    | 1.9  |
| 39  | Bird cherry (Padus avium Mill.)                                      | 1.63    | 0.68              | 1.12  | –              | 0.89   | 1.08    | –    |
| 40  | Common ash (Fraxinus excelsior L.)                                   | 1.85    | 2.11              | 2.59  | 2.67           | 2.82   | 2.94    | 2.5  |
| 41  | Apple tree (Malus domestica Borkh.)                                  | 2.38    | 2.43              | –     | –              | –      | –       | 2.41 |
Table 3. Average scores (Ki) of the state of shrub species and the general state coefficient (Ktotal) of the studied green spaces in Mtsensk

| No. | Type                               | Koli | Dmitrovsk-Orolevsky | Livny | Maloarkhangelsk | Mtsensk | Novosil | Ktotal |
|-----|------------------------------------|------|---------------------|-------|-----------------|---------|---------|--------|
| 1   | Pipperidge tree (Berberis vulgaris L.) | –    | –                   | 1.83  | –               | –       | –       | 1.83   |
| 2   | Common privet (Ligustrum vulgare L.) | –    | –                   | –     | –               | 2.68    | 2.68    |        |
| 3   | Single-seed hawthorn (Crataegus monogyna Jacq.) | –    | –                   | –     | 2.04            | –       | 2.04    |        |
| 4   | Boortree (Sambucus racemosa L.)     | 1.89 | –                   | –     | –               | –       | –       | 1.89   |
| 5   | White cornelian cherry (Swida alba (L.) Opiz.) | 1.63 | –                   | –     | –               | 1.52    | 1.58    |        |
| 6   | Cotoneaster (Cotoneaster lucidus Schlecht.) | –    | 3.1                 | 2.97  | 2.43            | 2.78    | 2.08    |        |
| 7   | Dwarf ninebark (Physocarpus opulifolius (L.) Maxim.) | –    | 2.65               | 3.42  | 3.14            | 2.92    | 2.78    | 2.82   |
| 8   | Pimpinelloid rose (Rosa pimpinellifolia L.) | –    | –                   | 2.41  | –               | –       | 2.41    |        |
| 9   | May rose (Rosa majalis Herrm.)      | 1.79 | –                   | 1.94  | 2.31            | –       | 2.01    |        |
| 10  | Villous rose (Rosa villosa L.)      | –    | –                   | 2.05  | –               | –       | 2.05    |        |
| 11  | Corymb rose (Rosa corymbifera Borkh.) | 1.94 | –                   | –     | –               | –       | 1.94    |        |
| 12  | Syringa vulgaris (Syringa vulgaris L.) | 2.13 | 2.04               | 1.69  | 1.93            | 2.26    | 2.18    | 2.04   |
| 13  | Billard meadowsweet (Spirea x billardii Dipp. l. c.) | –    | 1.72               | 1.96  | –               | –       | 1.84    |        |
| 14  | Oak meadowsweet (Spirea chamaedryfolia L.) | –    | –                   | 2.17  | –               | –       | 2.17    |        |
| 15  | Japan meadowsweet (Spirea japonica L.) | –    | –                   | 2.41  | –               | –       | 2.41    |        |

The results show the average state score for each type of tree and the general state coefficient of green spaces, the public areas of small towns in Oryol Oblast weakened. They require reconstruction, pruning, and sanitation (Table 2, 3).

The study shows the low vitality observed in plantings along the central streets with a car traffic. Here, the following species were subjected to the greatest damage: Fraxinus excelsior L., Aesculus hippocastanum L., Betula pendula Roth., Quercus robur L., Cotoneaster lucidus Schlecht., Rosa villosa L.

The main causes of mass thinning, drying out, and dying off of trees in the city are: the age of plantings, lack of proper agricultural technology, soil compaction and salinization, mechanical damage. In this regard, there is a great vulnerability to pests and diseases.

4. Conclusion
1. The main problems of the planting and gardening elements in small towns of the Oryol Region are the following: degradation of plantations; low species and varietal diversity of tree stands; lack of proper agricultural care for plantations; lack of understanding of the importance and role of plantings in the structure of urban areas.

2. The range of species of woody plants in small towns of the Oryol region can be expanded by attracting valuable species that were not used in these towns before. Specialized institutions of the Oryol Oblast (arboretums of the All-Russian Research Institute for Fruit Crop Breeding and the Oryol State Agrarian University named after N.V. Parakhin, Shatilov Agricultural Experimental Station), which actively and successfully conduct the introduction of woody plants, can be successful sources of planting material [8].

3. The system of increasing the sustainability of woody plants and protecting plantings in the city require specific actions. The main ones are: the organization of general supervision over the appearance and spread of pests and diseases and the implementation of measures to actively protect plants from those; quarantine and certification of planting material; preventive activities aimed at increasing the resistance of plants to negative factors of the urban environment (thinning and sanitary cutting, pruning, agricultural activities).
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