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Urban flora of Astana (Kazakhstan): A Technology for Creating a Comfortable Ecosystem

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Abstract*: *This paper describes the results of studying the state of tree plantations in the harsh climatic conditions of Astana. In this paper, the authors describe the assessment of the living state of the main tree varieties, their resistance to pests and diseases as elements of the emerging urban flora. The methods generally adopted in botany were used for assessing the sustainability of tree species and their living state. Total estimation of the living state of trees of each species in the green plantations was performed by 10 – 25 model trees. At seven objects (SP1 – SP7) of the research, widely spread tree crops (Populus balsamifera L., Populus pyramidalis Salisb., Populus alba L. and Populus bolleana Lauche, Picea pungens Engelm., Pinus sylvestris L., Ulmus parvifolia Jacq. and Ulmus glabra "Pendula"), Betula pendula Roth., Salix fragilis L.) show various degrees of resistance to ecotopic conditions, and have various positions in amenity planting of the city and the urban flora formed.

Index Terms*: *flora, urbanized territories, tree plantings, living conditions, recreation, ecosystem services.

I. INTRODUCTION

Urbanization is the dominant trend in society development in the 20th – 21st centuries. Urbanized territories of large cities are characterized by the formation of a special type of flora, which includes the totality of the plants growing within the administrative boundaries of the settlement. In the world practice, most studies on the effect of urbanization are focused on developed countries, despite the fact that urban sprawl is a global problem. In developing countries, which are also experiencing fast and uncontrolled urban sprawl, natural ecosystems are replaced by pavements and buildings, and the remaining natural soil is covered with green areas dominated by alien decorative species, thereby complicating the biota [1-7]. The "Kazakhstan-2050" strategy includes long-term principles of urban development. Among them, the leading cities are Astana and Almaty, as they are currently becoming the largest agglomerations in Central Asia [8]. An example of active urbanization is the new capital of Kazakhstan – the Astana city. It is a model of urban flora formation in the dry steppe zone.

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The flora of urbanized territories is a natural-anthropogenic formation that is a product of human civilization development. Large cities and the regularities of flora formation, their tolerance and adaptive qualities to the ecotopic conditions are among the hottest topics in studying the international natural science. Many authors [9-12] note that urban areas have unique sets of species, the biological diversity of which sometimes exceeds the natural flora and creates a wide range with a wide variety of plants' species, many of which are of alien origin. It has been found that the abundance of urban flora species is determined by various factors that are similar to those of urban flora in Europe and North America. The area of the city and the population size is one of the main reasons that determine the total number of species and the number of native species in the urban flora.

Species' spreading also depends on environmental processes. Studies of scholars such as J. Borysiak, Mizgajski A., Speak A. [13], Potgieter L. J., Gaertner M., Kueffer C., Larson B. M., Stuart H., Livingstone W., O'Farrell P. G., Richardson D. M. [14] have shown that the plants of the urban flora are polyfunctional in the context of providing the ecosystem services. Biodiversity of the flora is the basis of many of these ecosystem services [15]. People living in urban areas have special needs and requirements to the ecosystem services. This implies that urban ecosystems are largely transformed by human activities, their flora contains a significant share of alien plant species, many of which have been deliberately introduced to ensure diversity of the ecosystems. Tree crops provide several environmental services in urban ecosystems. Cultural services (aesthetics in particular) are the most well-known environmental services provided by tree plants in the urban areas of developed countries, while in developing countries, the services provided by tree plants are food production services. Despite numerous studies in this area, there is insufficient research devoted to revealing regularities of flora formation in urbanized territories and the adaptive properties of individual species in various climatic conditions (e.g., in the conditions of the Euro-Asian dry steppes) for including these ecosystems into the global preservation strategies [1].Important objects of the research will be the components of urban flora: a set of native species that give it a distinctive image and regional features, and adventive species, the number of which increases with widening the range of cultivated plants. Studying the spread of alien plant species that are a critical ecological event in the world is relevant. Literary sources note that by invading, alien species of plants disrupt the ecological structure of local ecosystems,

alter their composition, and lead to the eradication of the indigenous vegetation, and fauna afterward [16]. Therefore, the plants that form urban flora should be the objects of intensive management. Urban floristic studies are relevant for the key regions of Kazakhstan in the biogeographic and economic respect, such as Astana, which has been developing as the capital of Kazakhstan for 20 years. These studies have practical importance: they are required for the development of a scientific basis for forming the flora in urban areas, where approaches and methods of harmonizing the relationship between the man and nature are to be elaborated in the first place. The applied value of such studies consists in solving the city-planning issues related to optimization of the species composition and placement of green plantations. When growing plants in urban conditions, biotic and abiotic factors are considered, which influence the growth and development and, consequently, the overall decorative value and resistance of the crops. The species and varieties recommended for greening should correspond to the climatic characteristics of the region. In the process of planning Astana, one of the leading problems was creating recreational areas with trees and ornamentally floral crops. Over the recent years, many new avenues, parks, and squares have been developed and laid out, which has changed the image and the microclimate of the capital. Today, it is a green metropolis in the middle of the steppe. Astana is located on the riverside plain, and partly in the valley of the Esil River. The terrain is generally characterized by the absence of visible slopes and distinctly expressed relief. Characteristic elements of the terrain are numerous flat-bottom steppe depressions, in which lakes or swamps form in the spring. The city is located in the zone of dry steppes, in the subzone of dry fescue-feather grass steppes on dark chestnut soils. The climate in Astana is sharply continental, with hot dry summers and frosty winters with little snow. The average annual temperature is +3.2 °C. Summers are dry and hot, the absolute maximum temperature is +42 °C. Winters are snowy, dry, the absolute registered minimum temperature is -51 °C. The annual rainfall is 307 mm. Vegetation of plants starts in mid-April. Repeated spring and early autumn frosts are possible. The frost-free period is short, from the end of April to mid-August. In the conditions of Astana with its varied microclimatic, soil-climatic and environmental conditions with the sharply continental climate, selection and widening the range, monitoring the state of ornamental crops are high priority tasks. The overall number of trees in the city exceeds 450 thousand. Their number increases every year due to planting within the framework of greening activities, through the construction and reconstruction of parks and squares, and greening of new building facilities [17]. The average trees' survival rate in the capital exceeds 92 %. In three districts of Astana, namely, Almaty, Saryarka, Esil, 8,437, 5,606, and 2,260 trees, respectively, are planed every year. Greening is one of the efficient environment-forming factors. The role of amenity stands in reducing the negative environmental impact is in their ability to neutralize unfavorable factors of natural and technogenous origin. The high degree of negative impact of the anthropogenic factors inherent in urbanized areas naturally results in weakening of vegetation, premature aging, reduced productivity, the occurrence of diseases, pests and plants' death [18]. Ecologists and botanists recommend monitoring amenity stands in cities for their expansion and timely renewal [11].

Increased anthropogenic load and the climatic conditions of Astana make adjustments, and sometimes create harsh ecotopic conditions for tree crops. The purpose of the research was monitoring the state of tree stands in Astana, including monitoring the living state of the main range of tree crops and their resistance (damage by pests, diseases) for forming the main range of crops in amenity planting in the city. Such studies allow identifying the state of amenity stands, assessing and predicting the development of environmentally disadvantaged situations, obtaining the information about changes in the plants for further improvement of the environmental services. The studies have shown that despite the relatively wide range in the varietal composition of tree plantings used in the greening of Astana, the leading range is represented by a limited number of species. Thus, amenity stands serve two equally important purposes: being an independent, valuable object of observations and monitoring, and an indicator of the environment state.

I. MATERIALS AND METHODS

The research was performed in the summer 2016 – 2017 on the territory of the administrative-territorial unit of the Almaty district, which is the major district of the Astana city, together with AO "Astana - Zelenstroy". The district was founded on May 6, 1998; the district area is 206 km². The Almaty district has an intensively developing infrastructure, recreational zones with amenity stands, annual plantings amount to 7 to 8 thousand tree crops with the average trees' survival rate of 92 %. The species composition of plants in the areas in question was studied using the reconnaissance-route method [19, 20]. In accordance with generally adopted botanical methods, linear test plots were laid in plantings on the al-Farabi Street, Akhmet Baitursynov Street, Syganak Street, in National Museum complex; rectangular plots were laid out in the nonlinear facilities: the complex of Hazrat Sultan mosque, the Baiterek complex, and the Mangilik el Street. Trees were assessed on the species of the main range most commonly occurring in all types of plantings: poplar (balsamic – *Populus balsamifera L.*, pyramidal *Populus pyramidalis Salisb.*, white – *Populus alba L.* and Bolle hybrid – *Populus bolleana Louche*), blue spruce – *Picea pungens Engelm.*, pine - *Pinus sylvestris L.*, small-leaved elm – *Ulmus parvifolia Jacq.*, rough and weeping elm – *Ulmus pendula Lodd.*, weeping birch – *Betula pendula Roth.*, brittle willow – *Salix fragilis L.*Assessment of tree species' stability was performed for all elements of the amenity tree stands in the studied facilities in accordance with the commonly adopted methods. Calculation of the living state value in scores was based on the determination of the extent of leaf surface and crowns' damage: the number of live branches in the crowns of trees, degree of leafiness (needle packing) of the crowns, the number of live (without necrosis) leaves in the crowns, and the average percentage of live leaf area [21].

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The sample of plants consisted of 10 trees and shrubs in each studied plot (middle-age generative state g2) [22]. Morphometric studies were performed on 10 model plants, in which 10 branches of the lower third of the crown were marked along the perimeter. The annual growth of the length of lateral shoots was measured every 10 days using an iron ruler with the accuracy up to 0.1 cm. The number of leaves on a year-old shoot was counted in pcs. At the end of vegetation, the mass of leaves on year-old shoots was weighed on the scales with the accuracy of up to 0.1 g, and the area of leaves' surface was calculated with regard to punchings (1×1 cm) according to the method of I. V. Karmanova [23].

The living state of trees was assessed by the visual method based on determining the degree of disruptions in the assimilative apparatus and crowns [24]. In this case, the following is assessed:

1 - the share of living (R1) branches in the crowns of the trees (10% = 1 score);

2 - the degree of needle packing (R2) or leafiness of the crowns (10% = 1 score);

3 - the share of live (without necrosis) leaves (R3) in the crowns (10% = 1 score); and

4 - the average percentage (R4) of the live leaf area (10% = 1 score).

Total estimation of the living state of trees (LSv) of each species in the green plantations was performed by 10 – 25 model trees according to the formula:

$$LSv = P1 + R2 + R3 + R4.$$

The maximum value of the condition of the trees in normal plantations according to this method is 39 – 40 scores, and in weak and drying plantations – less than 39.

Using this method, the following has been determined:

- resistant types – their living state varies in the range between 39 and 40 scores;
- moderately resistant types – their living state varies in the range between 36 and 38 scores; and
- nonresistant types – their living state is below 35 – 33 points.

This method allows assessing the degree of reducing the productivity of trees under the action of a set of unfavorable factors resulting in the deterioration of their decorative properties.

II. RESULTS

The research has shown that the common use amenity stands in the Almaty district feature relatively high diversity of tree crops. One should note the dominance of 10 species of tree crops, which were present in the model plantings in various combinations (Table 1).

Table 1 – Objects of studying the common use amenity stands of the Almaty district of the Astana city

Sample plot number (SP)	Reference/location of the sample plot	Species
SP 1	al-Farabi Street	Lombardy poplar – *Populus pyramidalis Salisb.* Weeping birch – *Betula Pendula Roth.* Brittle willow – *Salix fragilis L.*
SP 2	the Khazret Sultan mosque	Common pine - *Pinus sylvestris L.* White poplar – *Populus alba L.* Balsamic poplar–*Populus balsamifera L.* Blue spruce – *Picea pungens Engelm.*
SP 3	Akhmet Baitursynov Street	Common pine - *Pinus sylvestris L.* Blue spruce – *Picea pungens Engelm.*
SP 4	the Baiterek complex	Lombardy poplar – *Populus pyramidalis Salisb.* Common pine - *Pinus sylvestris L.* Chinese elm –*Ulmus parvifolia Jacq.* Blue spruce – *Picea pungens Engelm.*
SP 5	Mangilik el Street	Blue spruce – *Picea pungens Engelm.* Common pine - *Pinus sylvestris L.*
SP 6	the National Museum complex	Blue spruce – *Picea pungens Engelm.* Common pine - *Pinus sylvestris L.* Weeping wych-elm – *Ulmus pendula Lodd.*
SP 7	Syganak Street	Lombardy poplar – *Populus pyramidalis Salisb.* Bolle's poplar –*Populus bolleana Louche* Common pine - *Pinus sylvestris L.*

For calculating the living state value of tree crops in SP1 – SP7, the extent of leaf surface and crowns' damage – the number of live branches in the crowns of trees, the degree of leafiness (needle packing) of the crowns,

the number of live (without necrosis) leaves in the crowns, and the average percentage of live leaf area – were determined. The total estimation of LSv of trees of each species at the research facility is shown in Figure 1.

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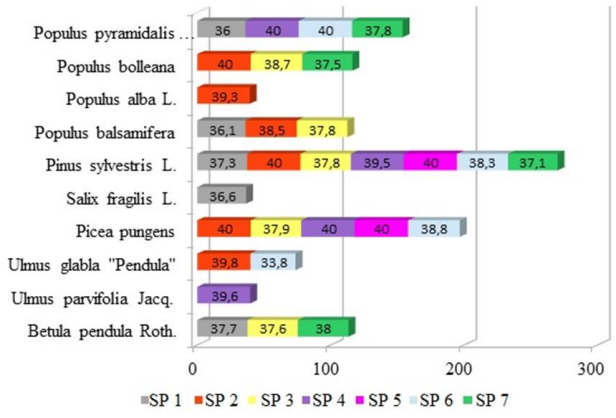

Figure 1 – The living state of tree crops

The research performed in the urban territory of the Almaty district shows a variation of the vital state of tree crops at the objects of study from 33.8 (SP 6) to 40 (SP 2, SP 4, SP 5) reflecting different levels of resistance and adaptation of individual species to the environmental conditions.

In accordance with the methodology, resistant species were identified with the LSv indicator between 39 and 40 scores on the experimental plots, the share of which was 40.0 % of the total number, as well as moderately stable species with LSv between 36 and 38 points, the share of which was 56.7 %, and unstable species with LSv below 35 – 33 points, the share of which was 3.3 %.

III. RESULT ANALYSIS

The values in the sample plots laid at the objects of the Hazrat Sultan mosque complexes, Baiterek, Mangilik el Street show good values of tree crops' vital state. This is due to the ecological features of these objects of research. A lower anthropogenic load is observed, which is due to the recreational conditions near these objects (fewer roads, location on various levels, and protection of the trees from the wind by the buildings of the complex).

Significant additional pressure on the common use amenity stands is put by the increased traffic on the al-Farabi Street, the Akhmet Baitursynov Street, and the Syganak Street. The stands show the living state of medium resistance – 36 to 38 scores (see Figure 1). The authors note the deterioration of the trees' state, greater depression of trees near highways due to the harsh ecotopic conditions as a result of intensive traffic, strong dry wind in summer and cold winds in the winter.

Depending on the location of the objects, a wide range of LSv indicators can be noted on the diagram of certain types of the basic range of tree crops (Figure 2 – 7).

Lombardy poplar (*Populus pyramidalis Salisb.*) at the objects of the al-Farabi Street, Sygynak Street, and complexes Baiterek and national Museum (SP 1, SP 7, SP 4, SP 6) shows a wide range of differences by the following indicators: the percentage of live leaves in the crown varies between 88 and 100 %; the percentage of live branches in the crown, and the degree of leafiness – 90 to 100 % (Figure 2).

With the high indicators of vital status (LSv) on the complexes, the poplars growing along the al-Farabi and Sygynak streets have frost cracks in the trunks, broken branches, and crown freezing. Sometimes, symptoms of cytospora dieback (*Cytospora joetidae VI. et. Rr.*) are visible on the trunk of weakened trees, sometimes necroses are formed on the leaves.

In streets greening, balsam poplars (Populus balsamifera L.) are frequently used.

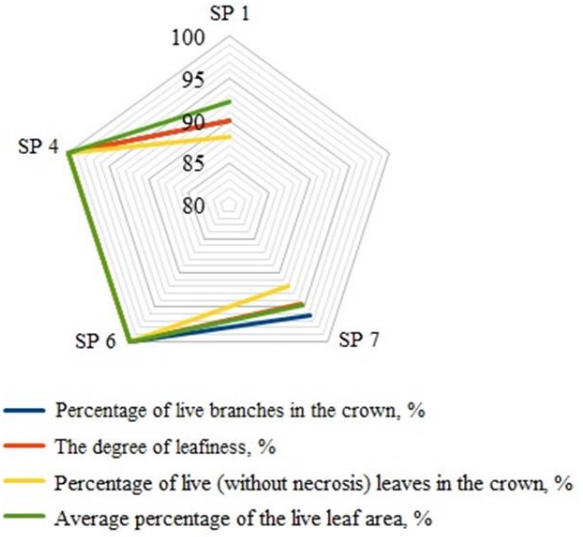

Figure 2 – Assessment of the state of Lombardy poplar on the samole plots of the Almaty district of Astana

At three studied objects SP1 (al-Farabi Street), SP2 (Khazret Sultan mosque), SP3 (Akhmet Baitursynov Street) assessment of the state shows high resistance of the species (LSv of 36.1 scores in the al-Farabi Street, and of 37.8 scores in the Baitursynov Street), due to the fact that the largest share of air and soil pollution from the traffic falls on these highways (Figure 3).

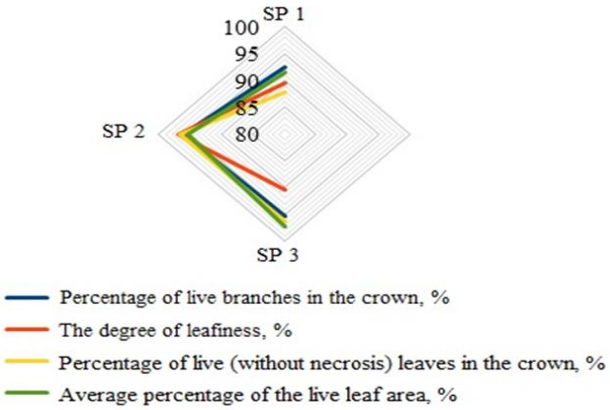

Figure 3 – Assessment of balsam poplars (*Populus balsamifera L.*) in the sample plots of the Almaty district of Astana

The harmful substances contained in the motor vehicles' emissions disrupt the growth and development of the plants, cause the formation of necroses on the leaves, premature leaves' drying and falling off, deteriorate the decorative properties, and sometimes cause trees' weakening and withering – this results in early aging and weakening of the plantings.

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In more comfortable growing conditions at the Khazret Sultan complex, the living state of balsam poplars (*Populus balsamifera L.*) was 38.5 scores.

One of the species in the amenity stands at the objects with a sufficiently high rate of living state is now becoming Bolle's poplar (*Populus bolleana Lauche*). At the Khazret Sultan complex, this figure reaches 40.0 scores (Figure 4).

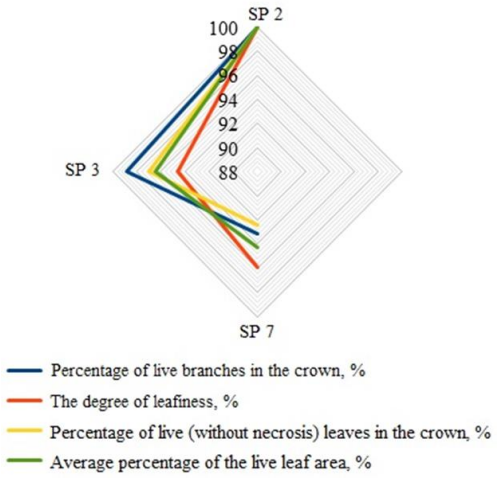

Figure 4 : Assessment of the state of Bolle's poplar (*Populus bolleana Lauche*) in the sample plots in the Almaty district of Astana

In the Baitursynov Street and the Syganak Street, with indicators of living state (LSv) equal to 37.8 and 37.5 scores, respectively, Bolle's poplar (*Populus bolleana Lauche*) shows a high percentage of live branches in the crown, and live leaves' surface area. Of all species of genus Populus, this species is the least exposed to the damage by phytophages and pathogens; however, there are deviations: premature drying, leaves' falling off, sometimes the weakening of the trees caused by the abiotic factors.

Currently, the variety of species in the amenity stands is being expanded by introducing coniferous species. Conifers do not lose their attractiveness and decorative properties throughout the year and usually live longer than deciduous species. They are a perfect material for creating compositions. One of the most rapidly adapting species is common pine (*Pinus sylvestris L.*). During the study, this species occurs at all objects – SP1 through SP7, showing various degrees of resistance to the environment and decorative properties. Various conditions of plant growing in the amenity stands influence their growth and development. Studying the plantings of common pine (*Pinus sylvestris L.*) in the *Mangilik el Street* (SP 5), where it takes the dominant position, showed that after using growth stimulants, significant growth of the green mass, as well as rapid growth and development of the central axial and lateral shoots, and wakening of dormant buds had been observed. Here, the indicators which make up the living state (LSv) reach the maximum.

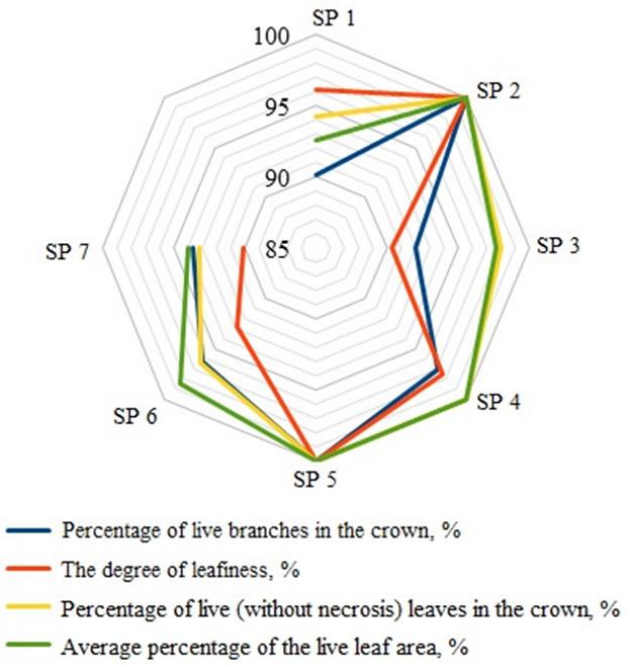

Figure 5 : Assessment of the state of common pine (*Pinus sylvestris L.*) in the sample plots in the Almaty district of Astana

Based on the research, it has been established that planting of pine (*Pinus sylvestris L.*) at SP2 (the Hazrat Sultan mosque complex) shows high stability at the level of leaves, shoots and the entire plant, as shown in Figure 5.

At SP4 (the Baiterek complex), with the existing high level of living state (LSv), needles' color change to violet and partial drying of lateral branches were noted in the pine trees (*Pinus sylvestris L.*) that grew under street lights or near them. Such changes were not noted in the pine trees that were more distant from the street lights.

The satisfactory state is shown by the plantations of pine (*Pinus sylvestris L.*) at SP1 (al-Farabi Street), SP3 (A. Baitursynov Street) and SP7 (Syganak Street) with symptoms of branches' drying in certain locations with sparse leafiness, with the leaves' and shoots' slight damage by pests and diseases. In the studied trees at SP7 (Syganak Street), damage by pine resin-gall moth (*Evetria resinella L.*) (2 – 5%) was noted in the crown of the trees, in the Baitursynov Street, witch-brooms disease (1 – 2%) was detected on pines (*Pinus sylvestris L.*), in the al-Farabi Street (SP1) in pine stands (*Pinus sylvestris L.*) of the current year, and in pine stands (*Pinus sylvestris L.*) near the national Museum complex (SP6), single specimens of the small owl larvae (*Panolis flammea Schiff.*) and stellate leaf-rolling sawflies (*Acantholyda Stella Chr.*) were found.

One of the ornamental crops that is actively expanding its presence in the greening of Astana is blue spruce (*Picea pungens Engelm.*).

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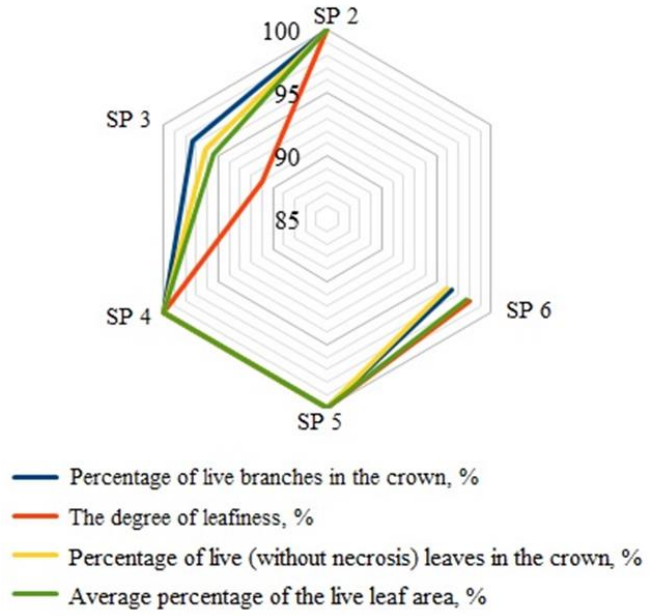

Figure 6 – Assessment of the state of blue spruce (*Picea pungens Engelm.*) in the sample plots in the Almaty district of Astana

At the studied objects, the species manifested high stability at the objects somewhat remote from wide streets: these were SP2 (the complex of Hazrat Sultan mosque), SP4 (the Baiterek complex) and SP5 (Mangilik el Street), surrounded by tall buildings. The living state (LSv) ranged from 37.9 (SP3 – Akhmet Baitursynov Street) to 40 points (SP2, SP4, and SP5).

Blue spruce (*Picea pungens Engelm.*) has high adaptive properties and long-term preservation of the decorative properties at the objects of the city (spruces *Picea pungens Engelm.* develop abundant strobila: 30 – 50 cm long branches contain up to 30 strobilae of the current year, the strobila length is 5 to 7 cm), where the climatic particularities (strong winds, high temperatures in summer) are compensated for by the surrounding high-rise buildings and regular organo-mineral fertilization of plants. At SP3 (Akhmet Baitursynov Street) and SP6 (the National Museum complex), depressed state of trees was noted as a result of branches' damage by Physokermes piceae Scher. This resulted in decreasing the percentage of leafiness (needle packing) and reducing the live leaf surface area down to 91 % and 95.4 %, respectively.

Birch (*Betula Pendula Roth.*) remains the dominant species in the birch alleys in the urban flora of Astana. At the objects of research in the Almaty district of Astana, birch (*Betula Pendula Roth.*) grows at SP1 (al-Farabi Street), SP3 (Akhmet Baitursynov Street), and SP7 (Syganak Street) at some distance from the roads; however, the living state (LSv) does not exceed 38 scores (Figure 7).

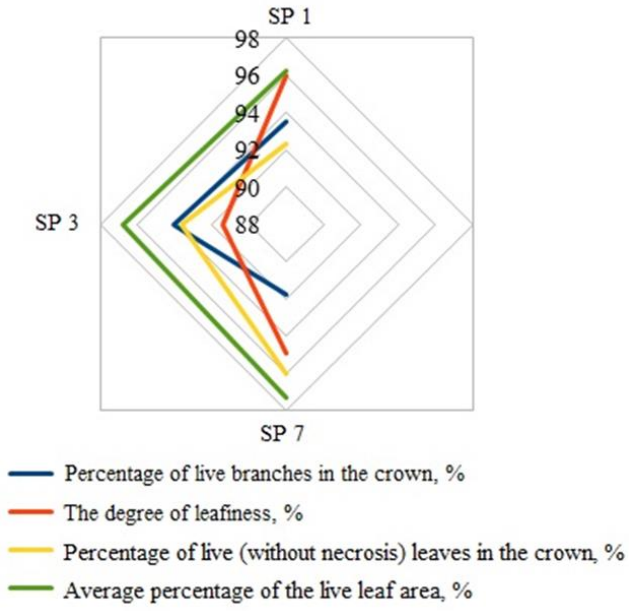

Figure 7 – Assessment the state of weeping birch (*Betula Pendula Roth.*) in the sample plots in the Almaty district of Astana

This crop has been one of the most widely spread tree crops in the period of the 1990s. During the formation of the capital, it had reduced its proliferation and became more exposed to harmful organisms, which resulted in the loss of resistance to environmental factors, and of the decorative properties.

Among the species of tree crops and amenity stands, there are species that grow at certain studied objects rather than everywhere (Table 2).

Table 2 – Assessment of deciduous tree species in the sample plots in the Almaty district of Astana

No.	Sample plot number	Trees species	Percentage of live branches in the crown, %	The degree of leafiness (needle packing), %	Percentage of live (without necrosis) leaves in the crown, %	Average percentage of the live leaf area, %	Live state, score
1	SP2	White poplar – *Populus alba L.*	98.2	98.6	97.8	97.9	39.3
2	SP1	Brittle willow – *Salix fragilis L.*	86.3	95.0	90.3	94.6	36.6

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3	SP2 SP6	Weeping wych-elm – *Ulmus pendula Lodd.*	100 88.1	98.4 80.2	100 85.0	100 84.8	39.8 33.8
4	SP4	Chinese elm – *Ulmus parvifolia Jacq.*	100	95.8	100	100	39.6

Species such as white poplar *Populus alba L.* (living state of the species – 39.3 scores), Chinese elm *Ulmus parvifolia Jacq*. (39.4 scores), given their living state (LSv) and the environmental strategies for living in urban conditions, may be used for the recreational zones of the city.

Tree crops in the studied district create a protective and aesthetic background for other plants in the recreational zone. The role of tree crops is especially important for the climatic conditions of the Astana city. In addition, the authors have noted distinctive features of the tree crops depending on the places of growth, i.e. exposure characteristics. Due to the biological peculiarities, the following crops may be identified in the recreational areas of Astana with a good living state: common pine (*Pinus sylvestris L.*), blue spruce (*Picea pungens Engelm.*), Lombardy poplar (*Populus pyramidalis Salisb.*), balsam poplar (*Populus balsamifera L.*) and Bolle's poplar (*Populus bolleana Lauche*.) (Figs. 1-7). Today, these crops make up the most part of the tree stands. It is noteworthy that some crops growing at the objects distant from large highways show the maximum values of the living state, such as conifers, blue spruce (*Picea pungens Engelm.*) and common pine (*Pinus sylvestris L.*); the deciduous species adapted to the growing conditions are Lombardy poplar (*Populus pyramidalis Salisb.*) and Bolle's poplar (*Populus bolleana Lauche*).

Balsam poplars (*Populus balsamifera L.*) feature medium stability in terms of the living force at all studied objects.

IV. CONCLUSION

The growth and global urbanization of Astana create the necessity of studying the regularities of urban flora formation, which includes species of various origin: indigenous and alien ones. Formation of flora largely depends on the growing area of the city, climatic conditions, and anthropogenic factors. The speed of Astana urbanization and the sharply continental climate dictate the conditions for the city and the urban flora transformation. In the urban flora of Astana, tree crops take a dominant position in providing ecosystem services, being environmental background plants for other decorative and aesthetic crops (flowers). The results of the research show a nonheterogeneous pattern of the living state (LSv) values among the tree crops at the studied objects. Currently, the formation of Astana's urban flora is in the process, and it has not been completed. The crops differ in their performance, depending on the habitats shown in Figure 1. Currently, adventive species, such as pine and spruce, become dominating if favorable growing conditions have been created for them, such as at SP2, SP4, SP6. Hoverer, the living state values and the depressed state at other plots (highways) show that the limits of these crops' proliferation in the future will change and set, which will lead to choosing the species that are tolerant to the conditions of Astana.

Along with that, a number of species virtually fall out from the urban flora at this stage, for example, the weeping elm (at object SP6 with the LSv index of 33.8 scores). The reduced spread of birch and willow is observed. With increasing the load on the highways, birch at SP3 (37.6 scores) and at SP7 (38 scores) shows deteriorated growth and development, formation of necroses on the leaves, premature drying and leaves' falling off, reduced decorative properties, and weakening and withering of the trees. Thus, the urban environment consistently involves into the urban flora the plants with special biological properties. In the case of Astana, these are coniferous (Pinus sylvestris – *Pinus sylvestris L.*, and blue spruce – *Picea pungens Engelm.*), and birch for growing in the recreational areas. Many adventive species, such as blue spruce, feel fine in parks, in the squares, but on the busy streets show depression and premature aging. In the conditions of permanent growth of the city, growth of the population, and especially increase in the number of vehicles, the choice of plants for greening from the number of native species becomes difficult. Special attention is attracted to poplar, which is difficult to find a worthy replacement for in Astana. Poplar is one of the most widespread tree species in urban greening. They release much more oxygen than many other tree species and can grow along busy streets, withstanding high levels of air pollution and soil salinity.

The most resistant to adverse environmental conditions in the city are Bolle's poplar and Lombardy poplar; there is also the need for increasing the number of representatives of interspecific hybrids of poplars along highways with lower degree of fluffing and more resistant to harmful organisms. For the conditions of Astana, there are several factors that allow increasing the diversity of poplars:

– poplar keeps metal-containing dust more efficiently;

– poplar plantations emit several times more oxygen than coniferous trees;

– poplars make one of the main and the most grateful objects of modern breeding of tree species aimed at accelerating the wood growth; and

– poplars are decorative, they grow fast, and feature high reproducing ability.

Yards in the residential quarters may be greened with not very large cultivars (to prevent damage to people and vehicles, for example, in the case of snowfalls and strong winds), such as pyramidal poplars.

Breeding work is to be performed for breeding new highly decorative cultivars since, with the amazing ease of hybridization, the potential of this tree species is practically unlimited. Among the spontaneous hybrids, which may often be found in uncultivated areas, one can sometimes find so highly ornamental plants that they may be recommended as mother trees. In addition, such hybrids are obviously adapted to the aggressive urban environment.

Thus, given the specific climatic conditions of Astana, it is necessary to develop a scientifically substantiated approach for the tree crops used for greening.

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