The Korean pine aboveground phytomass determination in the Far East south conditions

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Abstract. The forest stands phytomass purposeful studies in the Far East have not been carried out enough. Phytomass determination was mainly carried out as a necessary element for assessing physiological, hydrological and silvicultural processes in the forest. Phytomass largely determines the carbon sequestration, the litter amount, fire hazard, etc. (ibid.), its organic matter contributes greatly to the overall carbon and nitrogen cycle in the forest ecosystem. Research has been carried out to analyse the age 100-70 years pine plantations aboveground phytomass, growing in the Vladivostok agglomeration green zone. On the Vladivostok agglomeration green zone territory, four test plots were laid to assess the Korean pine phytomass according to the Atkin A.S. method, the size of the test plots was 0.4 hectares, the samples were laid in forest 3 types: rhododendral oak forests, shrub-forb oak forests, sedge ash forests - forbs. The Korean pine aboveground phytomass was calculated based on the Vladivostok forestry (stock) taxation description data. The presented materials’ analysis indicates that the Korean pine aboveground phytomass is characterized by high variability even within a specific forest type, it ranges from 7 to 35 t/ha (forest type D4). The data on any species' trees aboveground phytomass reserves from the trial plots allow us to calculate the aboveground phytomass reserves on all trial plots and per 1 forest hectare.

1. Introduction

Forest ecosystems play a huge role in the global biogeochemical carbon cycle and are considered today as the earth’s surface main climate-stabilizing systems, providing the global carbon sink bulk to non-terrestrial ecosystems. Due to the vast forest areas on the Russian Federation territory (their area is about 21% of all forests’ area in the world), the Russian forest ecosystems role in the global organic carbon cycle regulation is significant, and the total C run-off in them, according to various estimates, is from 230-240 Mt C year-1 to 546 ± 120 Mt C year-1 [1, 2].

Historically, a tree entire phytomass study was motivated by the need to evaluate all forest resources, not just wood, and to understand the mechanism by which the trunk assimilation apparatus determines the growth mass and surface. Since the mid-1960s there are much more reasons for studying the trees’ phytomass [3, 4, 5, 6]. With the ecosystem studies development, stimulated by the International Biological Program (IBP), allometric dependences detailed studies for the trees crowns and roots mass were required to quantify gas exchange in the crown, study the substances and energy flow associated with the tree components growth and decay, and the assimilates rules distribution parameterization in simulated growth models [7].
Recently, much attention in the plantations biological productivity studies has been given to the deposition and assessment issues' phytomass as the main indicator. This is because, firstly, the world community has begun to implement programs for carbon conservation and sequestration in its global cycle to prevent climate warming. The main role in these programs is assigned to the forest cover, in connection with which the coal-ore binding intensifying the processes tasks are set by expanding the area under forest crops and through other forestry techniques.

The natural pine stands environmental functions in the Far Eastern region are well studied (Uspensky, 1991). They are closely related to the forest ecosystems natural features, their structure, productivity, sustainability, and other factors (Protopopov, 1975; Rubtsov, 1984; Uspensky, 1991; Zalesov, 2002; Bugaev, 2003; Melekhov, 2003; Matveev, 2004; Martynyuk, 2008; Filipchuk and Yangutov, 2009).

However, in the Primorsky Region territory, due to the extremely variable geographical and climatic background, they have not yet been fully disclosed, and in the suburban forests, they have not yet been properly evaluated. Therefore, insufficient attention is paid to solving the increasing the region's forests ecological potential problem, their protection and rational use [5, 8, 9, 10].

We conducted research on the 100-170 years old pine plantations aboveground phytomass analysis, growing in the Vladivostok agglomeration green zone.

2. Methods
The research was carried out in 2018-2019 in the first and second age classes pine crops on the Vladivostok forestry (Azure forestry) territory, 4 trial areas of 0.4 hectares were laid. The necessary selection with the stand was selected by the forest management field surveys or viewing the materials' method.

Aboveground phytomass in a completely dry state is evaluated by the formula: Ph f = Kf M, where P " f is the stand, t/ha aboveground phytomass, Gf is the phytomass capacity coefficient, M is the standing stock, m³/ha.

The Kf coefficient characterizes the aboveground phytomass amount per stand stock per unit area. For pine trees, it is equal to 0.5126, regardless of the region and the stand parameters. This indicator was found by conducting long-term studies on the phytomass assessment and analyzing the available literature data. It is based on the 170 sample areas data laid down in different regions pine forests. In the final form, the formula has the form Rnf= 0.5126 M (Atkin, 1985).

3. Results
Trial areas were laid on the Azure Forest area territory.
Sample area No. 1 was laid out in the 34th quarter. The forest type on the test area is D4 (oakwood shrubby-mixed grass). The sample is located in the north-eastern exposure slope upper part, the slope steepness is 5°. The soils here are brown and grey mountain-forest, low-power, low-humus, fresh. The stand on the test area has the following composition 3YAS2KM2K1PC1LP1G. Planting fullness 0.6, bonitet IV. Composition formula: undergrowth 6K2E2K1; undergrowth 5.5 K1 4.5 H. The living ground cover is represented by the following species: sickle-shaped sedge, male shield fern, two-leaved bead-ruby, Ussuri skullcap, touch-me-not, tri-flowered undergrowth, narrow-leaved nettle, lance-shaped cacalia, doubtful twin-leaf. The average tax rates for this sample area are shown in table 1.

Sample area No. 2 was laid out in the 35th quarter. The forest type on the sample area is D1 (rhododendron oak). The sample is located in the eastern exposure slope middle part, the slope steepness is 5°. The soils are brown mountain-forest, low-power, low-humus, fresh. Planting fullness 0.6, bonitet III. Composition formula: stand 6D2K1YA51KM+G; young growth 8K2K1; undergrowth 5K15E1.

Living ground cover: Amurian shield-grass, shamrock, two-leaved bead-ruby, lance-shaped cacalia, boret, Manchurian sedge, male shield-grass, female stalk-grass, marsh marigold, bedstraw. The average taxation indicators for the sample area are shown in table 1.

The sample area No. 3 was laid out in the 34th block, allocated 6. The type of forest on the trial area is D4 (oak shrub-mixed grass). The sample is located in the eastern exposure slope middle part, the slope steepness is 8°. The soils are brown and grey mountain-forest, fresh. Planting fullness 0.6, bonitet III. Composition formula: stand 6D2K1P1KM; young growth 4E4P2Lp; undergrowth 4CH3Ki3A.

Living ground cover: sickle-shaped sedge, male scutellum, Amur scutellum, double-leaved mynik, forest horsetail, Canadian turf, bedstraw, May lily of the valley, sorrel, female stalk, Queen of the meadow. The average taxation indicators for the sample area are shown in table 1.

Sample area No. 4 was laid out in the 34th block, allocated 8. The forest type on the trial area is ASMG (ash sedge-mixed grass). The sample is located in the eastern exposure slope middle part, the slope steepness is 8°. The soils are brown and grey mountain-forest, fresh. Planting fullness 0.6, bonitet IV. Composition formula: stand 6D2K1P1KM; young growth 4E4P2Lp; undergrowth 4CH3Ki3A.

Living ground cover: sickle-shaped sedge, male scutellum, Amur scutellum, double-leaved mynik, forest horsetail, Canadian turf, bedstraw, May lily of the valley, sorrel, female stalk, Queen of the meadow. The average taxation indicators for the sample area are shown in table 1.
Table 1. The sample areas’ taxation characteristics.

| No i.o. | Composition     | Bonitet | Age, years | D (cm) | Nsr, m | Completeness | Stock, m³/ha |
|---------|-----------------|---------|------------|--------|--------|--------------|--------------|
| 1       | 2               | 3       | 4          | 5      | 6      | 7            | 9            |
| 1 (block 46, allotted 3) | 3YAs2KM2K1Pc1Lp1G | IV      | 170        | 36.0   | 20.0   | 0.6          | 225          |
| 2       | 6D2K1YAs1Km+G   | III     | 100        | 16.0   | 15.0   | 0.6          | 350          |
| 3       | 6D2K1Pc1KM      | III     | 100        | 16.0   | 15.0   | 0.6          | 140          |
| 4       | 3YAS3KM1K1Lp1G1Ol | IV      | 170        | 36.0   | 20.0   | 0.6          | 570          |

Yas-Manchurian ash, Km-small-leaved maple, K-Korean pine, Pc-whole-leaved fir, D-Mongolian oak, Lp-linden, G-hornbeam, Ol-gray alder.

For each test area, the aboveground phytomass of Korean pine was calculated based on the composition of the stand on the test area and the stock.

Table 2. Korean pine aboveground phytomass.

| No i.o. | Stand stock (pine), m³/ha | Aboveground phytomass, t/ha | Accounting error, σ /± ģ/ ± m |
|---------|----------------------------|-----------------------------|-------------------------------|
| 1       | 45                         | 23.067                      | -1.2/+2.1/+1.9                 |
| 2       | 70                         | 35.882                      | +1.3/+3.5/+2.4                 |
| 3       | 14                         | 7.1764                      | -1.7/+2.0/-0.9                 |
| 4       | 57                         | 29.2182                     | +2.7/-3.0/+4.1                 |

Thus, the Korean pine crops productivity in sample No. 1 was 23.067 t/ha, in sample No. 2-35.882 t/ha, in sample No. 3-7.1764 t/ha, in sample No. 4-29.2182 t/ha. Thus, Korean pine, growing in the same conditions, in this case, in one year gives an increase of about 9.2 t/ha, or 13.1 m³/ha. The presented materials' analysis indicates that the Korean pine aboveground phytomass is characterized by high variability even within a specific forest type, it ranges from 7 to 35 t/ha (forest type D4). Deviations
statistical analysis and calculated accounting errors according to the proposed method show (table 2), that the method systematic and random errors do not exceed 9-10%, and the total error (t) for all cases was 1.3-4.3%.

4. Conclusion
The stands aboveground phytomass quantitative and qualitative characteristics study is research an integral part of biological productivity, both in the biogeocenotic and resource aspects. The tree stands productivity can be divided into three types:
1) biological;
2) woody;
3) ecological.
All these productivities are the main part that shows the tree stands (forests) utility entire complex degree [3, 4, 11]. The data obtained on the sample areas No. 1-4 analysis basis refute the dependence on the main taxation indicators-diameter and height in the Far East south conditions.

The tree phytomass reserves data from the sample areas allow to calculate the phytomass aboveground part reserves on all the sample areas and 1 ha of the forest [12]. And knowing the plantings productivity on one forest hectare, you can determine the studied breed all plantings productivity, a certain age and growing conditions. Climate warming and related challenges have forced a new look at the role of forests and their functions, including their role in the global carbon cycle. This question formulation led to an increase in the researchers’ interest in the stands total phytomass determining the problem, in which the forest ecosystems carbon share bulk is concentrated. The scots pine crops biological productivity study, their growth forecast, development and changes in phytomass with age is a solvable problem with the data mandatory availability from long-term observations on permanent sample areas.

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