

Necessity and feasibility study of near-naturalization of *Pinus koraiensis* plantation

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Abstract. Using the "near-natural forestry" idea to manage the Korean pine plantation, the necessity and feasibility of natural transformation of plantation are discussed. Using experimental ecological methods, using 6a cutting holes, it was verified that the existence of gaps has a favorable aspect for the growth of *Pinus koraiensis* plantations. Through theoretical ecological methods, the number of *Pinus koraiensis* strains with different diameters was obtained, and the relationship between different inter-forest gaps provided a scientific basis for the management of *Pinus koraiensis* plantations.

Keywords: *Pinus koraiensis* plantation; near-naturalization transformation; inter-forest gap; feasibility; necessity.

1. Introduction

Aiming at the problems of single structure, low biodiversity and poor community stability of *Pinus koraiensis* plantation, this study studied the Korean pine plantation in the natural secondary forest area of Liaodong mountainous area, according to the methods and principles of near-natural forest management. The goals and approaches of the near-naturalization transformation were discussed. The main design method is to develop the long-term target development type of the Korean pine plantation near natural forest management under the premise of the upper-level target guidance of the forest multi-functional sustainable management and the analysis of the site habitat conditions and implement it within the conceptual framework of the development type. The target tree is characterized by a stand-up tending operation method. After moderately thinning the stand, the precious native tree species (yew, red spruce, ash, yellow pineapple, etc.) and Chinese herbal medicine (ginseng, asarum, platycodon) are introduced. And economic plants (Thorn Dragon's teeth, *Acanthopanax senticosus*) to achieve the purpose of improving the quality and quantity of tree species for the purpose of forest stand, and improving the biodiversity and economic utilization value, while accelerating the forest stand to the mixed forest of broad-leaved Korean pine forests in the mountainous areas of eastern Liaoning the goal of the forest succession process.

2. Necessity and feasibility study of near-naturalization of *Pinus koraiensis* plantation

2.1. Necessity study

As the main body of terrestrial ecosystems, forests play an important role in maintaining ecological balance and biodiversity, supporting human life systems, and are indispensable life infrastructures for



modern cities and an important symbol of ecologically civilized cities [1]. At the beginning of the construction of wetland afforestation, due to the influence of human factors, it was mostly characterized by single species, especially the evergreen broad-leaved tree species was not rich enough to reflect the principle of “suitable land for trees”; plus, the single type of community, simple structure, high density, etc. The problem is outstanding, and a large number of nursery-type and pure-forest plantations are formed, resulting in poor growth of tree species, serious pests and diseases, low function, poor ecological stability of the community, and seriously affecting the ecological function of water conservation forests. Therefore, the existing water conservation forests It is essential to carry out forestry transformation and structural regulation to realize the transformation of water conservation forests from artificial pure forests to multi-layered forests, so as to improve the community structure and ecological benefits of water conservation forests.

The management idea of natural forestry can be expressed as “forestry activities that follow natural conditions on the premise of ensuring the self-preservation ability of forest structure relationships”, which is a business model compatible with forestry production and nature protection. Near-natural forestry thoughts require forests to “return to nature” and reduce the proportion of planted forests (the proportion of planted forests in Germany has been as high as 80%), the natural management and renewal of existing plantations, and the afforestation on the basis of no forest land [2].

Pinus koraiensis is the main afforestation species in the northeastern state-owned forest area. However, in recent years, the cultivation of *Pinus koraiensis* plantation has resulted in low survival rate of afforestation, premature tillering, difficulty in becoming a forest, and difficulty in becoming a forest. The practical problems solved, which seriously affect the survival rate and ecological function of the Korean pine plantation, need to be solved through naturalization to solve the above problems.

2.2. Feasibility study

In 1898, Gayer, a professor of forest cultivation at the University of Munich in Germany, first proposed the management idea of “near natural forestry”. He believed that near-natural management should follow the development rules of the forest system itself, respect the natural forces of natural succession of forests, and use artificial measures to promote natural regeneration. According to the distribution law of zonal vegetation, the forest is constructed, and the forest stands are brought closer to the potential natural vegetation by various means of operation, so as to achieve the dynamic balance of the community, and with the assistance of artificial measures, promote the natural regeneration under the forest and make the forest progress. In the succession stage, the disadvantages of low diversity, poor stability, declining ground force, low ecological function, and sustainable management of traditional plantations can be avoided [3].

In the middle and late 20th century, near-natural forestry began to be promoted and practiced. The system's near-nature management theory began to take shape, including the specific theory of near-natural forest management characterized by “appropriate trees, mixed, different ages, and selective cutting”; In the 1980s and 1990s, near-natural forestry began to be popular in Europe, especially Germany, Austria, Sweden and other countries. In this period, near-natural forestry can be expressed as “forestry activities that follow natural conditions on the premise of ensuring the self-preservation of forest structure relationships. "Compatible with forestry production and forest ecological protection. On the basis of natural selection, it mainly promotes natural regeneration of forests by means of artificial thinning, pruning, weeding and irrigation of target species, so as to achieve "a mixed forest, a different age and a layer of forest." "The goal [4].

All in all, the core idea of the near-natural forestry theory is to respect the self-development law of forest ecosystems and adopt more naturalized construction measures and management methods to achieve sustainable development of forest ecosystems. It is not a return to natural forest types. However, as far as possible, the establishment, breeding and harvesting of forest stands can be carried out close to the spontaneous production of ecology, to achieve the dynamic balance of forest biomes, and to revitalize natural materials with artificial assistance [5].

3. Near-natural transformation test

3.1. Overview of the study area

The test site was set up in the 34-small class Banhongsong forest of Liangshui Nature Reserve. The forest was built in 1955, and the initial planting density was 4,400 plants/hm, due to the lack of light transmission and the formation of human-day mixed forests (see Table 1).). The altitude is 400m, the middle slope of the northwest slope, the slope is 5-15 degrees, the soil is dark brown soil, and the thickness is (A+B) 50-60cm.

Tab 1. Status of forests in the test area

project	Breast diameter /cm	Tree height / m	Density / strain · hm ⁻²	Accumulation /m ³ ·hm ⁻²	Accumulating annual growth / m ³ ·hm ⁻²
Korean pine	1.0-8.0	1.5-8.0	1200	4.2	0.17
Broadleaf tree	4.0-22.0	8.0-20.0	1850	110.5	3.07
Whole forest	1.0-22.0	1.5-20.0	3050	114.5	3.19
Proportion of Korean pine			Broadleaf: Korean pine = 6:4	Broadleaf: Korean pine = 10:1	

3.2. Implementation method

In the winter of 2015, the gap light transmission test was carried out: it was divided into 4, 8, 12, 16m pore gaps, comprehensive cutting and control areas. The shape items are arranged in a row, that is, each treatment is distributed from the slope to the slope. The specific method of cutting the gap is to select the red pine tree with the topography in the vicinity of the pre-position as the central tree and cut all the broad-leaved trees in the circle by 4, 8, 12, 16m respectively; the comprehensive cutting is to divide the rectangular area. All the broadleaf trees are cut down. The gap spacing is greater than the gap diameter. The forest stand survey is carried out before the cutting, and the position, tree height, breast diameter and crown width of the cut trees are recorded during the cutting. Each gap was 10, and the total cut and control area were 0.5 hm each. After three growing seasons, the first review was conducted in the spring of 2016. After six growing seasons, the second review was conducted in the spring of 2017, including forest surveys, analysis of wood and shrub surveys.

4. Results analysis

In the gap-transmitting test plots of the same site conditions, the difference between the pre- and post-cutting of *Pinus koraiensis* in each gap is 8-12 m; the gap: 16 m gap is slightly: 4 m. The gap of the gap is 3-7cm, which is due to the sudden exposure of the sapling, without any shade, in order to adapt to the reverse reaction of full light. In the third year, the growth amount increased greatly, but the average growth of 3a decreased by 1.8cm compared with that before harvesting. The growth of the outer edge of the gap was due to the increase of the edge growth and the high growth. See Table 2.

Tab 2. The growth of *Pinus koraiensis* in the gaps after 6 years of the hole test

Processing	Height growth/cm										Ratio of growth before and after 6a
	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	
Compared	22.4	10.7	13.4	17.0	15.8	11.4	11.0	15.2	17.6	16.8	1.04
4m	23.4	10.8	13.4	11.5	14.9	16.4	18.5	14.4	19.4	19.5	0.77
8m	26.8	23.5	15.2	11.0	10.7	19.5	12.4	16.8	12.0	12.5	1.22
12m	26.2	17.9	16.2	16.2	18.2	10.0	13.8	13.7	14.4	16.4	1.02
16m	29.7	34.3	21.4	15.5	15.3	16.4	12.8	12.0	11.9	14.4	2.16
All light	25.1	37.2	28.5	11.1	18.0	18.5	16.8	16.6	18.8	14.4	1.11

5. Discussion

5.1. Analysis of test results

The existence of gaps in the management system of *Betula platyphylla* and *Pinus koraiensis* is beneficial to the regeneration of *Pinus koraiensis*. The suitable ratio of tree height to gap width is 1: 1-4: 3. The management of *Pinus koraiensis* plantation can be carried out in the five grades of different grades of *Betula platyphylla*. The number of *Betula platyphylla*, the number of gaps, the gap size of the gap, and the number of different diameters of *Pinus koraiensis* Technical indicators such as the number of different sizes of Korean pine in each gap.

5.2. Hybrid planting natural transformation means

The design of near-naturalization transformation mainly includes the design of forest development type and the design of target forest sub-system. The type of forest development refers to the combination of the objectives of the social welfare and economic development with the natural characteristics and the law of evolution under the premise of the analysis of the upper-level target guidance of the multi-functional sustainable management of the forest, the habitat conditions of the site and the current state of the forest. The specific forest medium and long-term target model [4]. The target forest sub-operation system is a forest tillering operation method based on the ecological relationship between individual trees and individual differences under the guidance of the development type conceptual framework. The type of forest development and the target forest sub-operation method are obvious technical elements in the natural forest management technology system [5]. The specific purpose and adaptability of these two technical elements in the recent naturalization of *Pinus koraiensis* plantation is the main purpose of this research.

The type of suitable tree suitable for mixed forest species is in the type of transition from coniferous forest to primitive broad-leaved Korean pine forest. It is suitable for forest land in temperate mountainous areas. The soil is typical dark brown soil, which can be in the late stage of succession. Shows the dominant forest of *Pinus koraiensis*.

Tab 3. Forest development goals

Type	Target
Wood production	Red pine, <i>Picea koraiensis</i> and other large diameter conifers: target breast diameter of 45cm or more, incubation period: 81 to 120 years; ash, Mongolian oak, purple scorpion and other broad-leaved large diameter: target breast diameter 55 Above cm, incubation period: 70 to 100 years; final target tree density: 50 plants/hm ² or more, including 20 red pines and 30 broad-leaved trees; each manager harvests disturbing trees and produces some small and medium-sized materials.
Other products	<i>Pinus koraiensis</i> seeds, economic plants: <i>Aralia elat</i> , <i>Eleuthero coccus</i> , <i>Panax ginseng</i> , <i>Asarum sieboldii</i> , <i>Radix Platycodi</i> .
Tree species ratio	<i>Pinus koraiensis</i> 30% ~ 40%; ash, sable, Mongolian sorghum and other tree species 40% ~ 50%; associated tree species less than 10%; secondary forest layer also distributed <i>Syringa reticulata</i> . <i>Mandshurica</i> , <i>Acer pseudo sieboldianum</i> and so on.
Update target	90% to 95% of species such as <i>Pinus koraiensis</i> , <i>Fraxinus mandshurica</i> , <i>Aster</i> , <i>Quercus bentron amurense</i> , and 5% to 10% of associated trees.
Mixed type	The species of <i>Pinus koraiensis</i> , <i>Fraxinus mandshurica</i> , <i>Aster</i> , and <i>Quercus mongolica</i> are distributed as single plants, and other associated tree species are grouped.

Pinus koraiensis can be mixed with broad-leaved tree species such as alder, locust, ash, and sable in a row or block, and the forest is divided according to the target forest. The target forest is broad-leaved Korean pine forest. To create a pure pine forest, the last time the young forest was bred, the broad-leaved trees with cultivated value were selected as potential target trees to protect them. According to the target forest branch operation system, the target forests were broad-leaved Korean pine forests [6].

6. Conclusion

China's Korean pine plantation is large in size and ecological and economic service functions are very important, but there are problems such as single structure, low biodiversity, and community stability. If the forest is not nearly naturalized, the forest lighting conditions are improved, the tree species under the forest are promoted, and the native tree species are introduced, it is difficult for the forest to succeed to the broad-leaved Korean pine forest. The type of forest development of the Korean pine plantation proposed in this study is applicable to the Korean pine plantation classified as a public welfare forest (ie the source of the Dajiang River, the source of the river and the water source conservation forest upstream of the reservoir). The management of the Korean pine commercial forest can be appropriately borrowed from the paper. The type of forest development but should be appropriately adjusted according to specific breeding objectives.

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