The influence of selective cutting on the spatial pattern of regeneration of Korean pine in a mixed broadleaved-Korean pine forest in Xiaoqing’an Mountains, China

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1. Study Objectives

The two dimensional spatial pattern of individual trees in a stand can influence competition levels, growth rates, and understory development. Spatial patterns of forest regeneration are the result of seed dispersal, germination, and seedling survival in relation to the distribution of parent trees, competing vegetation, and seedbed conditions. Mixed broadleaved-Korean pine (Pinus koraiensis) forest is one of the major forest types in northeast region of China. Korean pine (KP) is the most dominant tree species in that forest type. Analysis of the spatial pattern of Korean pine regeneration could enhance our understanding of the seed dispersal, germinating, competition and mortality mechanisms of the species.

The objectives of this study were: 1) To test the spatial distribution pattern of KP offspring. 2) To test spatial association of KP offspring with mature KP, mature pioneer and climax tree species. 3) To detect the impact of single-tree selective cutting on the spatial pattern of KP regeneration.

2. Study Methods

The study was conducted in a 9 ha permanent study plot of a mixed broadleaved-Korean pine forest, located in Liangshui National Reserve of Xiaoqing’an Mountains. For all woody plants, species name, DBH, and their coordinates in the plot were investigated. Stems of KP were grouped into 7 DBH classes: 0–2 cm (seedlings), 2–6 cm (saplings), 6–20 cm, 20–35 cm, 35–50 cm, 50–65 cm, and >65 cm. Tree species with DBH bigger than 20 cm were defined as mature trees. Pinus koraiensis, Abies nephrolepis, Acer mono, Picea jezoensis, and Picea koraiensis were classified as climax species, and all the remained tree species were classified as pioneer species.

One part of the plot (about 1.3 ha) had undergone single tree selective cutting in the year 1971, KP in the overstory were partly removed, thinning density was 30%. We refer the managed part as selective cutting area (CA), and the remaining part as natural area (NA, 7.7 ha) (Fig. 1).
To test the spatial distribution pattern of the KP offspring and spatial association of KP offspring with mature KP, mature pioneer tree species and mature climax tree species, Ripley’s univariate and bivariate L functions were used, the significance test was done using a Monte Carlo procedure. 95% confidence bands were obtained by running 39 simulations. Index of association (IA) was obtained by dividing the L value by the upper or lower confidence band length. IA value was assigned for distances $t = 10$ m, assuming that 10 m extended far beyond crown influence.

Figure 1. Scatter graph of Korean pine by DBH class across in the 9 ha plot. The dashed rectangular area showed the selective cutting area (1.3 ha).

3. Results and Discussion

1) Natural area

In the natural area, a strong clustered distribution of KP seedlings was found from the univariate analysis; for the bivariate analysis, when the KP seedlings were compared against mature KP and climax species, significant negative associations were detected, when the KP seedlings were compared against mature pioneer species, a significant positive association was detected (Fig. 2).

Figure 2. Univariate analysis of KP seedlings, bivariate analysis of KP seedlings around mature KP, pioneer species and climax species in the natural area.

2) Selective cutting area

In the selective cutting area, univariate analysis showed seedlings and sapling of KP were cluster distributed. For the bivariate analysis, when the seedlings and saplings of KP were compared against mature KP, significant negative associations were detected (Fig. 3).