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Spatial Distributions Pattern and Associations of Dead Woods in Natural Spruce-Fir Secondary Forests

Keyi Chen[1], Huiru Zhang[2*], Bo Zhang[3] , Youjun He[1]
[1][Research Institute of Forestry Policy and Information, Chinese Academy of Forestry, Beijing, China],
[2][Research Institute of Forest Resources Information Techniques, Chinese Academy of Forestry, Beijing, China],
[3][Beijing Forestry University, Beijing, China]
*Corresponding author E-mail: huiru@caf.ac.cn.

Abstract

Natural secondary forest is the main part of forest resources in China. Studying dead woods (DW) could better reveal the community succession rule and promote the healthy development of them. We investigated basic characteristics and coordinates of each tree (DBH≥1 cm) within a plot (100 m×100 m) using the adjacent grid method and studied the spatial distributions pattern and associations of DW (in the last five years) in a typical natural spruce-fir secondary forest in Jingouling Forest Farm, Wangqing Forestry Bureau, Jilin Province, China. The results showed that the diameter class distribution of DW showed the pattern of left-single-peak curve, while the logs showed the pattern of multi-peak curve. DW number was related to the mixing degree of one species, but not to the total number of it. The distribution of DW was concentrated at 0~8m scale. As the scale increases, it changed to random or uniform. The aggregation distribution of DW of medium (10 cm≤DBH < 20 cm) and small (1 cm≤DBH < 10 cm) DBH at small scale below 8 m was the main reason for the aggregation distribution of DW. The DW of large (DBH≧20 cm) DBH and Saplings (1 cm≤DBH < 5 cm) showed a significant positive association at 2~25 m scale. There was no significant spatial association between DW and Small trees(5 cm≤DBH < 15 cm). At 0~3m scale, there was a positive association between Medium trees (15 cm≤DBH < 25 cm) and DW of small and medium DBH. At the 9 m, 11~14 m scale and the 15 m, 42~45 m scale, the DW of small and medium DBH were significantly negatively associated with Large trees (DBH≥25 cm). In conclusion, the biological traits, diameter class distribution and spatial distribution affected the abundance and diameter class distribution of DW of one species. The spatial distributions of DW and the associations between DW and standing trees varied across diameter classes and scales. Rational utilization of spatial information could optimize stand structure and promote positive community succession.

Scope and objectives

Changbai Mountain forest region is an important ecological security barrier in north China. It also has one of the most abundant forest resources in the same latitude in the world. Due to the over-harvesting of natural forests, it is found that (1) resources dropped sharply, (2) forests quality degradated, (3) rare tree species are in danger, and (4) the primary forest almost exhausted. After the implementation of the natural forest protection project in China, the forest resources in Changbai Mountain began to be effectively protected. The vegetation then gradually recovered, forming a natural secondary forest with *Abies Nephrolepis*, *Picea Jezoensis* and other constructive tree species. Therefore, studies on population growth and community maintenance mechanism are urgently needed. In order to provide scientific basis for forest conservation, forest structure optimization and sustainable management in Changbai Mountain, we studied the distribution pattern and spatial correlation of DW in natural spruce-fir secondary forests in Changbai Mountain, aiming at revealling the individual competition, stand self-thinning and community succession process.

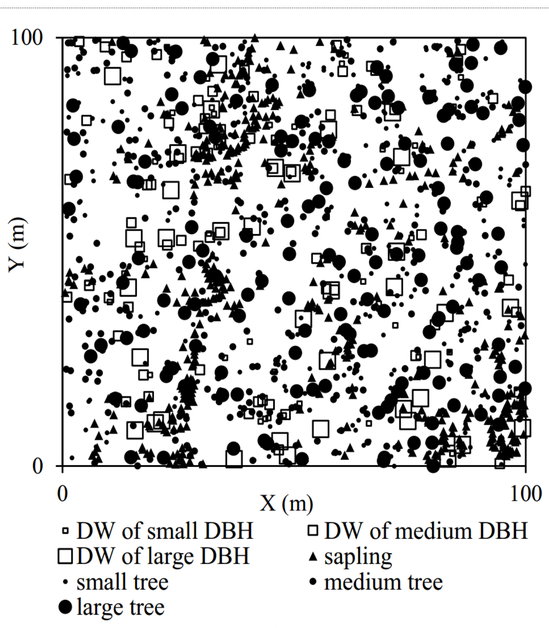

Fig.1

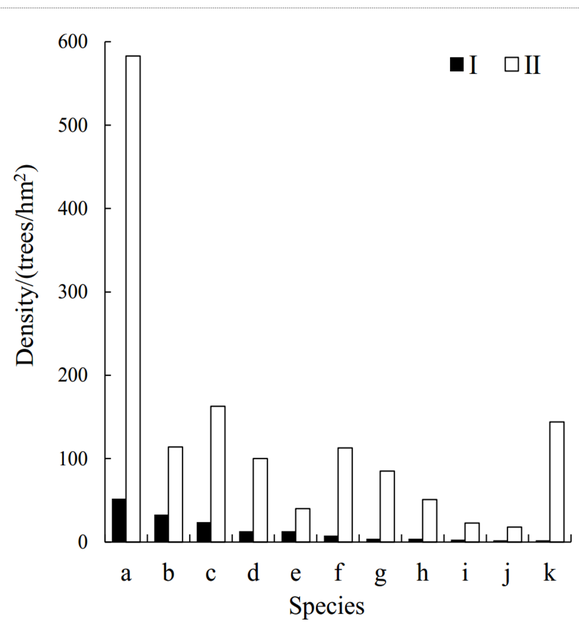

Fig.2

Fig.1:On the basis of full investigation, a fixed plot of 1 ha (100 m×100 m) was set up in a typical stand, and all trees with DBH≧1 cm were measured, and the information of tree species, DBH, height, spatial coordinates were recorded. The DW with intact trunks, large branches, relatively solid trunks or slightly rotten bark and sapwood but intact heartwood in the sample plots were investigated.
Fig.2:I: DW; II: All stand; a: *A.nephrolepis*; b: *L.olgensis*; c: *P.asperata*; d: *P.koraiensis*; e: *P.ussuriensis*; f: *B.costata*; g: *A.mono*; h: Miscellaneous wood; i: *U.pumila*; j: *B.platyphylla*; k: *T.amurensis*.

Results

(1) Tree species and diameter class distribution of DW
Only the number of DW of *Ulmus pumila* and *Betula platyphylla* was consistent with the proportion of total tree number in the community. DW with DBH less than 18 cm accounted for 80%.
(2) Isolation of DW
In the spatial structure unit, the DW of medium DBH had the highest isolation degree, followed by the DW of large DBH. The DW of small DBH had the lowest isolation degree. Among the DW of different diameter classes, the lowest isolation degree was found in *Abies nephrolepis*, while the highest isolation degree was found in different species.
(3) Spatial distribution pattern of DW
On the average, DW showed aggregation distribution at the small scale, which was mainly affected by the distribution pattern of DW of medium and small DBH. With the increase of the scale, the DW of each diameter class showed a random distribution pattern at the larger scale, and the uniform distribution was very rare.
(4) The spatial association of DW and standing tree
For saplings (Fig.3A), DW maintained a positive association with saplings at the medium and small scale, especially between DW of large DBH and saplings. For small trees (Fig.3B), there was no obvious spatial association between DW and small trees, but only positive association on individual scale. For medium trees (Fig.3C), DW of medium and small DBH maintained a positive association with them at the medium and small scale, while DW of large DBH maintained a positive association with them at the large scale. For large trees (Fig.3D), there was almost no positive association with DW at all scale from 0 m to 50 m, while there were sporadic negative association at some scales of different diameters.

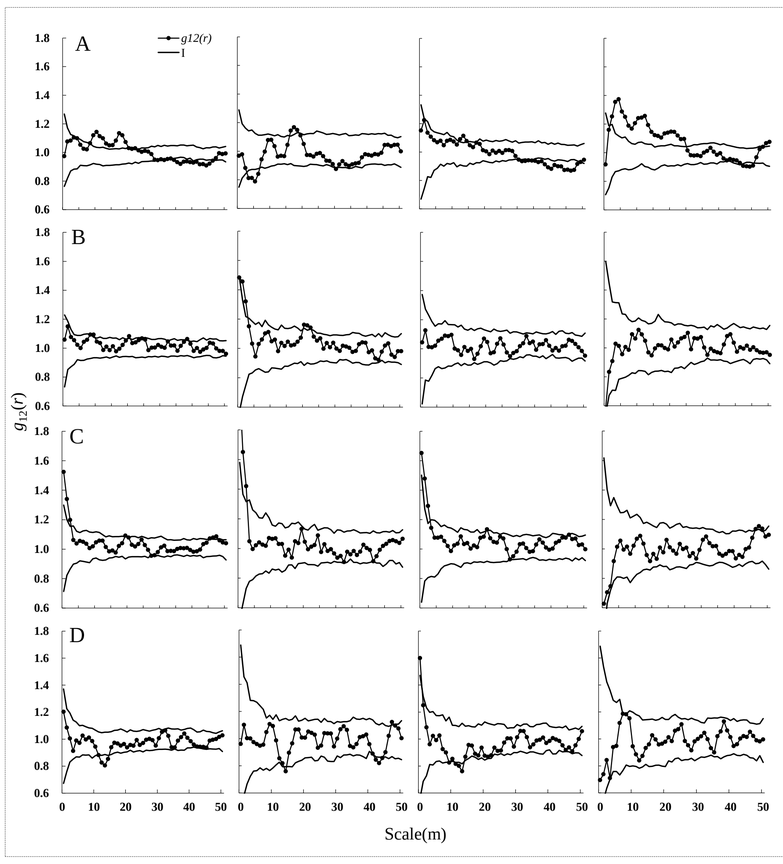

Fig.3:The spatial associations of DW of different DBH and saplings, small tree, medium tree, large tree. The $g_{12}(r)$ is the value of association function and the I represents envelope curve. In the row A, the spatial association between all DW, the DW of small, medium and large DBH and the saplings was represented from left to right. That's similar to row A, the row B, C, D showed spatial associations of DW and small, medium, large tree separately,

Conclusion

(1) Biological characteristics, DBH distribution and spatial distribution of tree species affected their mortality. Tree species with low isolation degree may have more DW. In the forest management, the isolation degree of target tree species in the stand could be increased to reduce its loss.
(2) The DW of large DBH have a significant positive effect on seedling development and sapling growth. For stands with high density and insufficient understory natural regeneration, it can be considered to artificially create similar effect at the medium and small scale to promote the sustainable forest regeneration.
(3) Saplings and small trees mostly influenced each other in the form of intraspecific competition at the small scale, while medium trees mostly influenced each other in the form of interspecific competition at the medium and small scale. Large trees will restrict the normal growth of small and medium trees in low intensity at the small and medium scale. Therefore, for the trees in the middle and lower layers of the stand that need special cultivation or special protection, it is necessary to carry out the medium and small scale transparent tending in the stage of competitive differentiation.