
Report RCSC-19-05

8 March 2019

Conditions in White Spruce Stands on the Black Hills National Forest

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INTRODUCTION

White spruce (also referred to locally as Black Hills spruce) is common in the northern coniferous forests of Canada, the Great Lakes region and the northeastern US. Its occurrence in the Black Hills is an outlier population removed from the general range. White spruce in the Black Hills is more abundant in the northern hills on north facing slopes and stream bottoms, but can be found scattered throughout most of the forest.

Spruce covers about 51,000 acres in the Black Hills representing a small percentage of forest cover (Walters et al. 2013). Most of the spruce is considered to be in large diameter classes. While limited in extent, it is still a valuable part of the forest contributing to timber products, wildlife habitat, and overall forest diversity. It is a shade tolerant species and new seedlings can be found underneath existing stands of spruce and other species. It is a relatively slow growing, long lived species in the Black Hills.

The most frequent damaging agents to spruce are bark beetles and root diseases. Bark beetles, either spruce beetle (*Dendroctonus rufipennis*) or spruce engraver beetles (*Ips* spp.), have killed trees in large numbers across other parts of white spruce's range. Root diseases, such as *Armillaria*, are commonly found in spruce and can lead to tree decline and death.

. Aerial and informal ground surveys have detected scattered spruce mortality in the Black Hills. A more systematic ground survey of spruce stands throughout the forest was conducted for the first time in 2018 to quantify spruce mortality and identify causal agents.

METHODS

A total of 30 white spruce stands were sampled in 2018 (Figure 1). In each stand a series of four 1/20th acre plots were installed along a transect line through the stand. In each plot all trees larger than three inches diameter breast height (DBH) were counted. Measurements included species, DBH, status (live or recently dead), and any damage agents. One dominant/codominant tree was cored in each plot to determine its age. Additionally, regeneration was counted for the entire plot noting total number of each species present and any damage agents present on the seedlings. In each plot a total of four live trees were checked for signs of *Armillaria* root disease.



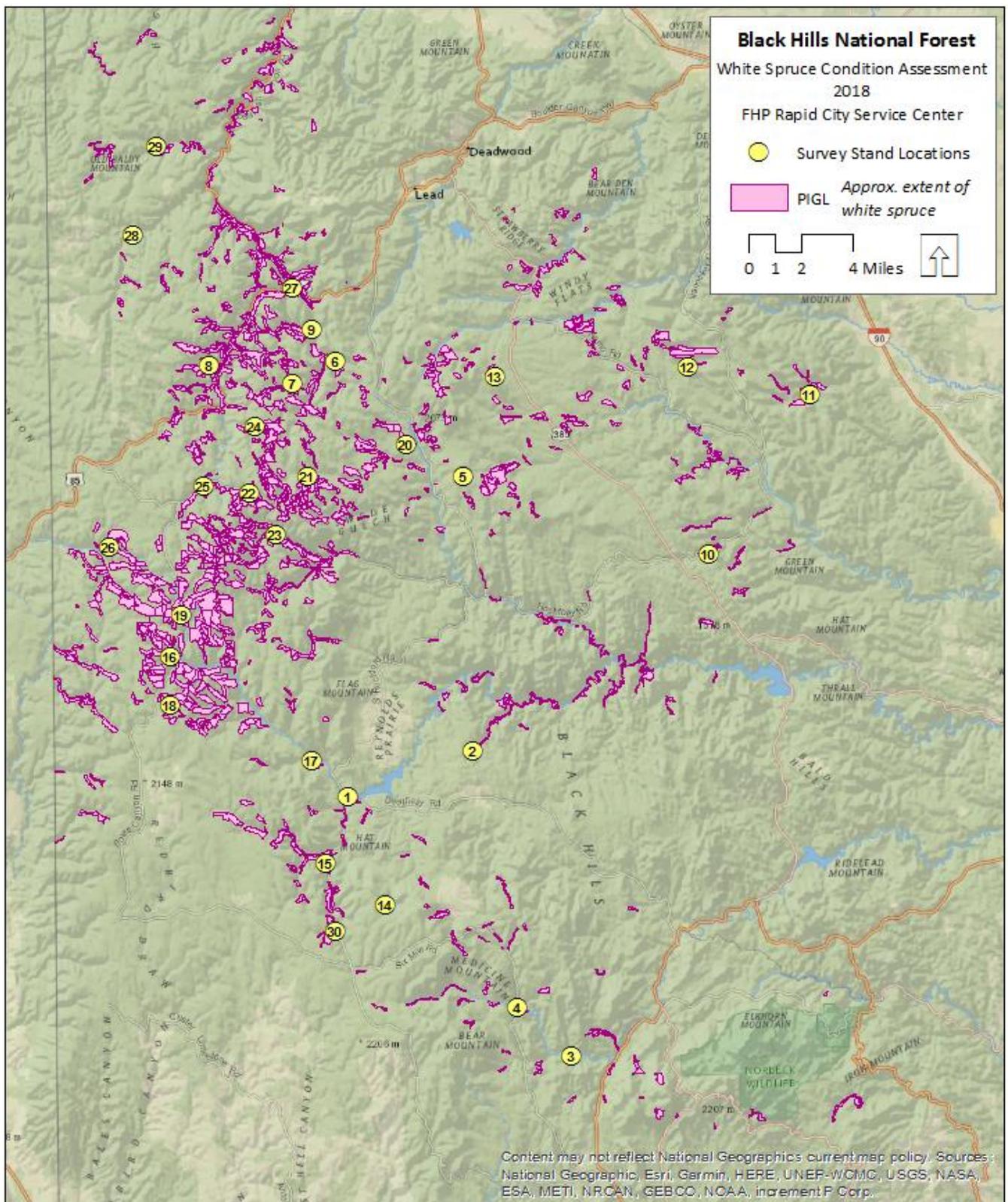


Figure 1. Location of spruce stands sampled.



Figure 2. Declining spruce stand.



Figure 3. *Armillaria* fan on spruce.



Figure 4. Spruce beetle galleries on spruce.

RESULTS

Nearly 1,800 spruce were sampled over 30 stands. Overall spruce mortality was low with 91% alive and 9% found to be recently dead (killed within the last 5-6 years). Only two stands had slightly elevated mortality rates greater than 1-3%/year. Stand seven had 31% mortality and stand 30 had 23% mortality (Figure 2). Spruce mortality ranged from 0-31% across all stands. Most stands were dominated by white spruce (92% of all trees sampled), followed by ponderosa pine (5%), aspen (2%), and birch (1%).

The average DBH of live spruce trees was 9.5 inches and the average DBH of dead spruce was 10.1 inches. Of the recently killed trees most had evidence of either *Ips* spp. (86%) or *Armillaria* root rot (89%), and frequently both (Figure 3). Only 10 recently killed trees were found to have evidence of spruce beetle (7%) (Figure 4).

The average age was 80 years on an 11.8 inch DBH tree. Average 10 year growth rate was 0.6 inches. Ages ranged from 55 (stand 19) to 117 (stand 17) years. All of the stands contained some level of live trees with *Armillaria* infection.

Regeneration was abundant across all areas, averaging about 600 seedlings/saplings per acre. Regeneration was largely composed of spruce (90%), followed by aspen (8%), ponderosa pine (1%), and birch (1%). There was no noticeable death or decline in the regeneration, with the most common damage agent being Cooley spruce gall adelgid, which was noted on 17% of the spruce regeneration. There appeared to be little or no impact from adelgids on spruce seedlings.

CONCLUSIONS

Overall the white spruce on the Black Hills appears to be in good health with very little recent mortality. We considered trees killed in the past 5 to 6 years as recent mortality and of all spruce sampled less than 10% were determined to have been killed in this timeframe. This results in about 1 to 2% mortality per year, or something in the realm of natural or expected mortality levels. There did not appear to be any damage agents causing mortality outside of relatively low, expected levels. Generally, there were no groups or pockets of mortality, but more single, scattered trees. Most of the recently dead trees had both evidence of *Ips* spp. and *Armillaria* root rot present. Again, in both instances, neither seemed to be creating localized, higher levels of mortality.

Since mortality was so low, there was no real indication that tree size or stand density played any part in tree mortality. The damage agents found appeared to be behaving more as secondary invaders, killing single trees scattered around the landscape. At this time, there does not appear to be any insect or disease organism that should raise concern about the future of white spruce on the Black Hills.

Regeneration in these stands was dominated by spruce and was generally plentiful. There did not appear to be any insect or disease concerns that were reducing or killing the regeneration.

LITERATURE CITED

Forests of the Black Hills National Forest. 2011. Walters, Brian F., Woodall, Christopher W., Piva, Ronald J., Hatfield, Mark A., Domke, Grant M., Haugen, David E. 2013. Resource Bull. NRS-83. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 36 p.