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Paper Birch in the Black Hills National Forest

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Introduction

Paper birch (*Betula papyrifera*; birch) is a northern forest species with a range covering most of Canada up to tree line. In the United States, it occurs in the northeast and Great Lakes areas. In the Black Hills this species is an outlier population at its southern range. These trees are more common in the northern parts of the Black Hills, though the southern part has some scattered trees and small stands. Birch is often found on cooler and moister north and east slopes in the southern reaches of its range (Marquis et al 1969). It is often found in stands mixed with aspen (*Populus tremuloides*), and to a lesser degree ponderosa pine (*Pinus ponderosa*) and Black Hills spruce (*Picea glauca*).

Although birch is not a timber species, this rare species provides forest diversity. Some wildlife species favor birch habitat (Mills et al 2000). However, it constitutes a small fraction of the forest in the Black Hills. Birch makes up about 3% of the forest cover and about 5% of the trees are classified as birch (DeBlander 2002). Almost all the birch on the Black Hills were classified as seedlings or saplings under 9 inches DBH (DeBlander 2002).

Paper birch mostly regenerates through seeds. It is a shade intolerant species, so it needs sunlight to establish and grow (Safford 1983). Regeneration from seed is best on a moist, mineral soil beds. Even with favorable germination conditions, seedling success rates can be only 10% (Marquis et al 1969). This species can regenerate by sprouting. For sprouting to be effective, trees should be cut when they are young. As trees get older the number of sprouts decrease (Safford et al 1990).

It is a fast growing, short lived species. From seed, trees reach maturity in about 60 years and have a lifespan of about 140 years. From sprouts, trees reach maturity about the same time, but having a lifespan of only 70-90 years (Marquis et al 1969, Safford 1983).

DeBlander (2002) indicated that about 76% of the birch stands on the Black Hills are in a high stocking category. High stocking suggests decreasing diameter growth and tree vigor, which could make trees more susceptible to attack from insects and disease. This report reevaluates many of the same stands that were surveyed in 2007 (Blodgett and Allen 2009). The objectives of this survey were to document the general conditions of birch in the Black Hills National Forest, and evaluate insects, diseases, and other damage agents occurring in birch.

Methods

Thirty-three birch stands were surveyed in July-August of 2017 (**Figure 1**). In 2007, many of the same stands (31 stands) were sampled. Stands selected for survey were composed of at least 50% birch and were at least 2 acres. Stands were systematically selected based on cover type maps and other information regarding birch occurrence on the forest. Four circular plots were established in each stand (1/20 acre for trees; 1/100 acre for regeneration). Plots within a stand were spaced 2 chains (~40 m) apart through the center of stands. At each plot center, location coordinates and altitude were recorded using global positioning.

Variables recorded in 2007 for most of the plots included: sample date, age (using an increment core from one living average size tree per plot), slope and aspect. Armillaria root disease was recorded per plot as found or not found based on examining 3 recent dead trees per plot. If *Armillaria* was found within a plot, it was then recorded as found or not found causing root disease per plot. This was based on examining 2 additional live trees with root disease symptoms per plot for the presence of the pathogen within live cambial tissue. The same variables were recorded for new plots in 2017.

Variables recorded in both 2007 and 2017 for trees included: species, diameter at breast height (DBH) for stem ≥ 3 inches DBH, host condition (live or recent dead), and associated stress/mortality agents (insects, diseases, and other damages). Recent dead trees were defined as having attached bark and at least some small branches (approximately dead within the past 3 years). If present, up to three recent dead birch trees were examined per plot for Armillaria root disease.

Variables recorded in both 2007 and 2017 for regeneration included: counts by species for only live regeneration, and stress/mortality agents (insects, diseases, and other damage agents). Trees with no DBH and <3 inches DBH were considered regeneration.

Results and Discussion

Due to where birch occurs on the forest, most of the 33 stands are located in the northern Black Hills and Bearlodge Mountains (**Figure 1**). The mean elevation of sampled stands is 5,426 feet above sea level. All stands had a north, northeast, or northwest aspect. Mean slope was 18 degrees.

Stands were relatively dense, consisting mostly of small trees. In 2017, the mean DBH of live birch was 5.6 inches; up only slightly from the 5.4 inches measured 10 years earlier. Stands had a mean live tree basal area (BA) of only 44.8 ft^2/acre with only 36.8 ft^2/acre for birch. Stands had a mean of 1,402 stems/acre of live overstory trees with 1,218 stems/acre for birch. This is consistent with the high stocking suggested by DeBlander (2002) 15 years earlier, and accounts for the minor diameter growth. Still, most of the trees (95.2%) were alive.

In 2017, birch made up 87% of the of the stand composition based on number of stems and 82% of the basal area. Four species made up most of the overstory composition (**Table 1**). Although the basal area was low, the mean overstory tree density was high. With such high stocking, both intraspecies and interspecies competition is expected.

Table 1. Percentage of overstory tree stems by species in the Black Hills National Forest.

Species	2007 Percentage of stems	2017 Percentage of stems
Paper birch	91	87
Quaking aspen	6	8
Ponderosa pine	2	4
Other hardwoods	1	1
Total	**100%**	**100%**

In 2017, estimated recent birch mortality per year was only 1.6%; slightly less than in 2007 at 2.4%. The mean DBH of recent dead birch in 2017 was 5.3 inches, suggesting mortality is not associated with age, but is the result of tree competition. Mortality levels are consistent with general background mortality in most forested stands, and are lower than expected given the mean stand density.

Mean stand age was 70 years, with a range of 47 to 124 years (for plots that could be measured). Some stands had too much decay, so stand age was not always measured; those stands were older than 70 years. About 88% of the stands are over 50 years old. This can be considered mature for birch, but their lifespan is likely between 90 to 130 years in the Black Hills. Although birch is a short lived species, many of the stands still have a few years before they express significant age associated mortality.

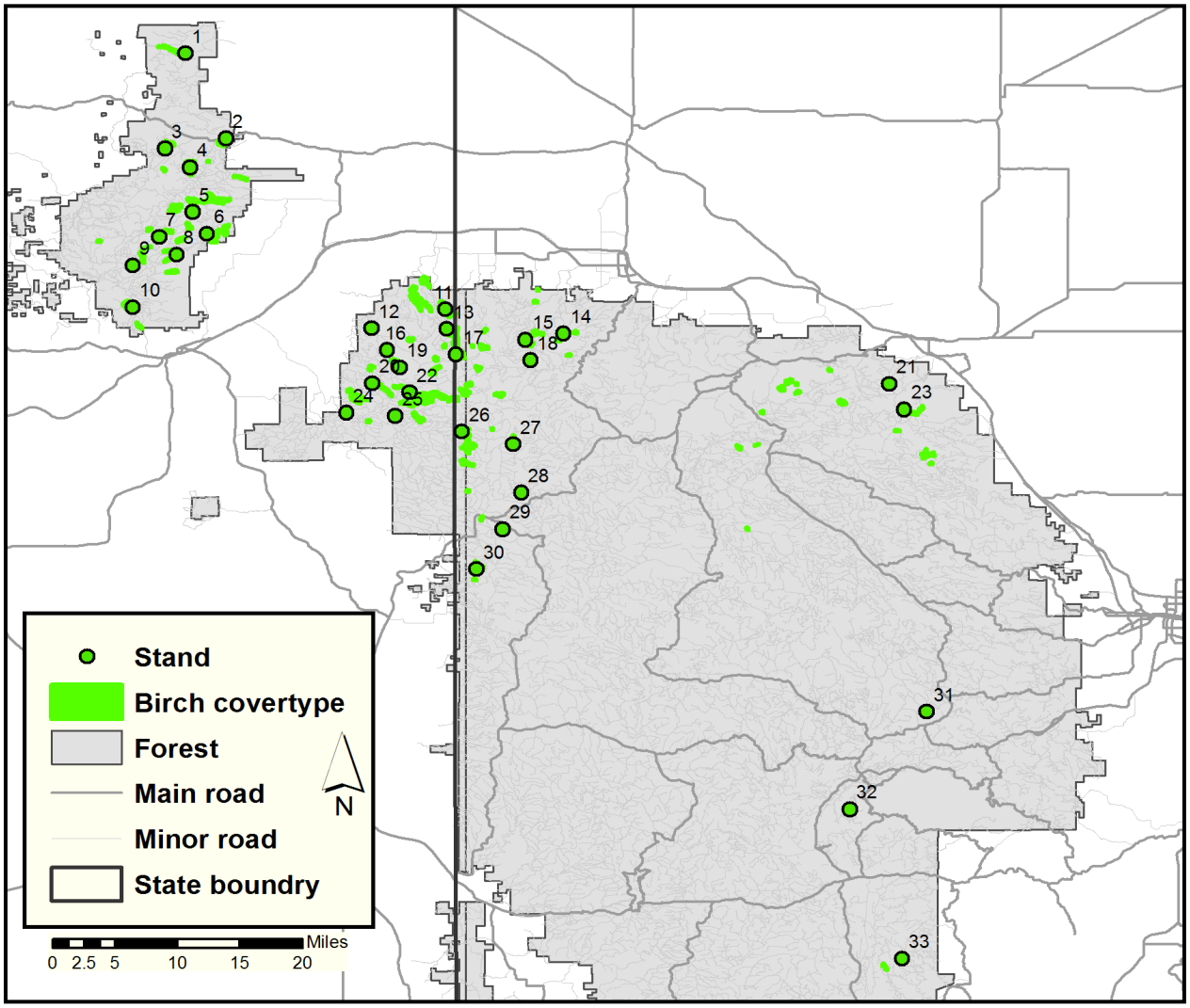

Figure 1. Location of paper birch covertype and sampled stands in the Black Hills National Forest in 2017.

Eleven damage agents were observed, but most were observed in <1% of the trees. All but one damage agent decreased from 2007 to 2017 (**Table 2**), consistent with the reduction in mortality. Only the decay fungus, *Fomes fomentarius*, increased slightly. This decay fungus was mostly observed in recent dead trees (24%). Decay was observed in 30% of the recent dead trees, but was likely much higher. Both *F. fomentarius* and *Inonotus obliquus* (another decay fungus) degrade wood and can be

involved in branch and stem breakage due to wood strength loss in birch. However, their overall effect on tree health is usually minor. Bronze birch borer (*Agrilus anxius*), a damaging bark beetle of birch, was observed in 1 plot in 2007, but was not detected in this recent survey. There are a number of defoliating insects that can be damaging, but none were detected. There were no damaging agents causing widespread mortality in the birch stands in the Black Hills National Forest in 2017.

Table 2. Percentage of trees affected by the most common damage agents of birch trees in 2007 and 2017 in the Black Hills National Forest.

Damage Agent	2007 Birch Trees Affected (%)	2017 Birch Trees Affected (%)
Dead top/dead branch	14%	2%
Metallic wood boring beetle	4%	<1%
Fomes fomentarius	3%	4%
Nectria canker	3%	1%
Physical damage	3%	2%
Sapsucker	3%	-*
Long horned beetle	2%	<1%

* Not recorded in 2017.

Armillaria root disease was present in all stands in both sample years. Given the time and difficulty of examining root systems, only a few trees were checked for *Armillaria*. Thus the total number of infected trees per plot is unknown, and *Armillaria* cannot be included in the percentage of trees affected; **Table 2**. However, in 2007 this root diseases was confirmed to be killing at least one live tree in 68% of the stands (*i.e.*, identified killing the cambial tissues of major roots or the root collar of live trees). In 2017, the pathogen was confirmed in 70% of the recent dead trees, and at most three dead trees were examined per plot. Since not all recent dead trees were examined, the pathogen was likely in far more than 70% of the recent dead trees. Armillaria root disease crown symptoms were noted in 13% of the live trees. This disease can also make trees prone to windthrow (Safford 1983, 1990). Although Armillaria root disease is likely the most common damage agent in birch in the Black Hills, mortality of the overstory trees was well within expectations; thus *Armillaria* is helping with the natural thinning of the relatively dense overstory.

Paper birch regeneration is lower than might be expected. In 2007 58% of the tree species regeneration was birch. The percentage increased to 69% in 2017, and the total numbers more than doubled (**Table 3**), but numbers are still a bit low. The low regeneration numbers are due to competing regeneration vegetation, the high numbers of overstory trees, and the lack of recent disturbance to the forest floor. Paper birch in Alaska can seed in at 700,000 seedlings per acre on open scarified seedbeds and 20,000 seedlings per acre on unscarified seedbeds (Safford 1990) compared to the 674 stems per acre we found. All stands surveyed were closed canopy stands, with little light reaching the ground. Being shade intolerant, regeneration of birch under these conditions would not be expected. However, a mean of 980 stems per acre for all species under these conditions is expected.

Animal browsing and *Armillaria* were the only damage agents noted in 2017, but each were observed on <1% of the birch regeneration. More damage was noted on regeneration in 2007, with animal browsing observed on 12%, *Armillaria* damage on 1%, physical damage on <1%, and cankers on <1% of the birch regeneration.

Table 3. Number of live regeneration stems per acre in 2007 and 2017 in the Black Hills National Forest.

Species	2007 Live (#)	2017 Live (#)
Paper birch	325	674
Quaking aspen	182	197
Bur oak	36	56
Conifers[1]	22	53
Total	**240**	**980**

[1] Conifers include mostly ponderosa pine, with some Black Hills spruce.

Summary

Paper birch is in good condition across most of the Black Hills. Compared to 10 years ago, birch tree mortality has decreased slightly, birch regeneration has more than doubled, and fewer damages are present in both overstory trees and regeneration. Birch regeneration is not abundant, but there has been little to no management of birch stands that would favor such an occurrence and all stands have dense overstories.

If birch regeneration is desired, the current overstory should be removed and a favorable seedbed created. Options to increase birch regeneration include clear cutting or burning in and around stands. Removing conifers around stands could increase the birch stand size. Encouraging soil disturbance when cutting will improve regeneration success since this species germinates well in areas with exposed mineral soil. Many of the stands are reaching an age where if regeneration through sprouts is desired, they should be coppiced; older trees produce few sprouts.

References

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Appendix-Table 1. Stand summary of age, estimated percentage birch overstory mortality, number of live paper birch overstory trees, and DBH of live and recent dead birch in the Black Hills National Forest in 2017.

Stand number	Age (years)	Mortality (%)	Number of live bepa per acre	DBH live bepa (inches)	DBH dead bepa (inches)
1	67	1.6	1,000	4.7	5.1
2	-	4.2	1,200	5.0	5.0
3	62	5.0	1,000	6.1	6.6
4	74	0.0	875	5.4	-
5	77	0.7	1,250	5.0	3.6
6	124	0.7	1,225	5.9	7.6
7	84	1.2	1,375	5.4	5.0
8	64	0.0	975	6.5	-
9	60	2.6	875	4.8	4.2
10	59	1.9	1,700	5.1	4.5
11	81	0.7	1,225	4.9	6.8
12	48	1.9	1,225	6.5	4.7
13	75	0.0	1,775	4.9	-
14	65	0.8	1,050	8.3	8.0
15	50	0.0	1,250	5.8	-
16	48	0.7	1,175	4.4	5.5
17	88	1.7	1,375	5.9	4.8
18	77	3.6	1,225	4.6	5.0
19	48	1.1	1,500	6.4	5.8
20	73	0.5	1,575	4.8	4.0
21	-	2.2	1,050	4.4	4.7
22	57	0.6	1,400	5.7	3.0
23	-	1.7	925	5.1	5.2
24	105	0.5	1,600	4.7	4.2
25	80	2.5	1,525	5.9	5.5
26	75	2.4	1,275	6.4	6.7
27	58	0.7	1,100	5.9	4.8
28	-	1.9	1,275	6.7	8.8
29	64	4.5	950	6.5	6.9
30	67	1.5	1,050	6.4	4.7
31	-	3.1	975	5.3	4.6
32	-	0.8	975	5.7	3.1
33	62	1.9	1,250	4.6	5.1
Mean	**70**	**1.6**	**1,218**	**5.6**	**5.3**

A dash (-) represents tree age was not measured often due to internal decay; or for DBH, there were no dead trees >3 inches DBH.