Heartrot Fungi's Role in Creating Picid Nesting Sites in Living Aspen

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Abstract—To determine the number of cavity-containing aspens in old-growth (>80 years), we counted the number of stems containing cavities in 132 0.02-ha plots in Wyoming. There were 8.7 cavities/ha of aspen type. At least 84% of the cavity stems were alive when the initial cavity was constructed; 60% were alive when examined. Fruiting bodies and Phellinus tremulae (a heartrot fungus) were present on 71% of all cavity-bearing stems but on only 9.6% of all stems >15 cm d.b.h. Cavities were present in 7.7% and 0.2% of living stems with and without fruiting bodies, respectively. Average d.b.h. of cavity stems was 27.4 cm. During a 4-year interval, 74 of 226 snags >15 cm d.b.h. fell, giving an average instantaneous rate of snag loss of r = –0.099. Ninety-six new snags >15 cm d.b.h. were created during the 4-year study period. Our results indicate that some primary cavity-nesting birds in northwest Wyoming preferentially selected living aspens with heartrot as nest sites and that the average longevity of aspen snags >15 cm d.b.h. is about 10.7 years.*

Introduction

Cavity-nesting birds are a major component of many avian communities, and the value of snags (standing dead trees) for nesting, feeding, and perching has been well documented (Davis 1983). The importance of living trees as nest sites has been studied less, but the importance of living pine with heartrot as a necessary component of red-cockaded woodpecker habitat is well documented (Ligon 1970; Jackson 1977; Conner and Locke 1984; Hooper et al. 1991; Conner et al. 1994). These woodpeckers select pines over 80 years old that are infected with the heartrot fungus *Phellinus pini* in which to excavate their cavities.

The aspen type in the mountainous west contains an abundant and diverse avian population. Approximately 34 species nest in cavities in aspen, *Populus tremuloides*; some species, e.g., the red-naped sapsucker (*Sphyrapicus nuchalis*), may be obligate aspen-nesters (Crocket and Hadow 1975). The importance of the aspen community to forest birds has been summarized by DeByle (1985).

Aspen is especially prone to attack by heartrot fungi, primarily *Phellinus tremulae* (*Fomes ignarius* var. *populinus*). This organism attacks aspen throughout its range, and the incidence of infection increases with tree age (Hiratsuka and Loman 1984). Previous studies support the conclusion that several species of sapsuckers select aspen that have fruiting bodies of *P. tremulae* (Kilham 1971; Erskine and McLaren 1972; Crockett and Hadow 1975; Winternitz and Cahn 1983). This fungus causes extensive decay of the heartwood while the sapwood remains intact, protecting the nest cavity. Over 55% of sapsucker nests in Colorado were in trees on which *P. tremulae* was fruiting (Crockett and Hadow 1974; Winternitz and Cahn 1983). Nest cavities were evenly distributed between live and dead aspen in trees with an average age of 170 years (Winternitz and Cahn 1983).

The rate at which conifer snags fall has received some attention (Bull 1983) but the longevity of aspen snags is unknown. DeByle (1985) predicted that, once

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dead, aspen snags are unlikely to stand for more than a few years, while Krebill (1972) assumed that most aspen remain standing for about 10 years after death. Others (Buttery and Gillam 1984; Wills 1984) predicted that aspen snags cannot be expected to remain standing for more than five years.

Our objectives were to determine: (1) the density of aspen cavity trees, (2) whether or not the trees were alive when the first cavity was constructed, (3) the presence or absence of *Phellinus tremulae* conks on cavity trees, and (4) the longevity and density of aspen snags.

Study Area and Methods

The study was conducted on the Bridger-Teton National Forest, northwest Wyoming. Aspen stands examined were located in three areas: north of the Buffalo Fork River, about 10 km east of Moran; within 10 km of the Goosewing ranger station on the Gros Ventre River; and between Cliff Creek and the Hoback River, approximately 10 km south of Bondurant. Stands studied occurred between 2,100 and 2,700 m elevation, with an interspersion of Engelmann spruce (*Picea engelmannii*), Douglas-fir (*Pseudotsuga menziesii*), and lodgepole pine (*Pinus contorta*). A more detailed description of the vegetation has been published (Mueggler 1988). The average age (as determined by counting annual rings in increment borer cores) of the aspen was 115 years (Gros Ventre) and 80 years (Hoback and Buffalo Fork).

During 1985, 65 0.02-ha circular plots in the aspen type were established on the Gros Ventre watershed and 14 similar plots were established near Moran. During 1986, 53 similar plots were established on the Hoback watershed. The condition and size of each aspen stem over 2.5 cm d.b.h. were recorded. There were 1,001 aspen snags >2.5 cm d.b.h. in the 118 Hoback and Gros Ventre plots at the time of establishment. Plots were originally established to determine the effect of elk (*Cervus elaphus*) on aspen demographics (Krebill 1972; Hart 1986).
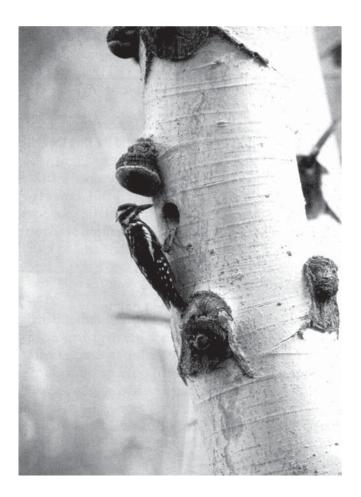
Four years after plot establishment the plots were re-surveyed to determine the number of new aspen snags and the number of original snags still standing. At that time the d.b.h., whether the tree was alive or dead, the number of cavities and their height, the presence or absence of callus tissue at the cavity entrance (to determine if the tree was alive when the cavity was first constructed), and the presence or absence of *P. tremulae* conks were recorded for each cavity tree within a plot and for other cavity trees that were encountered between plots.

Results

Data were collected on 23 cavity trees in the research plots and on an additional 22 cavity trees located outside the plots. These 45 trees contained 73 cavities. There were 9.2 cavity trees per hectare of aspen type in the Gros Ventre plots and 8.2 cavity trees per hectare in the Moran-Hoback plots, or an overall average of 8.7 cavity trees per hectare. The average d.b.h. of stems with cavities was 27.4 cm (range 14 to 41 cm), very similar to previously reported

values (Crockett and Hadow 1975; Winternitz and Cahn 1983). Based on the development of callus tissue at the cavity entrance, we determined that at least 84% of the stems with cavities were alive at the time the cavities were constructed; 60% were alive when the data were collected. Average height of cavities was 2.7 m (1.4 to 6.1 m); a similar value was reported by Crockett and Hadow (1975). Our value was much lower than the minimum nesting height (4.6 m) listed by Thomas et al. (1979:382) or the mean value (4.0 m) reported by Winternitz and Cahn (1983). Seventy-four percent of the cavities were not associated with knots, and 33% of the cavity trees contained more than one cavity (maximum of five).

P. tremulae conks were present on 71% of all cavity trees but on only 9.6% of all trees. As stem d.b.h. increased, the presence of *P. tremulae* conks increased from 6% for stems 2-15 cm d.b.h. to 13.5% for stems >30 cm d.b.h. All but one cavity entrance associated with the presence of *P. tremulae* conks (figure 1) were less than 6.5 cm in diameter and typical of the size cavity made by sapsuckers, downy woodpeckers (*Picoides pubescens*), or hairy woodpeckers (*P. villosus*). Only five cavity entrances were over 7 cm in diameter (northern flicker, *Colaptus auratus*); three were in dead trees without conks. The cavity in figure 1 was used by red-naped sapsuckers in 1985 and by house wrens (*Troglodytes aedon*) in 1990. In 1989 there were four cavities in this tree and a fifth was constructed in 1990. Newer cavities were constructed above older cavities. The tree failed to produce leaves in the spring of 1991 and no new cavities were constructed during 1991. The construction of new cavities by red-naped sapsuckers in the same aspen in successive years has been reported previously (Weydemeyer and Weydemeyer 1928; Kilham 1971; Erskine and McLaren 1972; Daily 1993).

Figure 1—Red-naped sapsucker under a *Phellinus tremulae* fruiting body on an aspen in northwest Wyoming.

The instantaneous rate of snag loss may be calculated from the equation for exponential population growth rate (Sedgwick and Knof 1992):
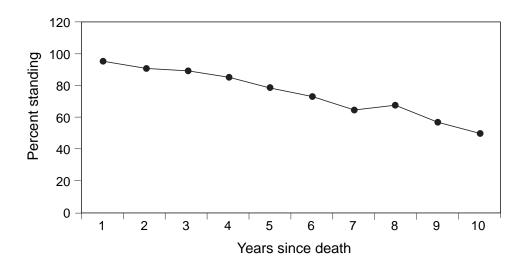
$$r = [\log_e N(t) - \log_e N(o)]/t$$

where r is the rate of loss, $N(t)$ is population size at time t (1989 or 1990), $N(o)$ is the population size at the beginning of the period (1985 or 1986), and t is the time period (four years). For all snags >2.5 cm d.b.h., $r = -0.087$, and for snags >15 cm d.b.h., $r = -0.099$. During the four-year interval, 293 of 1,001 snags >2.5 cm d.b.h. fell, while 191 new snags developed. While total snags decreased, those >15 cm d.b.h. increased from 226 to 248.

The year of death is known for 104 aspen trees >10 cm d.b.h. in the 14 0.02-ha plots near Moran that were monitored annually from 1985 to 1995. Snag fall appears to be minimal for the first four years following tree death (figure 2). Ten years after death, one-half of the snags had fallen. The approximate density of aspen snags >15 cm d.b.h. was 100/ha of aspen type and remained fairly constant during the four-year study period (table 1) and is similar to the 114 snags/ha reported for the Gros Ventre watershed in 1970 (Krebill 1972). The number of snags between 2.5 and 15 cm d.b.h. decreased from 328 to 276 snags/ha.

Discussion

These results, in combination with previously published papers (Kilham 1971; Crockett and Hadow 1975; Winternitz and Cahn 1983), strongly suggest that living aspen with heartrot caused primarily by *P. tremulae* may be a significant component of the breeding requirements of sapsuckers and possibly of other similar-sized picids (Hardin and Evans 1977). Our data suggest the

Figure 2—Percentage of aspen snags 10 cm d.b.h. standing, by number of years since death, Bridger-Teton National Forest, Wyoming, 1985–1995.

Table 1—Density of aspen snags in the aspen type in northwest Wyoming, 1985–1990 (no./ha).

Area	All snags >2.5cm d.b.h.		Snags >15cm d.b.h.	
	1985–1986	1989–1990	1985–1986	1989–1990
Hoback	415	398	47	62
Gros Ventre	432	367	135	140
Both areas	424	381	96	105

Phellinus infection was related in some way to nest site selection. The presence of the fungal conks may provide sapsuckers with a visual cue that such trees have a soft core and hence make optimal nest locations (Kilham 1971; Crockett and Hadow 1975). Conner et al. (1976) hypothesized that woodpeckers detect the presence of heartrot by pecking the tree and listening for a particular resonance.

Cavities made by primary cavity makers are subsequently used by numerous secondary cavity nesters (Winternitz and Cahn 1983). In Minnesota, 22 of 23 cavities used by boreal owls (*Aegolius funereus*), classified as a sensitive species by the U.S. Forest Service, were located in old aspen (Lane 1990). Buffleheads (*Bucephala albeola*) have been discovered breeding in Colorado in large aspen infected with *P. tremulae* following cavity excavation by northern flickers (Ringelman 1990). Both flying (*Glaucomys* spp.) and red squirrels (*Tamiasciurus hudsonicus*) (Kilham 1971), as well as other mammals (Thomas et al. 1979), frequently use cavities in aspen.

While the minimum d.b.h. needed by sapsuckers and many other cavity nesters before they will utilize a snag has been reported as 25 cm (Thomas et al. 1979), 36% of the cavity trees in this study had a d.b.h. <25 cm. The d.b.h. of the tree in figure 1, used repeatedly as a nest site by red-naped sapsuckers, was 23 cm. A red-breasted nuthatch (*Sitta canadensis*) nested in an aspen snag with a d.b.h. of 18 cm, considerably smaller than the minimum d.b.h. of 30 cm reported for this species (Thomas et al. 1979). Red squirrels also used trees with a smaller d.b.h. (21 cm) than is normally associated with this species (Thomas et al. 1979).

Species such as the boreal owl and bufflehead would require trees with at least a d.b.h. of 30 and 38 cm, respectively (Thomas et al. 1979). In this study, only 25% of the stems with cavities exceeded 30 cm d.b.h., and only two of 44 stems with cavities had a d.b.h. >38 cm despite the fact that many of the aspen in this area were over 120 years old. The combination of 2.2 living cavity trees/ha of aspen type over 30 cm d.b.h. and the 3.8 snags/ha greater than 30 cm d.b.h. may or may not have limited the density of intermediate-sized-cavity users (e.g., northern flickers or small owls) (Thomas et al. 1979:390). The 100 snags >15 cm d.b.h./ha of aspen type, in combination with living trees with heartrot, should have provided ample nesting habitat for the smaller cavity users (Thomas et al. 1979:390).

Although maintaining an abundance of snags (dead standing trees) has been emphasized in the management of cavity users (Thomas et al. 1979; Hoover and Wills 1984), living trees with heartrot may be more critical than snags to the maintenance of certain species. Sapsuckers (Crockett and Hadow 1975, this proceedings) and hairy woodpeckers (Lawrence 1967; Kilham 1968) nest almost exclusively in living trees with rotten centers. Decay increases as stand age increases (Hiratsuka and Loman 1984). The percentage of trees with decay is usually less than 10% before age 80, increasing to over 20% by age 100. Stands >100 years old begin to deteriorate (Schier 1975), although many stands reach

an age of 120 years or older (Mueggler 1989). It may be possible to regenerate declining stands by cutting or burning at approximately 120-year intervals.

Mature or old-growth aspen (>80 years old) appears to represent valuable wildlife habitat that cannot be duplicated in other forest communities. Species such as red-naped sapsuckers, and perhaps boreal owls in some areas, apparently require mature aspen forests. Land managers should strive to maintain a mixture of successional stages and ages in different-sized stands. We recommend at least part of each management unit should be scheduled for a long rotation period in excess of 100 years. The best way to manage for old growth aspen is to protect an adequate supply of what is now available and leave it alone even if it begins to deteriorate. Shorter rotations, or cutting large portions of an aspen forest, may cause a serious decline in avian species that depend on older forests. Trees with heartrots may have little or no commercial value but have significant value in maintaining biodiversity in our aspen ecosystems.

References

Bull, E.L. 1983. Longevity of snags and their use by woodpeckers. Snag habitat management: Proceedings of a symposium. U.S. Forest Service General Technical Report RM-99:64–67.

Buttery, R.F.; Gillam, B.C. 1984. Ecosystem descriptions. Managing forested lands for wildlife, Hoover, R.L. and Wills, D.L., eds. Colorado Division of Wildlife:43–71.

Conner, R.N.; Locke, B.A. 1984. Fungi and red-cockaded woodpecker cavity trees. Wilson Bulletin 94:64–70.

Conner, R.N.; Miller, O.K., Jr.; Adkisson, C.S. 1976. Woodpecker dependence on trees infected by fungal heart rots. Wilson Bulletin 88:575–581.

Conner, R.N.; Rudolph, D.C.; Saenz, D.; Schaeffer, R.R. 1994. Heartwood, sapwood, and fungal decay associated with red-cockaded woodpecker cavity trees. Journal of Wildlife Management 58:728–734.

Crockett, A.B.; Hadow, H.H. 1975. Nest site selection by Williamson and red-naped sapsuckers. Condor 77:365–368.

Daily, G.C. 1993. Heartwood decay and vertical distribution of red-naped sapsucker nest cavities. Wilson Bulletin 105:674–679.

Davis, J.S. 1983. Snags are for wildlife. Snag habitat management: proceedings of a symposium. U.S. Forest Service General Technical Report RM-99:4–9.

DeByle, N.V. 1985. Wildlife. Aspen: ecology and management in the western United States, DeByle, N.V. and Winokur, R.P., eds. U.S. Forest Service General Technical Report RM-119:135–152.

Erskine, A.J.; McLaren, W.D. 1972. Sapsucker nest holes and their use by other species. Canadian Field-Naturalist 86:357–361.

Hardin, K.I.; Evans, K.E. 1977. Cavity nesting bird habitat in the oak-hickory forest. . .a review. U.S. Forest Service General Technical Report NC-30. 23 p.

Hart, J.H. 1986. Interaction among elk, fungi and aspen in Rocky Mountain ecosystems. Phytopathology 76:1058.

Hiratsuka, Y.; Loman, A.A. 1984. Decay of aspen and balsam poplar in Alberta. Canadian Forest Service Infor. Report NOR-X-262. 19 p.

Hooper, R.G.; Lennartz, M.R.; Muse, H.D. 1991. Heart rot and cavity tree selection by red-cockaded woodpeckers. Journal of Wildlife Management 55:323–327.

Hoover, R.L.; Wills, D.L. 1984. Wildlife requirements and uses of snags and dead/down trees on forested lands of Colorado. Managing forested lands for wildlife, Hoover, R.L. and Wills, D.L., eds. Colorado Division of Wildlife:413–417.

Jackson, J.A. 1977. Red-cockaded woodpeckers and pine red heart disease. Auk 94:160–163.

Kilham, L. 1968. Reproductive behavior of hairy woodpeckers. II. Nesting and habitat. Wilson Bulletin 80:286–305.

Kilham, L. 1971. Reproductive behavior of yellow-bellied sapsuckers. I. Preference for nesting in *Fomes*-infected aspens and nest role interrelations with flying squirrels, raccoons, and other animals. Wilson Bulletin 83:159–171.

Krebill, R.G. 1972. Mortality of aspen on the Gros Ventre elk winter range. U.S. Forest Service Research Paper INT-129. 16 p.

Lane, B. 1990. A new species in old forests. Minnesota Volunteer, Sept-Oct:13.

Lawrence, L.K. 1967. A comparative life-history study of four species of woodpeckers. Ornithol. Monograph. 5. American Ornithol. Union. 196 p.

Ligon, J.D. 1970. Behavior and breeding biology of the red-cockaded woodpecker. Auk 87:255–278.

Mueggler, W.F. 1988. Aspen community types of the Intermountain Region. U.S. Forest Service General Technical Report INT-250. 135 p.

Mueggler, W.F. 1989. Age distribution and reproduction of intermountain aspen stands. Western Journal of Applied Forestry 4:41–45.

Ringelman, J.K. 1990. Buffleheads. Colorado Outdoors 39:8–9.

Schier, G.A. 1975. Deterioration of aspen clones in the middle Rocky Mountains. U.S. Forest Service Research Paper INT-170. 14 p.

Sedgwick, J.A.; Knopf, F.L. 1992. Cavity turnover and equilibrium cavity densities in a cottonwood bottomland. Journal of Wildlife Management 56:477–484.

Thomas, J.W.; Anderson, R.G.; Maser, C.; Bull, E.L. 1979. Snags. Wildlife habitats in managed forests—The Blue Mountains of Oregon and Washington, Thomas, J.W., ed. U.S. Forest Service Agricultural Handbook No. 553:60–77.

Weydemeyer, W.; Weydemeyer, D. 1928. The woodpeckers of Lincoln County, Montana. Condor 30:339–346.

Wills, D.L. 1984. Creating wildlife habitat conditions. Managing forested lands for wildlife, Hoover, R.L. and Wills, D.L., eds. Colorado Division of Wildlife:243–257.

Winternitz, B.L.; Cahn, H. 1983. Nestholes in live and dead aspen. Snag habitat management: Proceedings of a symposium. U.S. Forest Service General Technical Report RM-99:102–106.