

The Value of Coarse Woody Debris to Vertebrates in the Pacific Northwest¹

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Abstract

Many species of birds, mammals, amphibians, and reptiles use coarse woody debris (i.e., standing and downed dead wood) for nesting, roosting, foraging, and shelter. Woodpeckers depend on decayed wood to excavate nest and roost cavities in standing trees. Secondary cavity nesters then claim the abandoned cavities for their nesting or roosting. Many of the woodpeckers and secondary cavity nesters use dead wood to forage on forest insects, including bark beetles and defoliators. Characteristics that affect the type and extent of vertebrate use of dead wood include the physical orientation, size, decay state, tree species, and overall abundance. Some species of heartwood decaying fungi create hollow chambers in living trees, which eventually die to become hollow, standing dead trees. Standing trees with hollow chambers are used by Vaux's swifts (*Chaetura vauxi*) for nesting and roosting, pileated woodpeckers (*Dryocopus pileatus*) for roosting, black bears (*Ursus americanus*) for overwintering, American martens (*Martes americana*) for denning and resting, and many other species of small mammals for shelter. Once the trees fall, many of the same species continue to use the hollow structures, except the avian species. Solid logs provide cover or travel lanes for small mammals. Accumulations of logs stacked on top of each other provide important habitat in the open spaces formed under the snow where martens and small mammals spend much of the winter. Large-diameter logs are used extensively by pileated woodpeckers and black bears for foraging on carpenter ants. Extensively decayed logs provide habitat for amphibians and reptiles.

Introduction

Coarse woody debris, which is defined as standing dead trees and downed trees (i.e., logs) and large branches, is a critical element of healthy, productive, and biologically diverse forests. Coarse woody debris provides habitat for many vertebrate species, including birds, mammals, amphibians, and reptiles. Thomas (1979) identified 179 vertebrate species that use coarse woody debris in the Blue Mountains of Oregon and Washington, which represents 57 percent of the vertebrate species breeding there. For those species using standing dead trees, birds dominate the list by number of species, although many mammals and some reptiles and amphibians use cavities as well as other structural features of dead trees. In the Blue Mountains, 39 bird and 23 mammal species use standing dead trees for nesting and shelter (Thomas 1979). Bunnell and others (1997) found that about 25 percent of the vertebrate species in British Columbia used cavities. Harmon and others (1986) state

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that cavity-nesting birds account for 9-39 percent and 8-62 percent of the total bird species in deciduous and coniferous forests, respectively.

Coarse woody debris is formed in a variety of ways. Trees can be killed by fire, insects, decay fungi, flooding, drought, and windthrow. The means by which a tree is killed influences the manner in which it decays, how long the tree will stand, and the rate of deterioration. A strong relationship exists between the kind of decay in a tree and what species can use it, particularly for nesting and foraging. The degree of decay can be translated into structural classes of standing dead trees and downed trees (Bull and others 1997), which may be useful in categorizing the dead wood resources.

In addition to decay, characteristics that affect the type and extent of vertebrate use of coarse woody debris include physical orientation (vertical or horizontal), size (diameter and length), species of wood, and overall abundance of material (Harmon and others 1986). The majority of species that use snags are birds and bats, while the majority of species using downed trees include small mammals, amphibians, and reptiles. The importance of different characteristics of coarse woody debris will be discussed for the following groups of vertebrates: birds, mammals, amphibians, and reptiles.

Birds

Woodpeckers, termed primary cavity excavators, excavate the cavities they use for nesting and roosting. Species using vacated existing cavities are termed secondary cavity nesters. Woodpeckers usually excavate their nest cavities in decayed wood in dead trees because most woodpeckers lack the adaptations (bill structure, cushion in brain, muscle structure) needed to excavate in sound wood. The pileated woodpecker (*Dryocopus pileatus*) is the strongest excavator and can excavate cavities in sound wood, while weaker excavators like the Lewis's woodpecker (*Melanerpes lewis*) require advanced decay before they can excavate a cavity. A woodpecker's preference for a particular tree species for nesting is largely influenced by the specific decay characteristics that occur in that tree species. Live trees can function as dead trees if portions of the wood (e.g., dead tops or large dead branches) contain decay as a result of wounding, lightning, or other injuries. Loose bark on dead trees may also provide nesting crevices for brown creepers (*Certhia americana*) and some secondary nesting birds.

Hollow trees are a unique structural feature in forests. The heartwood in these trees is decayed by heart-rot fungi while the tree is alive (Bull and others 1997). Ninety-five percent of pileated woodpecker roost sites in northeastern Oregon were in hollow trees, and 5 percent were in vacated nest cavities (Bull and others 1992). Pileated woodpeckers excavate entrance holes in these trees to access the hollow chamber. Once an entrance to the hollow chamber has been made, other species like the northern flicker (*Colaptes auratus*) also use these trees for roosting. The great depth of some of these hollow chambers makes them unsuitable for nesting by most birds, except the Vaux's swift (*Chaetura vauxi*), which is dependent on these hollow trees for nesting in forest communities. All 21 swift nest trees located in northeastern Oregon were in hollow grand fir (*Abies grandis*). Swift nest trees averaged 67.5 cm d.b.h. and 25 m tall with an internal hollow chamber that averaged 28 cm in diameter and 5.7 m deep (Bull and Collins 1993).

In a recent study, I placed swift nest boxes (3 m deep and 30-cm square) in trees to simulate hollow trees in three categories of stands: stands of old forest multi-strata (multi-cohort, multi-strata stands with large old trees) in grand fir forest types, regeneration cuts in grand fir types, and mature stands of ponderosa pine. Thirty percent of the bird boxes in old forest multi-strata stands were used by swifts for nesting. Other use included roosting by pileated woodpeckers and northern flickers and nesting by flying squirrels (*Glaucomys sabrinus*) and red squirrels (*Tamiasciurus hudsonicus*).

Size of dead tree can be critical for nesting for some species. Woodpeckers must select a dead tree that is large enough to accommodate the cavity they excavate at a height at which they prefer to nest. Typically, the larger diameter dead trees can accommodate a greater variety of species and stand longer than smaller diameter snags. The larger woodpecker species are particularly important because they create larger cavities that can be used by larger secondary cavity nesters, like the northern saw-whet owl (*Aegolius acadicus*).

Many woodpecker species forage extensively on invertebrates found in dying and dead trees and logs. Woodpecker foraging may effectively reduce populations of some bark beetles (Steeger and others 1998). In northeastern Oregon, 38 percent of pileated woodpecker foraging was on dead trees, and 38 percent was on logs; carpenter (*Camponotus* spp.) and red forest (*Formica* spp.) ants were the primary prey based on analysis of woodpecker scats. Logs preferred for foraging by the pileated woodpeckers were decayed Douglas-fir (*Pseudotsuga menseizii*) or western larch (*Larix occidentalis*) larger than 38 cm in diameter (Bull and Holthausen 1993). Foraging on logs occurs primarily in snow-free months when logs are accessible. Northern flickers forage on logs with a high incidence of decay. Black-backed (*Picoides arcticus*) and three-toed woodpeckers (*Picoides tridactylus*) also forage on bark beetles (Scolytidae) and secondary insects (Cerambycidae and Buprestidae) in logs. Foraging by vertebrates on logs probably peaks toward the middle or late stages of decay when logs are softer and invertebrates and fungal fruiting bodies are more common (Harmon and others 1986).

Although isolated dead trees and logs are used for nesting and foraging, concentrations of dead trees and logs provide better cover and more opportunities for use. Some woodpeckers, like the pileated woodpecker, frequently nest in the same vicinity but use different trees each year. Woodpecker nests in isolated dead trees may be more vulnerable to predators than nests in a cluster of dead trees where predators would have to search more dead trees and other vacated cavities.

Some cavity users may be associated with natural disturbances like fire. Hutto (1995) reported that black-backed woodpeckers seemed to be largely restricted to standing dead trees created by stand-replacement fires in Montana. In southwestern Idaho, Saab and Dudley (1998) found high densities of black-backed and Lewis's woodpeckers in stand-replacement fires in ponderosa pine (*Pinus ponderosa*), although nesting black-backed woodpeckers in northeastern Oregon were not restricted to stands with fire (Bull and others 1986).

Some of the cavity-nesting birds like the pileated and white-headed woodpeckers (*Picoides albolarvatus*), Vaux's swifts, and flammulated owls (*Otus flammeolus*) are associated with stands with large-diameter trees because of their reliance on large trees and other structural attributes of these forests.

Mammals

Dead wood, both standing and down, is important to mammals for cover, denning, and resting. The cavities created by woodpeckers are readily used by red squirrels, flying squirrels, bushy-tailed woodrats (*Neotoma cinerea*), and some bats. Larger cavities in decayed heartwood are used by American martens (*Martes americana*), fishers (*Martes pennanti*), bobcats (*Lynx rufus*), and black bears for denning and shelter. The function of logs depends largely on the extent of decay, their size, and abundance. Logs lacking decay are typically used for cover and runways. As logs decay and the bark loosens, small mammals can burrow into the wood under the bark.

Research in the last two decades has identified the value of cavities in snags for roosting bats. Maternity colonies of silver-haired bats (*Lasionycteris noctivagans*) normally are located in cavities in trees during the summer, although males and nonreproductive females may roost alone in cracks in trees and under bark (Mattson and others 1996, Betts 1998). In northeastern Oregon, trees with cavities that were used by roosting bats were taller, less decayed, and farther from adjacent trees than a sample of available trees; this selection presumably took advantage of the absorption of solar radiation and retention of heat in the trees (Betts 1998). Silver-haired bats are dependent on trees, typically roosting in narrow crevices in tree trunks or under the bark in large trees in Canada (Barclay and others 1988, Nagorsen and Brigham 1993). In southern interior British Columbia, big brown bats (*Eptesicus fuscus*) roosted in hollow cavities in large-diameter ponderosa pine snags (Brigham 1991). Vonhof and Barclay (1996) found that four species of tree-roosting bats (*E. fuscus*, *L. noctivagans*, *Myotis evotis*, and *M. volans*) preferred roosts in tall trees associated with lower canopy closure. Of 21 roosts, 14 were beneath loose bark, 5 were in cavities excavated by woodpeckers, and 2 were in natural cavities.

Long-legged bats (*Myotis volans*) in the central Oregon Cascades roosted in large Douglas-fir snags averaging 97 cm dbh and 38 m high (Ormsbee and McComb 1998). Bats in California roosted in basal hollows in old-growth redwood stands (*Sequoia sempervirens*) in both contiguous forests and in small isolated remnant patches (Zielinski and Gellman 1999).

Hollow standing trees, both live and dead, and hollow logs are used extensively by black bears, American martens, fishers, bushy-tailed woodrats, and flying and red squirrels. Hollow trees with either a top-entry or base-entry comprised 22 percent of 165 black bear dens in northeastern Oregon; 12 percent of the dens were in hollow logs (Bull and others 2000). Top-entry den trees averaged 114 cm dbh, while base-entry trees averaged 108 cm dbh. The majority of hollow trees and logs were grand fir, with Indian paint fungus (*Echinodontium tinctorium*) being the primary agent responsible for creating the hollow chambers in these trees.

Hollow trees and logs are particularly important habitat for American martens in northeastern Oregon where 23 percent of 1,184 rest sites of martens were in trees with cavities (mostly hollow trees) (Bull and Heater 2000). Seventy-three percent of natal dens were in hollow trees, while 58 percent and 21 percent of maternal (post-natal) dens were in hollow logs and hollow trees, respectively. These hollow structures provided dry, warm, and secure sites that were inaccessible to most predators.

Many carnivores are associated with dead wood. Logs provide cover for mountain lions (*Felix concolor*) at diurnal bed sites and at natal and maternal den

sites (J. Akenson, pers. comm.). Wolverines (*Gulo gulo*) may require coarse woody debris in some habitats for denning (MacKinnon 1998). Lynx (*Lynx lynx*) require mature forests for denning and a high density of logs (Koehler 1990). Logs and stumps may be the most important component of lynx denning habitat because they provide cover for kittens (Koehler and Brittell 1990). Accumulations of logs under snow are used extensively by American martens for hunting and for shelter (Buskirk and Powell 1994). These accumulations of logs are also used by red squirrels for their middens during the winter.

Abundance of small mammals is associated with log cover. On the Olympic Peninsula, abundance of deer mice (*Peromyscus maniculatus*), red-backed voles (*Clethrionomys* spp.), Trowbridge's shrews (*Sorex trowbridgii*), and shrew-moles (*Neurotrichus gibbsii*) increased with coarse woody debris in coniferous stands (Carey and Johnson 1995). Red squirrels are abundant in older aspen stands (Roy and others 1995) and use snags and large trees for nesting and cover and use fungi and lichens growing on coarse woody debris as food.

Red-backed voles use logs extensively for cover and food, eating mostly fungi and truffles, many of which are associated with logs (Ure and Maser 1982). The mean number of captures of this species was positively correlated with mean log diameter and size of log overhang (Hayes and Cross 1987). The larger logs probably provide more protective cover from predators than the smaller ones for traveling voles. In southwestern Oregon, locations of radio-tagged red-backed voles coincided with downed logs 98 percent of the time, even though only 7 percent of the study area was covered with logs. In addition, red-backed voles used logs in the later stages of decay significantly more often than logs in the earlier stages of decay (Tallman and Mills 1994).

Amphibians and Reptiles

At least 16 species of salamanders are associated with forests in Oregon (Bunnell and others 1997). More specifically, three species of predatory salamanders (*Batrachoseps wrighti*, *Ensatina eschscholtzi*, and *Aneides ferreus*) deposit eggs within logs in coniferous forests in western Oregon, as well as foraging on most invertebrate species found in those logs (Maser and Trappe 1984, Harmon and others 1986). Clouded salamanders (*Aneides ferreus*) are found in large coarse woody debris with loose bark, and their populations are positively correlated with stand age (Aubry and Hall 1991). Ensatinas (*Ensatina eschscholtzii*) are associated with decayed coarse woody debris (Bury and others 1991). Species diversity and abundance among the herpetofauna differed among different forest structures in the Oregon and Washington Cascades (Bury and Corn 1988) and in southwestern Oregon and northwestern California (Welsh and Lind 1988).

Conclusions

Although a great deal has been learned about the importance of dead wood to wildlife and ecosystems in the last two decades, there are still information gaps. The influence of fire, insects, and disease on creating and removing (fire) dead wood across landscapes needs intensive research to understand the dynamics of this ecological component in western forests. Additional information is needed on the density and types of dead trees and their relationships to the density and types of live

trees also present that will provide habitat (particularly for foraging) for viable populations of primary and secondary cavity nesters. The best methods for creating dead trees is still an important issue in restoration efforts. Artificially creating hollow trees is as yet not possible, although experiments using inoculation of decay fungi are ongoing.

Limited information on the density and kind of logs is available for many areas, and few studies have addressed the density required to provide habitat for viable populations of small mammals and herpetofauna. Many management plans do not adequately address density of logs, particularly on a landscape level. There continue to be conflicts in management agencies between retaining logs and lowering fuel levels to reduce the risk and extent of wildfire. If maintaining viable populations of species that require high densities of logs (like pileated woodpeckers and American martens) is an important management goal, an integration of managing the risk of wildfire, the habitat requirements of these species, and the ecological processes resulting from fire is needed.

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