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Deadwood Habitat in Canadian Boreal Forests

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Highlights

- Snags and downed deadwood serve as critical habitat for many forest wildlife species.
- The lowest amounts of deadwood are found in forest ages that coincide with rotation age. If rotation lengths and/or harvesting methods are not adjusted to accommodate for this, harvesting will result in long-term loss of deadwood and, thus, critical wildlife habitat.
- Future research should focus on determining abundance and importance of deadwood for wildlife habitat in naturally disturbed forests. Examples of such research directives can be gleaned from studies conducted in the western forests of North America and from boreal forests in Europe.

Deadwood can be found in the form of both standing and downed dead trees. Standing dead trees (snags) provide necessary foraging and nesting cavity sites for many species of birds and small mammals. Without these snags, following disturbance many animal species would be without homes and/or sources of food, which could eventually result in these species becoming locally extinct. Downed deadwood also provides necessary habitat for many insects, fungi and mosses, not to mention tree seedlings!

Forest management has come a long way in terms of its treatment of deadwood. There is recognition that the removal of all deadwood following harvesting can be extremely harmful to the forest ecosystem. Still, questions persist regarding the functional and structural importance of deadwood. For an overview of the various functions deadwood plays, please refer to the SFMN Research Note entitled *Deadwood in Canadian Boreal Forests.* This research note focuses on the critical role deadwood plays as habitat for animal and plant species.

Snags as habitat

Birds

Snags, or standing dead trees, provide important foraging and nesting habitat for many species of birds. Several species of birds, including woodpeckers, act as primary cavity excavators, meaning that they excavate holes, or cavities, in snags both when looking for food and to build homes. Without snags, these birds would not persist in forests. Some birds, as well as most cavity dependent mammals, are secondary cavity users, meaning that they depend on primary excavators and/or natural decay of trees to form cavities that they can use for nesting.

Cavity-dependant bird species comprise anywhere from 20-40% of the birds in a given forest.[4] Supporting this, researchers at the Greater Fundy Model Forest in New Brunswick have found that snags commonly comprise 5-10% of the total number of trees in mixedwood mature forests there, and that most of these snags show signs of usage by insectivorous birds.[3] Snags, then, serve as important habitats for insects and the insectivorous birds that feed on them. Research conducted in black and white spruce and aspen mixedwood forests in Alaska showed that three different species of woodpeckers were reliant on snags following fire. These three species were able to co-exist because each had a unique foraging niche which was determined, in part, by the degree of charring incurred by snags as a result

of the fire.[8] The degree of charring determined what types of (and how many) insects were found in snags, which, in turn, determined which species of woodpecker foraged there.

A large study in fire disturbed aspen mixedwood forests in Alberta illustrated that old aspen stands had the greatest species richness and that 63% of bird species sampled had their highest abundance in old stands. These findings were related to the structural heterogeneity of old stands, including the presence of standing dead trees that served as nesting and foraging sites for birds.[11] Young stands contained the second highest species richness and abundance. Again, these numbers were attributed to forest structural attributes—one of the most important being the presence of standing and downed deadwood. Studies such as these illuminate the importance of snags to bird species (whether it be as nesting cavities or foraging grounds) in Canadian boreal forests.

Other animals

There are many other living creatures that benefit from snags for a variety of reasons. Raptors use snags as perches, bats often roost under bark flakes, and small mammals may use excavated cavities for denning, foraging, and protection from thermal drought. Snags also provide some cover and, thus protection, from predators for small mammals such as martens. In addition, as discussed above, snags serve as home to many species of insects, including many species of beetles. In fact, the beetle species that live on dead and dying wood worldwide outnumbers all mammal, bird, reptile, and amphibian species found in the entire world! The importance of snags in the forest, then, is clear—as is the subsequent need to manage for this important component of boreal forest ecosystems.

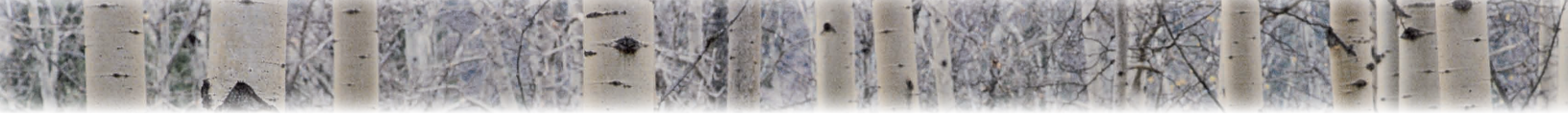
Downed deadwood as habitat

Small mammals

Small mammals depend on downed deadwood for denning and foraging sites as well as for protection from predators. Small mammals that have been studied in relation to deadwood habitat in Canadian boreal forests include marten, deer mice, and meadow and red back voles. In Alberta mixedwood boreal forests, it was concluded that the removal of trees and woody debris changed relative composition among three species (red back vole, meadow vole, and deer mice), with dominance moving from red-backed voles to deer mice as residual standing and downed deadwood decreased.[7] Additionally, there was a much higher abundance of red backed voles on sites where residual trees were left in 40 m diameter circular patches and woody debris was evenly distributed throughout the cut site. While meadow vole populations actually increased with less dead wood, there was one grid in the study area where no meadow voles were counted at all. The significance of this finding lies in the fact that this grid was the most spatially isolated of all the grids, indicating that the degree of fragmentation can negatively affect mammal populations.

Martens, once one of the most abundant small mammals in eastern North America, have been extirpated in several areas in eastern Canada and the U.S. and are threatened in much of their remaining range. This is due, in part, to loss of habitat via harvesting and fire, as well as trapping. Marten have most often been found to prefer older coniferous and mixed forests[12,14] (although this has not always been found to be the case[1,10]) , in part because of their structural diversity (including abundance of cwd) and subsequent greater abundance of prey.

Deadwood lying on the forest floor provides martens with natal dens, protection from predators, and subnivean (below snow) habitat for denning and hunting during winter months. In Ontario, marten densities were found to be 67-90% lower up to 40 years following clearcutting compared to densities in uncut forest.[13] Because of extreme losses in Newfoundland and New Brunswick, as well as the continuation of harvesting of remaining marten habitat in eastern North America, there is continued concern over the fate of this species. In areas where populations are viable, the possibility exists that future management can provide continued suitable habitat for these animals if care is taken to preserve viable amounts of older forests and/or younger forests with attributes that more closely resemble older forests (i.e. deadwood). On a landscape level, connectivity of patches has also been eluded to as a necessity for maintaining viable marten populations.



Amphibians

To date there have been extremely few studies conducted in the boreal forests of Canada linking deadwood habitat to amphibian populations. The few studies that we found (i.e. Greater Fundy Model Forest in New Brunswick) substantiate findings in many temperate forests of North America (and elsewhere) that amphibians such as toads, frogs, and salamanders rely on downed woody debris on land to protect them from thermal drought (i.e. drying out of their skin), predators, and to provide them foraging sites. Furthermore, these species depend on fallen logs in streams and lakes for breeding and feeding habitats as well. In southwestern Oregon State, amphibian populations were found to be positively correlated with levels of coarse woody debris.[6] Results from studies conducted in New Brunswick support the claim that amphibians require deadwood for survival.

Bryophytes, lichens, fungi, and seedlings

Deadwood not only provides critical habitat for animal species, but it also is a preferred growing medium for various species of bryophytes, lichens, and fungi. In east-central Alberta, old aspen stands were found to have higher species richness of these life forms than younger stands, which, in turn, had higher species richness than mid-aged (economically mature) stands.[2] These levels corresponded to the levels of downed woody material which is most abundant and diverse in old forests and lowest in economically mature forests, with young forests lying somewhere in between. In managed boreal spruce forests of northern Sweden, species richness was found to be higher for several species of mosses, fungi, and lichen in forests where downed woody debris was more abundant.[5] This study also urges the consideration of the size of deadwood, as higher species richness was observed when fine woody debris was mixed with coarse woody debris than when just coarse woody debris existed.

Rotting wood found on the forest floor can also provide good seedbeds for several boreal species including both black and white spruce. The consistent supply of moisture and nutrients offered by downed wood encourages good seedling growth, which, in turn, promotes the natural succession of these species in the forest.

Summary

Deadwood plays a key role in maintaining populations of various species of birds, amphibians, insects, and plants. Whether it is serving as home, providing protection from prey, or offering a site for young seedlings to grow, deadwood is an important component to forest ecosystems. Harvesting affects the abundance, distribution, and attributes of snags and downed woody debris and often does so in ways that differ from natural disturbance patterns. Often, natural disturbances leave many more snags and downed wood than harvesting does. The increased awareness of the importance of deadwood as critical habitat coupled with the ever increasing importance put on mimicking natural disturbance patterns in forest management across Canada have resulted in an augmented desire to manage deadwood in Canadian boreal forests.

Management Implications

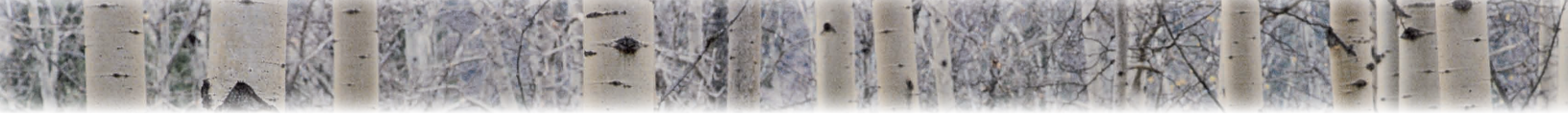
Generally speaking, from a wildlife habitat point of view, it has commonly been assumed that some deadwood is better than none and that more is better than some. We offer the following recommendations in the hopes of providing some specific guidelines for forest managers looking to add and/or maintain deadwood as a component of their forest management plan.

Snag management

Simply put, not all snags are equal. Insofar as wildlife habitat is concerned, there are several important factors that need to be taken into consideration when managing for snags.

Size

The size of a snag is of utmost importance, as larger animals will not be able to utilize snags that are too small in diameter and/or height. There is some evidence that even smaller animals, who are technically able to use



smaller snags, prefer to use snags with larger diameters. In mixedwood boreal forests in New Brunswick, researchers have recommended leaving 12-15 snags/ha greater than 20 cm diameter at breast height (dbh) for feeding sites for birds and 10-12 live or partially dead trees/ha with dbh greater than 25 cm for nesting sites.[3] Dbh estimations for two species of woodpeckers found in Canadian boreal forests (black backed woodpecker and pileated woodpecker) were made for these species in Oregon and Washington based on a model for estimating snag requirements proposed by Thomas et al.[12] Minimum snag size was estimated to be 31 cm. for black backed and 51 cm. for pileated woodpeckers.

Dbh is not the only attribute to look at when considering optimal snag size. The height of snags is equally important, as most animals prefer cavities that are high off the ground in order to protect themselves from predators. An added benefit of keeping taller snags is that they persist longer in the forest because it takes a longer period of time for them to decay to the point where they fall over. Selective cutting regimes that allow for the leaving of tall snags should be encouraged. Where this is not possible, leaving tall stumps (2-4 m) after cutting could potentially offer similar habitat for animals requiring taller deadwood cavities.[4]

Overall, attempts should be made to maintain larger dead trees when harvesting. While this may mean a loss in economic profit from merchantable timber, it does not necessarily have to. Dead trees that are already decaying or have deformities that decrease economic valuation can be identified and kept as opposed to completely merchantable snags. Furthermore, tops of snags can be lopped off above the deformity and/or decay so that part of the tree is left on site while merchantable parts are still harvested.

State of decay

Woodpeckers, with their notoriously chisel-like bills and thick skulls, are skilled at excavating cavities in hard snags; however, not all primary excavators have this skill. Therefore, both soft and hard snags should be left on site after harvesting. Leaving snags in varying states of decay has the added benefit of providing more long term and a more continuous supply of snag habitat.

Location

Snags will be utilized by certain species whether or not they occur as single stems or clumps of snags over the landscape. Single stems may help ease competition between species because they provide a wider range of potential habitat. However, clumps of snags scattered throughout the harvested landscape can be quite beneficial for snag users as well. Clumps of snags can help make foraging more efficient and can provide protection from predators for animals roaming on the ground. Clumps are especially important if the overall number of snags on the landscape is low, as single stems (in this case) may not provide enough habitats within the home range of individual cavity users.

Quantity of snags

While there have been several models suggested for determining appropriate numbers of snags to leave after harvesting, most of these predictive models have drawbacks that make them impractical to use. For example, the model proposed by Thomas et al.[12], predicts snag requirements based on woodpecker demographics and habitat use. This becomes a problem if there are no woodpeckers in the area being used and/or if there is a need for decay cavities large enough to provide for larger species of birds and mammals (i.e. ducks, raccoons, etc…). Furthermore, we simply don't yet understand the ecology of woodpeckers well enough to employ the model with any degree of certainty.

What then to do when trying to determine how many snags to leave? In general, it is often advised that some are better than none, and more are better than some. Leaving as many as is feasible in an array of live trees and dead trees in varying states of decay will help to provide a long term supply of snags for wildlife use.

Downed deadwood management

Size

Small mammals, as well as fungus, bryophytes, mosses, and lichens, all benefit from a variety of sizes of downed woody debris. From a management point of view, this means leaving branches and twigs, as well as some larger pieces of wood (i.e. small stems or bits of stems that are damaged). The importance of both fine

and coarse woody debris should not be overlooked and efforts should be made to leave quantities of both on site after harvesting.

Location

One of the biggest concerns of forest managers when trying to manage for deadwood may be the fact that, for species that prefer exposed mineral soil for seedling germination and survival, leaving deadwood behind means a loss in available area containing optimal seedbeds. Furthermore, large piles of downed wood can create large patches of shade which may additionally harm species that prefer direct sunlight for optimal growth. Piling downed woody debris can result in damage to wildlife who may not be able to move through the piles (i.e. larger ungulates, hares, etc…), so, from several points of view, efforts should be made to avoid leaving large piles of coarse woody debris in cutblocks.

Perhaps more amenable to both tree species and wildlife is to spread downed woody debris evenly in lines (if exposed mineral soil is necessary for seedlings) in between planting rows over the entire landscape. This has the added benefit of providing a continuous travel route for wildlife using downed wood as subnivean habitat and/or as protection corridors from predators.

Quantities

Simply put, as with snags, some downed woody debris is better than none—and more is better than some. In mixedwood forests in New Brunswick, it has been recommended that a minimum of 10m^3/ha be left throughout rotations. In similar forests in Ontario[9], naturally disturbed mixedwood stands had 132 m^3/ha of snags. While it may not be realistic to assume that managed forests should contain this large of a quantity of snags, if emulation silviculture is a goal of management, aiming for a balance between amounts that may be economically desirable and those that are currently found in naturally disturbed forests (and, thus, considered to be ecologically desirable) would be a good start.

Future Research Needs

Relatively speaking, the amount of research that has been done on deadwood in Canadian boreal forests is considerably less than that done in other forest types across North America (northeastern U.S. hardwood forests, coastal temperate forests) as well as that conducted in Europe (Sweden and Finland). One possible reason for this is that intensive management of our boreal forests has begun relatively recently in comparison to these other forest types, thus delaying clearly identified needs to look at all forest ecosystem components—including deadwood. The hardwood forests of northeastern U.S. have been being harvested for much longer. Forest management practices in temperate forests found in western North America have, in the past couple of decades, undergone increasing scrutiny as the general public has become more aware of important issues associated with the very old forests there (i.e. biodiversity, unique old growth habitat).

We have an opportunity to learn from the research done in other forests—even if the precise results are not widely applicable (although, at this time, this is unknown). In the very least, the research done to date in these forests can act as a directive for future research in the boreal forests of Canada. Specifically, this should include more studies focusing on quantities of downed deadwood and snags in naturally disturbed forests, and more studies linking wildlife habitat requirements with the presence (or lack thereof) of deadwood.

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