Creating and Maintaining Wildlife, Insect, and Fish Habitat Structures in Dead Wood[1]

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Abstract

Dead wood is an important component of the forest for many species. In many locations, however, the presence of dead wood has declined, and there is a need to make what is left more suitable for the myriad of creatures dependent on this material. In this paper, I will summarize the value of dead wood for these species and describe methods for improving the dead wood component of the forest to meet the needs of a variety of vertebrates and invertebrates.

Creating Wildlife Habitat Structures in Snags, Logs, and Stumps

In forested ecosystems, habitat diversity is directly related to tree form diversity. Snags are trees, dead or living (living snags are live trees with dead sections) that have been killed or altered by disease, lightning strikes, and wind. Each snag is unique since various factors, such as age, species, location, and cause of mortality or alteration, characterize each snag differently.

Snags (standing or downed trees) and other forms of dead or unmerchantable woody structures are recognized by many land managers to benefit wildlife and other biota on forested lands. At least 96 vertebrate species are associated with snags found in forests of Washington and Oregon (Rose and others 2001). A large proportion of forest-associated bird and mammal species require cavities to live in, many provided by snags or other forms of woody debris in various stages of decay. Thomas and others (1979) documented 62 wildlife cavity users in montane forests of northeast Oregon and southeast Washington. To other landowners, snags may represent unclaimed firewood, lightning rods, fire hazard, or loss of potential timber commodity. Many political jurisdictions have forest practice rules or policies requiring prescriptions to retain snags or designate green trees for future snag recruitment in managed landscapes. Wildlife habitat prescriptions, whether they are scientifically based or not, that are implemented and monitored may provide more habitat management options in the future and a more positive effect to increase species diversity and/or abundance as the forest matures.

Both dead and living snags are important and offer somewhat different habitats. For example, living snags that retain some lower branches below a sturdy, bare trunk or spike provide ideal protection and support for large predatory birds such as hawks

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and eagles. When a snag is formed abruptly, for example, by wind or lightning, the damaged tissue is quickly colonized by insects and fungi, which in turn provide meals for primary excavators such as woodpeckers and predatory insects. Secondary cavity users such as owls, chickadees, swifts, bats, and bees extend the usefulness of the snag modified by primary excavators. Flaps of loose bark, hollows, and crevices often found in snags are favored bat roosting sites (Tim Brown, pers. obs.).

As the snag decomposes and falls to the ground, it will provide shelter, dens and runways for a variety of small mammals and amphibians. Hollow tree trunks, either in the partially standing snag or the downed trunk, creates protective habitat for denning martens *(Martes americana),* fisher *(M. pennanti),* coyote *(Canis latrans),* and raccoon *(Procyon lotor).* Shrew-moles *(Neurotrichus gibbsii),* shrews (*Sorex sp.*), deer mice *(Peromyscus maniculatus),* salamanders, and frogs may use smaller cavities in the decaying wood for thermal and protective cover, in addition to foraging on the various insect larvae harbored there. Small mammals can act as dispersing carriers for fungi, and if they are using a down log as a runway, their feces deposit fungi, which in turn, recycle nutrients to the soil. The "dead wood" on the ground is a storehouse of energy and nutrients. The decay of this debris steadily contributes to the organic layer of the soil. This organic soil is critical to establishing a fertile medium for supporting a diverse ecosystem of plants, small mammals, amphibians, and invertebrates.

The purpose of this paper is to review techniques that I have experimented with in the last 30 years. As a former professional timber industry tree faller, forest firefighter, and owner and operator of a tree-service company, I have witnessed a plethora of wildlife using wood habitat, such as cavities, broken tree-tops, and deep fissures of lightning-struck trees. From these observations, my goal was to create similar habitats using chainsaw and drills. On trees and standing snags, many of the enhancements were performed aboveground anywhere from 2 m to as high as 30 m or more. Although most of the methods described in this paper were employed in the Pacific Northwest, these enhancements should work in other temperate conifer and hardwood forests of the U.S. and overseas. Land managers and their biologists can likely employ most of these techniques presented in this paper by considering the specific type, size, and location of the alteration for the particular target species of their area.

Wood Habitat Planning and Retention

With skill and planning, forest management activities and wildfires resulting in wildlife habitat loss may be managed to reduce further impact to wood habitat. In all likelihood it will be necessary to prioritize the efforts devoted for snag or other habitat preservation. The following are criteria useful for selection of elements of the landscape to be retained or managed:

- Trees or snags with trunks of 30 or more centimeters DBH
- Snags providing sites for platform nests
- Snags with obvious wildlife holes
- Snags with hollows
- Snags with conks (indicating soft decay is underway)

- Downed trees with hollows.

To retain snags in proposed logging operation sites, no harvest or no-work zones can be established around designated snag-retention areas. In a forest fire situation, crews, at their discretion, can reduce the potential hazard posed by these trees by routing fire trails around them and establishing no-work zones around each snag. These zones should cover an area with a radius of 1.5 times the height of the snag.

The hazard zone can be reduced to acceptable limits by topping threatening snags. Criteria and procedures for any topping should be introduced by the biologist/ecologist of the land management entity and incorporated into the sale administration process. Safety regulatory agencies should participate with the land managers to review topping prescriptions. Topping prescriptions, as well as other restoration techniques, may vary within a planning area depending on, for example, existing stand conditions, snag species, and proposed tree harvest methods. Holistic forest management planning is especially important to foster long-term stand and landscape conditions for wildlife species and other biota associated with snag and down wood habitat.

It is apparent that the same features that make the snag an asset for wildlife habitat may be a liability for the forest worker or visitor. Signs of a hazardous tree may include:

- A significant lean
- A broken top and/or branches that are hanging up in the tree
- Snags with hollows
- Root or other disease (noted by needle discolor, poor cone production, etc.)
- Advanced decay into the bole of the tree
- Visible cracks or hollows in the bole of the tree
- Visible wildlife excavations
- Loose bark
- Length of time that the snag has been dead or tree stressed
- Lightning scars.

In forest fire situations the possibility of the snag serving as a "fire ladder" that may spread the fire into the canopy can be reduced by removal of low hanging and dead branches from the lower portions of the tree. Snags can be protected by removing fine litter and woody undergrowth at its base, thereby eliminating material that could fuel the fire near the snag.

Ultimately, the safety of the crew takes precedence over maintaining wildlife habitat. If, for example, establishing a "no-work zone" around a potentially hazardous snag is not an option, or if a combination of dangerous features, such as degree of lean and amount of decay, are significant, then worker safety requires removal of the snag. If a snag must be felled, it may still provide valuable habitat. Large, downed hollow or partially hollow logs are among the slowest habitat elements to be replaced after harvest or fires. Hollow logs may be homes for returning marten, fisher, lynx *(Lynx canadensis),* bobcat *(L. rufus),* bear (*Ursus* spp.), raccoon, and numerous other creatures.

Specific Habitat Creation Techniques

Hollow Trees

Hollow trees provide the basic ingredient for a blue-ribbon wildlife tree. In the Pacific Northwest, for example, tree species such as western red cedar *(Thuja plicata)* or Douglas-fir *(Psuedotsuga menziesii)* at least 60 cm in diameter should be checked for hollowness with a sounding ax. A hollow tree will emit a lower sound when struck than a solid tree. An increment borer can be used to determine whether the tree is indeed hollow and the extensiveness of the cavity. Once a hollow tree has been located, the worker should check to ensure that existing fissures or cracks provide entry to the hollow. If there is no suitable entrance, a quick drill with a chainsaw may permit access. Bats will enter a hollow tree from all levels, including open root areas that lead up into the tree trunk. However, a 9-meter (30 feet) or higher entrance hole is desired because it provides enough drop space for the young as they launch their first flights.

Locations for entrance holes should be selected carefully. Enlarging an existing partial opening or placing the hole in an already existing dead area, such as a dead branch stub are good places. The opening should be free of obstructions for safe egress and ingress. The opening should also be placed at a 20-degree angle upward from the horizontal. This angle helps keep the interior warm and provides a measure of safety from predators.

Bat Roosting Slits

On standing trees and snags these installations combine the close quarters and large surface areas that bats use. They serve as bat apartment houses and provide a dry, warm pocket for roosting or possibly nurse colonies. For a multiple slit dwelling, an entry port about 20 cm by 30 cm (8 inches high by 12 inches) long is excavated in the side of the tree. After the entry port is excavated, the slits are cut up into the interior of the tree as vertically as possible. Two to three separate slits may lead off from a single entry port. Alternatively, separate entry ports for each slit may be excavated. If the selected tree is green, it will be necessary to cut away the bark around the entry ports to prevent their closure by heal-over from cambium growth. It is also important to cut the cambium away to prevent oozing sap from sticking to the bats' fur and causing flight problems, or perhaps, avoidance of the site because of the presence of oozing sap.

Bat Bark Flange

A magnificent old Douglas-fir tree typically has bark at least 15 cm (6 inches) thick, with many vertically running fissures or crevices up to 15 cm deep and several meters long. The crevices in large-diameter (i.e., > 76 cm) Douglas-fir, or other species with deep fissures, provide abundant niches for forest bats. Solitary male bats use these crevices extensively. Smaller-diameter Douglas-firs (< 51 cm) have not developed the thick-fissured bark, and management of early seral forests for habitat restoration requires an innovative approach for creating surrogates for bark crevices.

To install bark flanges, tangential cuts should be made upwards about 25 cm (10 inches) on the side of a tree trunk. The depth of the cut should be just through the bark with only enough wood to provide a stable flange. Wedge a 19 mm (¾-inch) diameter piece of wood up into the top of the flange to keep it open.

Bat Girdle Flange

A tree that has been selected for killing by girdling can be utilized as bat habitat while the tree is dying. The girdle is designed with multiple collars or flanges 20 to 25 cm long around the circumference of the tree and hanging down over the shaved-off portion of the girdle. Bats will be attracted to the underside of these flanges. For convenience, the bat girdle flange may be placed at breast height (1.4 m above the ground). Tree girdled at this height can be expected to remain erect for 20 or more years, and the girdle needs to be installed 6 m (20 feet) off the ground. This increased longevity is worth the trouble of tree-climbing in most cases.

Bat Stumps

Usually a second growth forest has stumps left over from the preceding forest. These old, large-diameter (> 76 cm) stumps are particularly valuable habitat and even smaller stumps can be used to enrich the habitat. The tallest stumps are most suitable for bat stumps. A chainsaw can be used like a drill to bore out a tunnel through the stump. The tunnel should be no wider than 19 mm (about twice the kerf width of the bar) and at least 20 cm (8 inches) from the top of the stump to keep the interior dry. Bats will use these artificial hollows for roosting.

Sapwells

Sapsuckers create sap wells in the bark of coniferous and deciduous trees and shrubs. Sap is an important seasonal component in the diet of these birds. Sapwells are often used by other birds such as chickadees, hummingbirds, warblers, and nuthatches. Squirrels and chipmunks also exploit sapwells. Sapwells can be installed with a chainsaw by lightly touching the trunk of a tree with a small chainsaw or drill. The bark is barely opened up to the cambium, not into the wood. The best time for sapwell construction is in the early spring, when the cambium is rapidly producing new phloem. Sapwells can be placed at all levels in live trees, but levels 5 m (15 feet) or greater seem to be preferred.

Lightning Strikes

In late-successional forests in the western Cascade Mountains in Washington, many of the tallest surviving trees have been struck by lightning at some time but have not burned significantly. If the strike was fairly recent, an irregular charred line that runs down the vertical length of the tree should be obvious, but often evidence of a lightning strike is not visible. Visible damage to the tree trunks may include superficial bark flaking to strip like furrowing along the trunk. Often the tree tops have been shattered and lost, and a spiral scar with a crack along its axis winds around the trunk. Most have shallow continuous scars 15 to 127 mm (0.6 to 5.0 inches) wide along their trunks. The average scar extends along 80 percent of the tree height, often to the ground level (Taylor 1969).

Lightning strikes expose the cambium of the trees to insect activity that provides a bountiful and convenient food source for insectivores. Fungi may enter at splits and deep openings made by lightning and begin the process of sapwood and heartwood rots. Birds also can readily use the lightning-induced crevices as points to initiate excavation. Conner (1975) noted that some lightning-created snags were used by cavity-nesting birds. Bats find temporary roosting sites along the strike crevices. Since lightning struck trees are usually poor quality for timber, they should be retained on the landscape as wildlife trees. The structure of a lightning strike can be mimicked by installing a long vertical slit down the trunk of the tree. Strikes often travel straight down for some distance but then curve off center nearer the base of the tree. Artificial lightning strikes should be installed in this asymmetric way and can be installed in either dead or living trees.

Raptor Perches

"Healthy" second-growth forests that open along rivers and lakes may be lush-looking, but provide marginal perch habitat for eagles and other large-bodied raptors. Bald eagles *(Haliaeetus leucocephalus),* for example, need lookouts and towers from which to locate prey and to begin their hunt. Typically, early-seral hardwood forests, such as small-diameter (< 30 cm) red alder *(Alnus rubra)* and black cottonwood *(Populus trichocarpa),* are densely branched and not useful as raptor perches. However, branches in dense crowns can be thinned to create raptor perches. Trees along a river in a fairly open location may be improved for use by eagles by thinning and girdling branches to provide visibility and convenient perch sites. When pruning, branches in the lower third of the trees are removed and those in the upper two-thirds of the trees are thinned.

Mammal Dens

Most of our forest mammals use some sort of cavity for denning. Insectivorous small mammals, such as shrews (*Sorex* spp.), shrew-moles, and deer mice, are known to exploit log or stump cavities for den sites and runways. Larger carnivorous mammals, such as members of the weasel family, use hollow logs or hollow trees as den sites. Maintenance or creation of some of these den structures can facilitate use by these creatures.

Habitat Logs

Dens can be constructed in logs of all sizes. Windthrown logs suspended above the ground are ideal, because they remain drier longer than logs flush with the surface of the soil. With a chainsaw, selected log should be cut laterally to create two halves, then sliced at the end of the cut to release the upper half. A den of the target species can be cut, contingent upon log size. An entrance hole just large enough for the target species should be placed along the side of the cut. The lid on top of the log should be secured with nails or cable.

Jagged Top Snags

A jagged top snag will collect a greater number of fungal spores to begin the decay process. Irregularities in the bole will collect precipitation and fungal spores and appear more natural. To "naturalize" a snag, a portion of the top of the newly topped tree should be sliced at an angle. Then the top of the snag should be cut to create crevices in the top. Finally, the saw should be "bounced" on the top to create a number of incisions.

Improvement of Aquatic Habitats for Wildlife

Urban development and past management of forests along streams, wetlands, and lakes, have reduced the presence of large dead trees that historically fell into these wet areas. Introducing wood habitat to lotic ecosystems, for example, may require extensive and expensive restoration efforts and may conflict with social, political, and scientific efforts to protect Federal-listed salmonids, especially in regions within the Pacific Northwest.

If restoration is practical, especially in urban areas with lentic habitats, re-introducing wood habitat will likely benefit invertebrate and vertebrate species and associated biota where future recruitment of wood is unlikely to occur. Adding woody debris directly in water and adjacent uplands can increase amphibian productivity, for example. Observations show that placement of thin-stemmed woody vegetation in the water provides egg oviposition sites for the northwestern salamander (Richter and Roughgarden 1998). And water temperatures are crucial for the proper development of amphibian egg masses. Areas shaded from direct sunlight may not provide appropriate temperatures for quick development of amphibian egg masses compared with portions of lakes exposed to sunlight for longer periods. So when providing structures designed to provide support for amphibian egg masses, one should prioritize areas with warmer water due to longer duration of sunlight. Other species of native amphibians, such as the red-legged frog, may also loosely secure their egg masses to woody stems. Such woody material would float up and down with the water level fluctuations, preventing desiccation during water level changes. Aquatic amphibians spend a good deal of time in upland habitats. Addition of large woody debris to upland areas enhances amphibian overwintering opportunities.

Waterfowl, amphibians, turtles, and riparian-associated wildlife are attracted to open bodies of water, and the presence of logs associated with open water areas increases the quality of the habitat for such species. In open bodies of water, a mixture of loafing logs for waterfowl, otter, and turtles should be placed to maximize use by individual wildlife species. Addition of logs to the area of ponds and lakes receiving the greatest amount of daylight provide basking sites for turtles so that they can more quickly increase their body temperature in a secure location. Waterfowl roost safely on secured logs in the water, and several mammals use floating logs, including mink *(Mustela vison),* river otter *(Lutra canadensis),* and beaver *(Castor canadensis).*

Maintenance and Improvement of Snags and Logs for Pollinating and Predator Insects

Predaceous and pollinating insects, such as ants, wasps, bees, and ladybugs, contribute to forest health and productivity. Taxa including ants and ladybugs prey on a number of forest insect pests. Solitary and colonial bees pollinate a variety of flowers and berry-producing shrubs.

Many of these insects use snags and downed woody debris for many of their life activities. Some are primary cavity excavators, such as beetles and ants, that create cavities in dead wood for rearing their young. Many insects are opportunistic and use cavities of all kinds, including those created by wood rotting fungi, for their own reproduction or for overwintering habitat. Special structures and installations for pollinating and predaceous insects in standing and downed wood materials may be created by various mechanical means. Galleries of a variety of dimensions are excavated in snags and logs by larvae of wood boring beetles and the vacated galleries are often used by a variety of other insects. A native bee, the orchard mason bee (*Osmia* spp.), uses holes approximately 8 mm by several centimeters deep for egg laying. Artificial cavities for this beneficial bee can be created with a standard drill bit. A portion of the tree facing south should be selected to optimize temperature regimes needed by this bee. Holes should be about 8 cm (3 inches) deep with an 8 mm (5/16-inch) drill bit. The hole should be cleaned out so that rough edges do not impede the bees.

Honey bees (*Apis* spp.) were originally imported from Europe, but have become well established in the U.S. and have become essential pollinators for orchards, cranberries, and native plants. They commonly use hollow logs, decayed or hollow trees, and various other cavities for their nests. Bee nests are a delicacy for forest omnivores such as bears. Creation of cavities in trees, logs, and stumps can enhance the habitat for these bees. Suitable cavities can be excavated in erect trees and then covered with face-plates, that include small entrance holes, over the cavity. A tree should be selected in an open stand that receives plenty of sunlight. With a chainsaw, a cavity should be excavated approximately 1 cubic foot. A faceplate should be secured onto the cavity with a 1 centimeter entrance hole at the base or one long slit 1 centimeter in width. Hollow logs or trees with no entrance can be opened up to the exterior with a small drill to provide access. In addition to honey bees, wasps also commonly use these structures and contribute to both pollination and pest control.

Lady bugs (*Hippodamia* spp.) are predaceous insects that overwinter in tiny crevices in wood, logs, or stumps in areas with adequate insolation. Suitable size crevices can be constructed with a chainsaw in trees and stumps in sunny sites. The tip of the chainsaw should run approximately 15 cm beyond the bark layer in several locations of a snag and/or stump.

Discussion and Conclusion

Management activities will, incidentally, contribute to varying levels of habitat loss. Losses will vary, but in nearly all cases, rehabilitation can lead to enhancement of wildlife components faster than if habitats are unmanaged.

The first step to rehabilitation is to assess the damage of the activity with respect to wildlife habitat. It is important to evaluate the condition of vertical and horizontal elements of the habitat. If necessary, for example, cut green trees or partially decayed logs can be delivered from off-site to act as nutrition logs and habitat for wildlife. Logs should be selected so that they will reach mid-succession in the decay sequence when the regenerated forest stand can begin recruiting its own snags and downed logs. As a precaution, any downed logs brought into the rehabilitation area should be recruited as close as possible from the managed site and inspected to minimize the introduction of unwanted fungal diseases and insects.

Taking remedial action over the entire area of interest may not be feasible, however, and it is essential that remediation result in creation of a mosaic of habitats at a variety of scales that will provide habitat for prey, as well as perching, nesting, and denning sites for predators. If small mammals and birds are provided suitable cover and rest sites, they may cache seeds harvested in the surrounding green areas. Their feces will also inoculate the soil with fungal spores, some of which are essential to functioning forest, including mycorrhizal fungi.

Intensely burned areas may leave significant amounts of downed woody debris and standing snags. However, the habitat and nutrient benefits of these snags and debris may be severely limited if fire has caused the exterior of the wood to be case hardened. Case hardening results from moisture loss coupled with chemical changes that occur on the fire-exposed surface of wood. Case hardening increases the compressional strength and brittleness of the snag or log, and more importantly, seals off the nutritional resources within the tree. This sealing, along with the direct loss of bark and cambial nutrients, limits the usefulness of the post-fire dead wood for many species. Birds, mammals, and bark beetles cannot penetrate and shape case-hardened wood in their usual manner. Furthermore, reduction in vertical cover and loss of organic duff on the ground reduces the habitat suitability for numerous forest organisms.

The degree of success of artificial structures is generally proportional to on-site supervision by an experienced professional during enhancement activities. Without proper training and preparation, application of these methods could place workers in hazardous situations. Because the chainsaw is the tool of choice for many of the projects, it is strongly advised that workers be properly trained and certified to handle such equipment on the ground, and especially, when working above the ground in trees.

In the last three decades in which many of these techniques have been applied, it is apparent that there is an information gap in reporting either the success or failure of the techniques. Forest land managers and natural resource biologists should ensure that existing and future projects are monitored vigorously with the intention of documenting enhancement results or lack thereof. Wildlife habitat enhancement methods and techniques can be blended to retain and enhance not only threatened, endangered, and sensitive species, but also to include the total biotic composition that is associated with wood habitat. Some general observations have shed light on the suitability of the various restoration techniques presented in this paper and allow optimism for the success of many projects. Preservation and management of wildlife structures and associated biota that use them, and the workers performing their tasks in wood habitat retention areas, can be simultaneously achieved with foresight and innovative planning.

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