EMEND





ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #11

Ecological Messages:

- Coarse woody debris (CWD) is naturally patchy in the boreal forest.
- Retention levels following harvesting and forest overstory composition affect the type and quantity of CWD.
- Small-diameter CWD increased after harvest, followed by a pulse of large-diameter CWD after 10 years.

Management Implications:

- Variable retention harvest (≥20%) maintained more CWD after 10 years than clear-cutting.
- Snags persisted almost exclusively in high-retention deciduous stands.
- Across harvested landscapes, variation in retention levels will promote more diverse dead wood resources than clear-cutting alone.

Seeing the forest for the snags: managing coarse woody debris in harvested landscapes

Research led By Dave Langor, Daryl Williams, and John Spence

Dead and dying trees bring new meaning to the phrase "life after death." Studies in forests around the world have revealed that dead wood is in fact teeming with life. Landscapes with long histories of clear-cutting have seen sharp biodiversity losses, due in part to dead wood removal over decades, as has been observed in much of Europe. Variable retention harvesting provides a possible tool for conserving deadwood and, thus, preventing similar losses of biodiversity in the Canadian boreal forest. But how well does it work?

Heavily decayed wood. Photo by Jim Witiw (DMI).

At EMEND, we have been monitoring dead wood for over 10 years to answer that question. By comparing dead wood amounts, types, and numbers of pieces, ***our study reveals that dead wood patterns in partially harvested stands show little resemblance to those in clear-cuts***.

Coarse woody debris ("CWD," dead wood ≥7.0 cm diameter) exhibited two overall "pulses" across the experimental area. The year after harvest, there was a pulse of small-diameter CWD—slash left behind as harvested trees were dragged across the ground. Roughly 10 years after harvest, there was another pulse, this time consisting of fallen large, old trees.

The overall distribution of CWD on the EMEND landscape was extremely patchy prior to harvest. Following harvest, snags were maintained almost exclusively in high retention deciduous-dominated stands. Meanwhile, stands harvested to variable retention prescriptions (≥20% retention) maintained more CWD after 10 years than did clear-cut stands.

Rather than providing a single solution for maintaining dead wood in the long run, as with other habitat characteristics studied at EMEND, our results show that variability in the amount of dead wood across the landscape is key. ***Read on to find out more . . .***

Dead wood plays a keystone role in forested landscapes

There is more life contained within a dead tree than a living one. It sounds contradictory, but it makes more sense the closer you look. Standing and fallen trees and pieces of dead wood provide important habitat and food for invertebrates, fungi, mosses and liverworts, and the creatures that feed on them. No matter the age of a forest, dead wood is a critical habitat component!

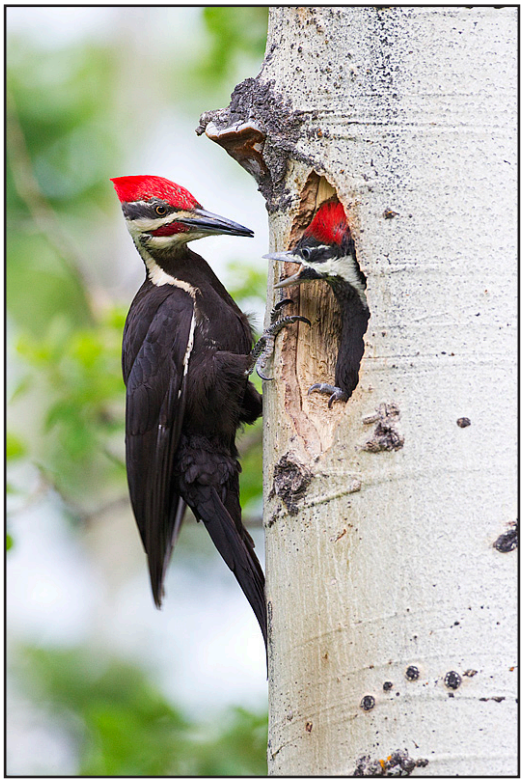
Forest fires leave a legacy of charred dead trees ("snags") and debris in a forest stand, which are quickly exploited by specialised wildlife like the black-backed woodpecker. After about a decade, most of the burned snags have fallen, and much of the original debris has decayed. Over the next century, downed wood increases as trees, snags, and branches fall to the ground. Likewise, snags slowly increase in number as old and damaged trees die off. These rotting trees and snags are excavated to provide nesting cavities for woodpeckers and the creatures that subsequently occupy the cavities, including flying squirrels and even American kestrels.

If the processes that produce dead wood are interrupted or altered, the consequences to ecosystem health can be severe. Traditional clear-cut stands contain very little dead wood apart from rapidly-decaying slash, and almost no snags. Regions with a long history of intensive clear-cutting (e.g., Fennoscandia) have experienced well-documented biodiversity losses, mostly attributed to "saproxylic" species that depend on dead wood. These losses have resulted from decades of clearing dead wood away, leaving little or no habitat for a wide range of species.

Fortunately, alternatives to clear-cutting are available to forest managers, and these options may better maintain dead wood in the long term. We studied the effects of clear-cutting and variable retention harvest on the amount and long-term persistence of coarse woody debris (CWD) in all four stand composition types at EMEND. Our permanent plots were sampled prior to harvest and then periodically during the 10 years following harvesting. The results can provide guidance for managing CWD in harvested landscapes. ***History has shown that where CWD is managed effectively, benefits for biodiversity and ecosystem function follow.***

About EMEND:

The Ecosystem-based Management Emulating Natural Disturbance (EMEND) Project is a multi-partner, collaborative forest research program. The EMEND project documents the response of ecological processes to experimentally-delivered variable retention and fire treatments. The research site is located in the western boreal forest near Peace River, Alberta, Canada, with monitoring and research scheduled for an entire forest rotation (i.e. 80 years).



A pileated woodpecker raises chicks in a cavity nest. Photo by Gerald Romanchuk.

Main findings

CWD was patchy in unharvested stands

In unharvested stands, the amount of CWD increased as conifer dominance increased, but there was significant variation from plot to plot. Some of this variation might be due to the sampling method used in this study, but it also reflects the natural patchiness of CWD within forest stands.

The factors and processes that create (or help create) dead wood are highly unpredictable over time and space. Competition, root- and stem-rot, and wind-throw occur unevenly across forests. These processes may be distributed randomly across stands, but also sometimes occur in clumps (e.g., an area where a disease pocket occurs). This patchy distribution of CWD makes it difficult to estimate its amount at the stand level, even using many sampling plots.

Despite the challenges for sampling CWD, the data make ecological sense and provide a clear message for forest managers: dead wood is naturally uneven in the boreal forest. Thus, forest management should aim to leave a patchy legacy of CWD on harvested landscapes rather than a single, universal, cutblock-level target.

Harvesting produced short- and long-term pulses of downed CWD

The amount of downed CWD increased sharply after harvest. This debris mainly consisted of small pieces (slash), and the largest amounts were observed in stands dominated by deciduous trees. Deciduous tree branches broke off more easily during skidding than the branches of conifers, and these broken branches tended to be larger than those of conifers (i.e., large enough to qualify as CWD). These increases were likewise largest in low retention stands (clear-cuts and 10% retention), where higher harvest volumes produced more slash.

Downed CWD amounts remained relatively steady until 10 years post-harvest, when a sudden and steep increase occurred in all forest types and treatments, including the controls. The amount of CWD increased more at 20% retention and higher because there was more standing timber to eventually fall, break off, or die, compared with the clear-cuts and 10% retention treatments.

The most substantial increases occurred in high-retention (≥20%) mixed and conifer-dominated stands. These stands were characterised by large numbers of old coniferous trees whose shallow root systems make them more susceptible to blowdown. Roughly 10 years after harvesting, a substantial number of coniferous trees had fallen.

Snags were difficult to maintain over 10 years

The number of new snags created over time was closely related to how many trees were left behind after harvesting. ***However, new snags were almost exclusively created in deciduous-dominated stands***.

Aspen and poplar die and decay relatively easily, but they generally resist blowdown better than spruce. These snags may remain upright for many years as woodpeckers drill into them, fungi grow in them, and insects like carpenter ants eat through the wood. For the 10 years following harvest at EMEND, existing deciduous snags persisted and new snags were created as the live trees retained during harvesting eventually died.

The shallow root systems of coniferous trees, mainly spruce at EMEND, leave them more vulnerable to blowdown despite their longer lifespans and resistance to decay. Ten years after harvesting, many spruce had fallen in high-retention coniferous and mixed stands. Even though coniferous and mixed stands received massive CWD inputs, they had far fewer snags than deciduous stands with the same retention level.

Natural coarse woody debris recruitment. Photo by Jim Witiw (DMI).

Management implications

By embracing a variable range of retention levels, forest managers will be able to increase the amount and variety of CWD over time within harvested landscapes. Small, large, and standing CWD are all important components of a healthy, functioning boreal ecosystem. Unharvested, fire-origin stands contain higher amounts of CWD than are present in clear-cuts, and variable retention harvest is an important step toward closing that gap and increasing landscape-level variation in CWD.

Targets for the amounts and distribution of CWD can be defined with help from the results from unharvested stands at EMEND and wider landscape studies, which represent patterns left after wildfire and following normal stand dynamics. The results from EMEND show that variable retention harvests are associated with significant landscape-level variation in CWD, something generally typical of natural boreal stands.

The results from EMEND suggest that snags will be present at lower than natural levels without additional effort to manage them on harvested landscapes. Thus, ***long-term snag maintenance is a key management challenge*** as snags were only maintained effectively in high-retention deciduous-dominated stands. High-retention coniferous and mixed stands were particularly vulnerable to blowdown of conifers, suggesting that other management tools are likely necessary for conserving conifer snags. However, novel techniques such as "high stumping"—when a tree is harvested but a 6–10-foot stump is left—have been used successfully in Europe to create conifer snags, and may be a possible option for longer-term conifer snag retention in Alberta.

Further reading

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