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Salvage logging and habitat conservation

Highlights

- Canada's forests are frequently disturbed naturally by fire, disease and insects. The resulting disturbed forest provides unique habitat for a number of species.
- Researchers recommend that a proportion of disturbed stands at different stages be maintained across all forest regions to provide habitat for post-disturbance species.
- In post-fire forests, a diversity of small to large diameter snags from different species should be retained to accommodate foraging and breeding requirements of fire-associated beetles and their predators.
- In mountain pine beetle-affected forests, researchers recommend salvaging large areas while retaining patches of dead lodgepole pine and non-lodgepole pine species to provide contiguous cover for vulnerable wildlife.
- Research indicates that riparian areas affected by wildfire or insect and disease outbreaks should remain unsalvaged to maintain stream conditions for key aquatic species.

Disturbances such as wildfires, insect and disease outbreaks are an important part of Canadian forest dynamics. They create unique forests characterized by snags and downed trees, which provide habitat for many species. In addition, disturbed stands contribute vital ecological functions with respect to soils, watersheds, vegetation and wildlife.

Currently, salvage logging of dead and dying trees after natural disturbances accounts for a large part of Canadian forestry. Forest managers use this practice to attempt to recover losses resulting from forest fires, insect outbreaks and disease. Typically, damaged trees are harvested immediately after the disturbance before they deteriorate or become non-merchantable due to decay and wood checking. A second goal associated with salvage logging is to get the disturbed forest back into production as quickly as possible.

Although a common practice, salvage logging raises concern among ecologists and forest managers. Disturbed ecosystems have important ecological functions that should be represented, at least in part, in forest landscapes. Many questions are associated with salvage logging: How much of a naturally disturbed stand should be harvested? Which disturbed stands make the best candidates for retention? How will salvage logging affect post-fire plant and wildlife habitat?

This note draws from research conducted across North America on the silvicultural and ecological impacts of salvage logging with a focus on wildlife habitat conservation in post-fire stands and landscapes.

Ecological considerations for salvage logging

Wildlife habitat

A number of mature forest structures, such as large live trees, large declining or recently dead stems, snags and downed wood, are used or required by 35 to 40 percent of terrestrial forest-dwelling vertebrates. Many wildlife species are strongly associated with post-disturbance forests and could be threatened if unsalvaged areas are not retained across the landscape. Recent research suggests that between 20 and 30% of naturally

disturbed forest area should be retained in different stand types, in the interests of biodiversity and wildlife habitat conservation.

Wildfire creates open stands with warm and exposed mineral soils and increased shrub cover that benefit species such as bark beetles, Black-backed Woodpeckers, deer mice and moose. The standing dead trees or snags, which can remain standing for up to 15 years, play a key role in the functional organization of food webs. In addition, disturbed forests provide an abundance of resources (woody debris) where organisms often concentrate (e.g. fire-associated insects and their predators).

Salvaged-logged vs. naturally disturbed sites

With their inherent temporal, structural and spatial variability, naturally disturbed stands and landscapes are distinctly different than traditional clear cuts. Most types of harvesting, including salvage logging, create unique features such as slash piles, skid trails and landings as well as linear landscape features that generally do not have natural counterparts. Research has shown that salvage logging of burned forest creates a longer-lasting negative impact than wildfire alone on some wildlife communities, notably the songbird community.

In some provinces, salvage logging practices create stands more similar to clear cuts than to burned stands. However, with greater awareness and interest in natural disturbance management, forest companies increasingly harvest to better approximate natural disturbance patterns. Under a natural disturbance framework, a complete salvage harvest with no retention does not mimic any stage of natural forest succession. Partial harvests, on the other hand, would be more similar to the ecological legacy of natural disturbances.

The case of woodpeckers

Bark-probing birds, such as woodpeckers, follow the invasion of post-fire stands by wood borers and bark beetles. Much of the research on the impacts of salvage logging has been on woodpeckers. Black-backed Woodpeckers, in particular, are considered key to post-fire forest ecosystems because of their role in providing nests (cavities) for other species, and their interaction with wood-rotting fungi.

Numerous studies have shown a decreasing abundance or an absence of colonizing bird species after both partial and complete salvage logging. For example, researchers have found that woodpecker species are less abundant on salvaged burned sites than on unsalvaged burned sites. This suggests that the effects of salvage logging may exceed those of fire alone.

Aquatic ecosystems

Large-scale salvage logging has similar impacts on aquatic ecosystems as clear-cut logging. Standard guidelines for the protection of riparian zones should, therefore, apply. Logging in riparian zones can result in increased sedimentation, water temperature changes and the long-term depletion of coarse woody debris.

Sedimentation can interfere with foraging by fish, reduce aquatic insect abundance and, for species that broadcast their eggs, it can decrease oxygen to eggs and may block fry emergence. The removal of insect-damaged or fire-killed trees from streambanks can result in water temperatures as much as 10°C higher than normal for up to 15 years (until a substantial canopy regenerates). Such changes have negative impacts on coldwater species such as rainbow trout and Dolly Varden.

The depletion of coarse woody debris through salvage logging in riparian areas can also significantly alter water conditions and aquatic productivity. Although post-salvage logging increases in productivity are common, a drop to below pre-harvest productivity levels is usually observed about a decade after the salvage harvest. Coarse woody debris provides habitat by creating large, deep pools of slow-moving water which species like salmonids require to manage their energy demands and as cover from predators. This type of debris also creates areas of lower stream gradient important for juvenile and spawning habitat.

Impacts on understory vegetation, soils and regenerating growth

Salvage logging can alter the characteristics and conditions of forest vegetation and soil, directly or indirectly affecting post-disturbance fauna. In boreal Québec and northern Saskatchewan, studies have shown that salvage logging tends to "homogenize" understory vegetation. The post-salvage vegetation resembled that found after

the most extreme wildfires with a decrease in plant abundance and diversity. More invasive species were also associated with salvage logged sites in the same areas.

Timber removal after fire disrupts the nutrient cycle even further. More specifically, potassium depletion has been observed after salvage logging of stands in northwestern Quebec. On severely burned and subsequently salvage-logged sites, it was estimated that magnesium and calcium levels would not return to pre-fire levels in a 110-year rotation. Salvage logging may also result in soil compaction (e.g. skid trails, ruts, etc.), when ground based machinery is used, increasing the amount and duration of topsoil erosion and runoff. Post-fire harvesting, by allowing greater light penetration to the forest floor or by altering the micro-climate, can result in accelerated soil drying, which in turn, decreases nutrient assimilation by understory vegetation and regenerating growth.

Studies in salvage-logged areas of Québec's boreal forest have indicated there can be reduced seed sources for species such as black spruce post harvest. Burned trees provide shade that aids in seedling regeneration especially on high elevation and dry sites. In burned, aspen-dominated stands in north-central Alberta near Slave Lake, salvage logging two years after fire with moderate to severe soil disturbance resulted in decreased aspen growth overall compared to unsalvaged or low soil disturbance sites.

Current salvage logging policies across Canada

Regulations for salvage logging vary widely from province to province. Few official, explicit guidelines exist for salvage logging with respect to habitat retention.

In British Columbia, the minimum 3.5% retention rate for salvaged stands and an average of 7.5% over a licensed forest area is consistent with standard logging operations. Salvage harvesting has increased dramatically since the onset of the mountain pine beetle epidemic yet few studies exist on the impacts of the practice on wildlife habitat and biodiversity. In the last few years, the annual allowable cut in some timber supply areas (e.g. Lakes, Prince George and Quesnel) has been increased with the assumption that an additional 12% stand-level retention rate above the standard stand-level and old-growth rate would be introduced.

Alberta has a fire salvage planning and operations directive. Draft guidelines address landscape-scale retention of burned areas, and retention of live and dead trees within salvaged areas. The proposed regulations recommend retaining all live trees and 5 to 10% of burned trees.

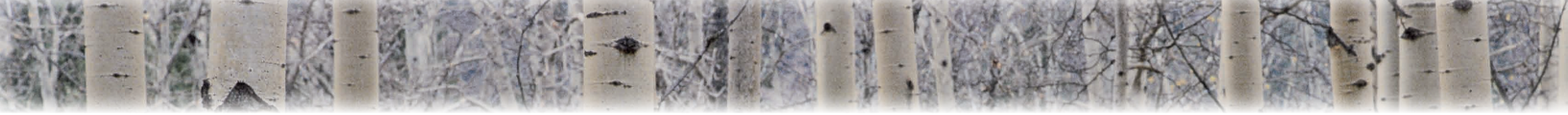
Saskatchewan currently retains 3% of salvage-logged stands – consistent with practice for conventional logging operations. Saskatchewan also has draft guidelines that aim to emulate natural fire patterns by ensuring structural diversity. Manitoba has no fixed retention targets and prescribes retention on a case-by-case basis.

Ontario's Ministry of Natural Resources (OMNR) has adopted a forest management policy (Forest Management Guidelines for Natural Disturbance Pattern Emulation) to emulate natural disturbance patterns. It has provisions for stand-level retention in salvage logging operations, which vary from 10 to 36% retention at the landscape-level. In areas of particular concern –areas around sensitive forest values including wildlife habitat—the OMNR encourages forest managers to avoid fire salvage logging to retain fire-origin habitat. Where salvage logging is acceptable, the OMNR stipulates that minimum residual standards apply. This results in some areas being unavailable for salvage, and reduced volumes of merchantable timber in other burned areas.

Quebec has drafted a policy on salvage logging to maintain diverse, post-fire components on the landscape although no specific targets have been set. This proposed policy is to address concerns over the current Quebec Forest Act, which exempts salvage logging management plans from regulations that dictate some level of tree/stand retention.

Post-fire stand retention: what and how much?

The number of snags retained during salvage logging after wildfire significantly influences the subsequent bird community. Cavity-nesting birds, such as Black-backed Woodpeckers, prefer burned forests and are highly sensitive to salvage logging. Research suggests that salvage logging, particularly after stand-replacing disturbances, should retain a diversity of snag sizes to provide bird and insect habitat. Precise numbers of snags



to retain and patch size to aim for, however, are scarce due partly to the unique nature of every disturbance and landscape.

Some researchers advocate that salvage logging guidelines, which generally recommend retaining 6-10 trees/ha, need to vary with plant community type, succession stage and fire severity. Recently burned conifer forests, for instance, have snag densities of hundreds per hectare. This density is not reflected in retention guidelines. Increasing the snag retention would address the differing habitat requirements of species associated with post-disturbance conditions.

Researchers do know that colonizers of post-fire sites (i.e. wood-boring beetles) have a life span of up to three years, which represents a brief window of opportunity for wood-drilling woodpeckers. Their population generally peaks around four years post-fire and declines to near zero in several years. This suggests that if salvage logging is to occur, it would be preferable to delay it until the habitat benefits have been realized.

Researchers also know that while younger, smaller-diameter (less than 10 cm dbh) disturbed stands could provide adequate habitat for some species, they are not suitable for deep-boring insects and other species requiring larger trees to complete their life cycle.

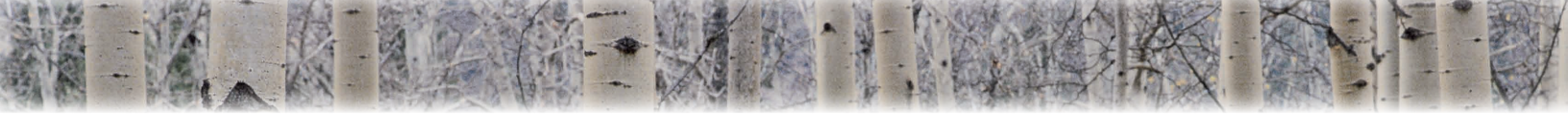
The following is a summary of specific recommendations:

- Some researchers suggest that unsalvaged patches retained for Black-backed Woodpecker habitat should more closely resemble their home range sizes, estimates of which vary from 60 to 200 ha.
- As the size of the salvage block increases so does the need to retain more disturbed forest. Some research suggests that for openings > 500 ha, levels of up to 25 percent retention should be strived for and represented by individual trees and retention patches. In burns up to 250 ha, retention rates might range from 7.5 percent to 20 percent using a combination of retention practices to achieve well-dispersed structural diversity.
- Fire severity impacts bird abundance; Black-backed and Three-toed Woodpecker abundance peak in moderately burned sites while Downy and Hairy Woodpeckers prefer severely burned sites. This therefore emphasizes the importance of retaining sites of differing burn severity.
- Study results from the U.S. Northwest suggest that, to encourage the highest bird abundance, 21 snags per hectare larger than 48 cm dbh, 34 snags/ha in the 16 to 24 cm dbh range, 180 snags/ha smaller than 15 cm dbh are required.
- Where feasible, patches of burned trees should be left unharvested for up to four years to allow bird communities to forage on post-fire beetles.
- Woodpeckers generally prefer nesting in aspen snags and foraging on dead jack pine. Managers should consider maintaining a diversity of tree species in a retention strategy.
- Snags retained for wildlife use should be buffered by other retained trees so they are less subject to windthrow and can provide habitat for as long as possible.
- Some conservation biologists recommend retaining patches of up to 300-500 snags/ha to better emulate stand-replacing disturbance events.

Insect outbreaks and salvage logging

Researchers agree that species dependent on mature forest are the most affected by salvage logging. Salvage-logged stands, regenerated with species that occur in the mature forest, could potentially provide mature forest habitat in a shorter timeframe than unsalvaged stands. The trade-offs in terms of wildlife habitat, however, is not known.

For example, salvage-logged stands have little or no value for mature forest dependent species, such as fisher, marten and woodland caribou. While salvage logging may produce a mature forest sooner, there are few available food and habitat resources for these species until the forest regenerates. However, unsalvaged stands can still provide critical benefits as a result of persistent lichen populations, reduced predator numbers, and critical habitat features, all of which would be lost in salvage-logged stands.



In contrast, early seral species, such as bobcat and snowshoe hare, benefit immediately from salvage logging. Therefore, salvage logging management needs to account for the different temporal habitat needs of forest-dependent species—such habitat proportions have not yet been established.

Thus, there are large knowledge gaps about the response of vulnerable species to salvage logging of mountain pine beetle stands. **However, recent work has led to a number of recommendations:**

- Large blocks up to 1000 ha can be salvaged with patches of retained forest (10 to 100 ha).
- Large areas (i.e. 25% for every 1000 ha) of mixed stands containing less than 40 to 60% lodgepole pine should be retained to maintain habitat for such species as fisher and woodland caribou that require contiguous forest cover.
- Patches of at least 0.2 ha of dead lodgepole pine should remain unsalvaged for at least 10 years or until the trees fall down. Larger trees are used by cavity nesters and, if surrounded by non-lodgepole pine species, should resist windthrow.
- Species other than lodgepole pine should be retained for habitat along with small groups (> 0.2 ha) of dead pine. Such a strategy would benefit early seral and generalist wildlife species that rely on forest edges and those that use downed, non-lodgepole pine wood for dens (such as marten).
- Leaving large post-disturbance areas unharvested is beneficial, particularly for aquatic habitats and late seral species.
- Half of the winter range for each known lodgepole pine ungulate should be retained from salvage.

Summary

Natural disturbances create unique habitat types for many forest species. Studies suggest that a proportion of burned, diseased or insect-disturbed stands should be left on the landscape to ensure ecosystem representation of these habitat types over several decades. The first 5 to 6 years in post-fire forests represent the most biologically unique time for those species. Research still needs to address questions of patch size of unsalvaged and salvaged stands and at what temporal stages (i.e. early to late seral) they should be distributed over the landscape.

Management Implications

- Salvage logging of disturbed sites should be considered in the context of a natural disturbance framework from both a stand and landscape level perspective.
- Where possible, partial salvage harvest should become the practice of choice. Retention of post-disturbance deadwood of commercial size should include a diverse range of mixedwood, coniferous and deciduous stands within the landscape. A range of diameter, tree species and clumps vs. single tree retention patterns will provide habitat diversity for post-disturbance species.
- Snags with a minimum of 10 cm dbh are required for some post-fire species. Larger diameter (at least 40 cm dbh) snags should also be retained for nesting.
- Research suggests that in order to emulate natural disturbance, the number of snags to be retained should be increased by up to 50-fold for less naturally dense sites.
- Key post-fire species, such as woodpeckers, may be sustained by unsalvaged patches of around 600 ha in size.
- If salvage logging is primarily for pulpwood, delayed harvest of at least two years is recommended. A delay would allow for a window of habitat available for species that are associated with post-fire conditions.
- In mountain pine beetle-affected forests, large areas (up to 1000 ha) can be salvage logged provided that patches (10-100 ha) of unsalvaged forest are maintained to create contiguous cover for some species.
- Riparian areas should not be salvage logged in order to maintain coarse woody debris supply, reduce sedimentation and maintain stream conditions for sensitive aquatic organisms.

Further reading

Brais, S., Paré, D. and R. Ouimet. 2000. *Impacts of wildfire severity and salvage logging on the nutrient balance of jack pine and black spruce boreal stands.* For. Ecol. and Manage. 137: 231-243.

Bunnell, F.L., Squires, K.A., and I. Houde. 2004. *Evaluating effects of large-scale salvage logging for mountain pine beetle on terrestrial and aquatic vertebrates.* Mountain Pine Beetle Initiative, Working Paper 1

Hutto, R.L., 2006. *Toward meaningful snag-management guidelines for postfire salvage logging in North American Conifer Forest.* Cons. Bio. 20(4): 984-993.

Nappi, A., Drapeau, P. and J.-P.L. Savard. 2004. S*alvage logging after wildfire in the boreal forest: Is it becoming a hot issue for wildlife?* For. Chron. 80(1): 67-74.

Purdon, M., J. Noël, J. A. Nappi, P. Drapeau, B. Harvey, S. Brais, Y. Bergeron, S. Gauthier et D. Greene. 2003. *The impact of salvage-logging after wildfire in the boreal forest: lessons from the Abitibi.* Reseach Note. Chaire industrielle CRSNG UQAT-UQAM. Knowledge and Technology transfert document produced by the NSERC UQAT-UQAM for industrial and government partners of the forest sector. http://web2.uqat.ca/cafd/accueilF.asp

Schmiegelow, F.A., Stepnisky, D.P., Stambaugh, C.A. and Koivula, M. 2006. *Reconciling Salvage Logging of Boreal Forests with a Natural-Disturbance Management Model.* Cons. Bio. 20 (4): 971-983.

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