EMEND





ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #9

Ecological Messages:

- White spruce retention patches maintained saproxylic beetle assemblages similar to those of intact forests, but assemblages in the harvested matrix were very different.
- Negative edge effects were evident in small and medium patches, especially for predatory and fungus-feeding beetles.
- Retention patches larger than 3.3 ha better conserve saproxylic beetle assemblages than do smaller patches.

Management Implications:

- Retention patches of all sizes maintain biodiversity of saproxylic beetles better than clear-cuts.
- White spruce retention patches larger than 3.3 ha are recommended to provide sufficient interior habitat for saproxylic beetle conservation.
- Strictly emulating the many small retention patches (< 1 ha) left by wildfires will likely do less to conserve saproxylic beetle assemblages characteristic of natural white spruce stands.

Retention patch size influences saproxylic beetle conservation in white spruce stands

Research Led By Seung-Il Lee, John Spence, David Langor, and Jaime Pinzon

Biodiversity conservation is central to sustainable forest management, and retention of living trees has been promoted as a way to achieve this in harvested stands. Patches of residual trees (retention patches) play a pivotal role as 'life boats', providing habitat for species characteristic of forest interiors while the surrounding forest regenerates.

Xylotrechus undulatus, a long-horned beetle. Photo by Seung-Il Lee.

One group that might benefit from these life boats is saproxylic beetles – beetles associated with dying or dead trees. Saproxylic beetles are extremely diverse, and they are well known to be vulnerable to traditional forestry practices. Locally co-occurring saproxylic species inhabiting the full range of deadwood decomposition are known as 'assemblages'.

Retention patches provide the dead and dying wood that supports assemblages of saproxylic beetles, but how large must these patches be to be effective for conservation? We addressed this question in 10-year-old boreal white spruce blocks harvested in northwestern Alberta in 2000. We tested for patch size and edge effects on saproxylic beetles in patches ranging from 0.6 to 5.9 ha.

Our results show a positive effect of retention patches on beetle assemblages regardless of patch size, meaning that even small patches provide conservation benefits over clear-cuts. We also found edge effects that negatively affected some species in both small (0.6–1.1 ha) and medium patches (1.4–2.9 ha). Thus, large retention patches (≥ 3.3 ha) will likely better maintain saproxylic beetle assemblages similar to those in intact forests.

There is no single threshold patch size that is ideal for retaining all forest biota, but for species needing interior forest habitats, bigger is generally better. Patches larger than 3.3 ha are better than smaller patches for conserving saproxylic beetles on harvested landscapes. ***Read on to find put more . . .***

The context: retention forestry

Retention forestry attempts to balance timber production and conservation by leaving live merchantable trees behind in harvested stands. Retained trees might be distributed relatively evenly throughout the cut-block ('dispersed retention'), or they can be aggregated in patches ('aggregated retention'). A central objective of leaving these residual trees is to provide habitat and structure in order to retain biodiversity across the landscape. Eventually, this biodiversity will aid with the recolonization of regenerating stands.

While the value of retention patches is increasingly recognized, there is no consensus about a standard threshold retention patch size for biodiversity conservation. Different species likely require different patch sizes, depending on their size, mobility, and resource requirements. Nonetheless, relatively small patches (≤ 1 ha) are known to be insufficient to maintain insect assemblages similar to mature forest.

Importance of saproxylic beetles in deadwood ecosystems

Saproxylic organisms are critical to forest ecosystem function because they play important roles in nutrient cycling. Their use of dying trees or woody debris as food and habitat returns nutrients to forest soils. Saproxylic beetles are also highly diverse, including a large number of species and ecological functions.

Different saproxylic beetle species have different habitat requirements, and the presence and absence of species provides information about habitat availability and quality. Understanding these assemblages can contribute to effective deadwood management, which is increasingly accepted as a critical part of sustainable forest management. In addition, saproxylic beetles are significant indicators of habitat loss and fragmentation in forest ecosystems.

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).

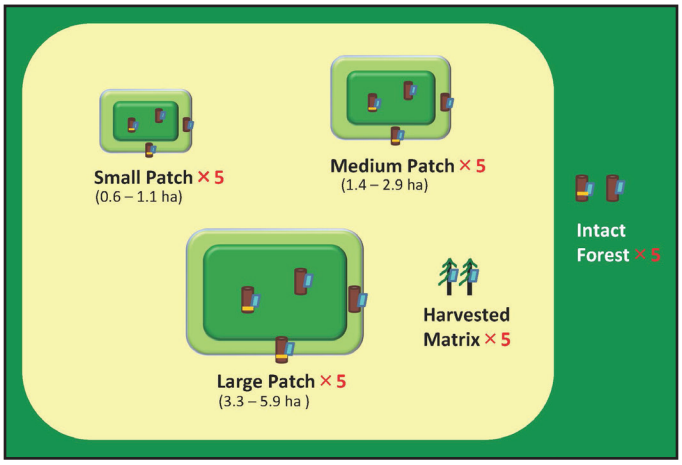

Figure 1. Window traps were attached to snags and girdled trees at the center and edge of each patch, within the harvested matrix, and in the intact forest.

Study design

This work was conducted in three large industrial harvest blocks (44 ha, 105 ha, and 379 ha) dominated by white spruce (*Picea glauca*) in northwestern Alberta, Canada. These blocks were harvested in 2000, and various sizes and shapes of retention patches were left as an early attempt to create a natural disturbance-inspired harvest design.

Saproxylic beetles were sampled using window traps attached to snags and girdled trees in 2010 and 2011. Sampling occurred in 15 retention patches of three size categories: small, 0.6–1.1 ha; medium, 1.4–2.9 ha; and large, 3.3–5.9 ha. Traps were installed at the centers and edges of retention patches to explore edge effects. Harvested areas (the 'harvested matrix') and nearby intact forests ('control') were also sampled to better understand the effects of retention patches (Figure 1).

Research questions

How effective are retention patches of white spruce for saproxylic beetle conservation on harvested mixedwood landscapes?

What is the optimal patch size required to maintain this functionally important group of beetles on harvested landscapes?

Main findings

Retention patches: something is better than nothing, but bigger is better

Saproxylic beetle assemblages in the harvested matrix strongly differed from those of retention patches and intact forests. Assemblages in the middle of all patches more closely resembled those of intact forests, but the assemblages at the edges of small and medium patches did not. **Beetle assemblages at the middle of small patches were clearly affected by edge effects because they had little or no interior habitat remaining.**

Different feeding guilds – groups of species defined by their main food source – showed different responses to patch size. Predators and fungus-feeders were negatively influenced by proximity to edge in small and medium patches. In contrast, edge effects were not found for phloem-feeders, such as bark beetles. The most common species in each feeding guild were absent or uncommon in the harvested matrix. **Together, these results emphasize that retention of patches is better than leaving no patches at all, but the interior habitat in larger patches (≥ 3.3 ha) better conserves many species.**

Peltis fraterna, a fungus-feeding species of the bark-gnawing beetle family. Photo by Seung-Il Lee.

Quality, not just quantity

Although downed deadwood volume was similar among treatments, the quality of deadwood varied. Different saproxylic beetle species require deadwood with different degrees of decay, meaning that a full spectrum of decay levels is needed to support diverse assemblages. No deadwood of early or advanced decay classes was found in the harvested matrix as sun and wind exposure resulted in most deadwood being dry and only moderately decayed. There was also less deadwood in advanced decay stages at the edges of small and medium patches, compared to intact forests. **Together, these results show that exposure to wind and sun affects habitat quality and likely the composition of saproxylic assemblages. Retention patches clearly supply a broader selection of deadwood quality and hence support a larger range of saproxylic species than does the harvested matrix; however, patches need to be large enough to minimize edge effects.**

A well-decayed piece of downed wood. Photo courtesy Jim Witiw, DMI.

Management implications

Retention patches clearly help to conserve saproxylic beetle diversity, and patches larger than 3.3 ha better conserve species associated with intact forests than smaller patches. **Large patches likely better maintain native saproxylic beetle assemblages by maintaining a greater diversity of deadwood. Although patches less than 1 ha may be more common than large patches following wildfire, larger patches with fewer edge effects likely have greater conservation value.**

There is no single best retention prescription that works for all forest organisms. 'Optimal' conservation strategies will vary according to tree species, stand age, and target taxa. **Forest management that strictly emulates wildfire would maintain many small patches; however, in an era of large-scale and continuous harvest, this strategy may not maximize the conservation value of retention patches.**

Finally we propose two important and timely questions that build on this research to further improve management outcomes:

1. How might large retention patches be optimally distributed in a harvest block to maximize their capacity for conserving habitats and species characteristic of forest interiors?
2. How can the harvested matrix quality be improved to better maintain the structure of retention patches and associated forest specialists?

We conducted a concurrent study exploring the combined effects of retention patches and dispersed retention, which will be covered in a later issue of EMEND Insights. Stay tuned!

Further reading

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WRITTEN BY:

SEUNG-IL LEE, PH.D.

COORDINATING EDITOR: S. ODSEN & M. PYPER
GRAPHICS & LAYOUT: S. ODSEN

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