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How retention patches influence biodiversity in cutblocks

Highlights

- Retention patches serve important functions by increasing landscape heterogeneity and providing source habitats for biodiversity within harvested blocks.
- Patches greater than 1.8 hectares had ground dwelling beetle species and ambient temperatures that were the most similar to mature forest stands.
- Managers looking to supplement natural disturbance patterns with biodiversity research would benefit from increasing the frequency of larger retention patches on managed landscapes.

The Ecosystem 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 harvesting and fire treatments. The research site is located in the western boreal forest near Peace River, Alberta, Canada, and is scheduled to last for an entire forest rotation (i.e., 80 years). As part of the envelope of EMEND studies, researchers have begun to evaluate forest management practices within industrial harvest blocks surrounding (i.e., outside) the EMEND site. This research note explores the role of industrially-deployed retention patches in harvest blocks for conserving ground-dwelling beetle assemblages within mixedwood landscapes in northwestern Alberta.

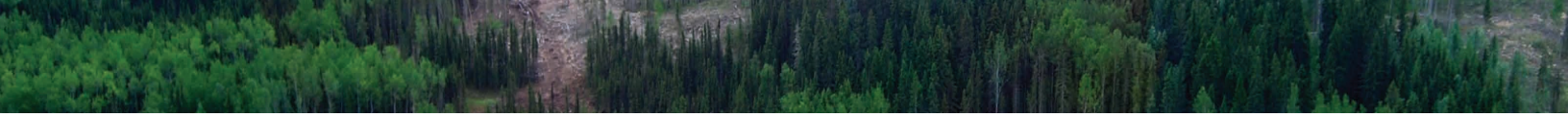
Why the interest in retention patches?

The context

As forest management strategies have evolved to embrace emulation of natural disturbances, new harvesting techniques and patterns are being applied to the landscape. One technique is the use of retention patches, defined as isolated patches of live trees within harvest blocks (Figure 1). Although these patches are maintained for a variety of reasons, a main rationale is to emulate fire 'skips', which contribute heterogeneity to landscapes shaped by wildfire. This heterogeneity is often considered essential for the maintenance of biodiversity on forested landscapes.

Figure 1. Example of a recent harvest block (ca. 136 ha) in the boreal forest of northwestern Alberta. This block incorporates retention both as large patches (clumped) and small clusters of trees (dispersed). Photo courtesy of J. Witiw, Daishowa-Marubeni International Ltd.

Thus, some forest managers looking to emulate not only pattern on the landscape, but also processes, consider that retention patches function to promote recovery of



biodiversity within harvest blocks during regeneration. Retention patches can help to achieve these goals both by maintaining habitat 'life boats', and by providing legacy elements for some organisms (e.g., deadwood). In essence, these patches may serve as sources of biodiversity characteristic of mature forests, while also adding heterogeneity to a landscape.

These functions are critical because perfect emulation of post-fire pattern is extremely difficult, if not impossible. Thus, we suggest that by understanding how retention patches function to promote recovery and maintenance of biodiversity, we can apply this knowledge in the design of harvested landscapes. In turn this may better promote ecosystem processes, such as recovery, rather than relying solely on the emulation of patterns.

Research rationale

Despite the widespread application of retention patches, important questions about their efficacy remain unanswered. For example:

- Do the patches achieve biodiversity objectives?
- What patterns and sizes of patches are needed to achieve biodiversity goals?

In this research note, we summarize the results of a recent study of retention patches conducted in northwestern Alberta, and discuss our findings within in the broader context of natural disturbance emulation. Although an understanding of connectivity within large harvest blocks is of equal importance, this research note focuses on how different retention patch sizes conserve species representative of mature forests.

Do retention patches serve as lifeboats?

It is important to first understand the context in which most studies have addressed this question. To date, most studies in the boreal forest have focused on comparing the biotic composition in retention patches to that of mature, or intact, forest sites to determine possible size thresholds for patches. Studies that directly compare retention patches to similar-sized fire skips are, however, limited. This is because wildfires are highly variable, and are often large distances from each other and from harvested sites with retention patches. Fire 'skips' and retention patches are best studied when they are in close proximity to reduce the confounding effects of geographical variation.

Considering this context, most published studies suggest that retention patches up to approximately 1.5 hectares (ha) in size do not conserve biodiversity representative of mature forests. This conclusion seems to be relatively consistent, even given variation in both study group and region. For example, a study conducted on vegetation communities in boreal mixedwood forest in Alberta found that mature forest communities were not preserved in patches up to 1 ha, the largest patch size studied. Studies on Fennoscandian ground-dwelling spider and beetle communities showed that species representative of mature forests were not maintained in patches up to 0.55 ha, the largest patch size studied.

Patch sizes larger than 1.8 hectares provide life-boating capacity

Given that no studies, to our knowledge, assessed retention patches greater than 2 ha in size, we set out to investigate biodiversity responses to larger retention patches. We aimed to determine if there exists a minimum (i.e. threshold) patch size necessary to preserve species characteristic of mature forests. We sampled patches ranging in size from 0.2 to 14.1 ha, in both deciduous-dominated (primarily aspen and balsam poplar) and conifer-dominated stands (primarily white spruce). We sampled ground-dwelling beetles (families *Carabidae* and *Staphylinidae* of the order *Coleoptera*) as indicators of biodiversity responses to retention patch size. These beetles are effective indicators for biodiversity responses to retention patch size because they are known to respond directly to forest harvesting, particularly at spatial scales relevant to in-block forest management.

In our study, we found a distinct difference in species conservation between patches less than 1.5 ha and those that are between 1.8 and 4.4 ha, in both cover types. In particular, we found that patches less than 1.5 ha were invaded by open-habitat species from the surrounding harvested areas (e.g., Figure 2), limiting the ability of small patches to preserve species representative of the mature forest stands. Larger patches (i.e., that are 1.8-4.4 ha or greater), however, maintained species characteristic of mature forests, and also had higher numbers of species identified as 'mature forest specialists' (Figure 3). These findings demonstrate the value of larger patches in conserving species within harvested stands.

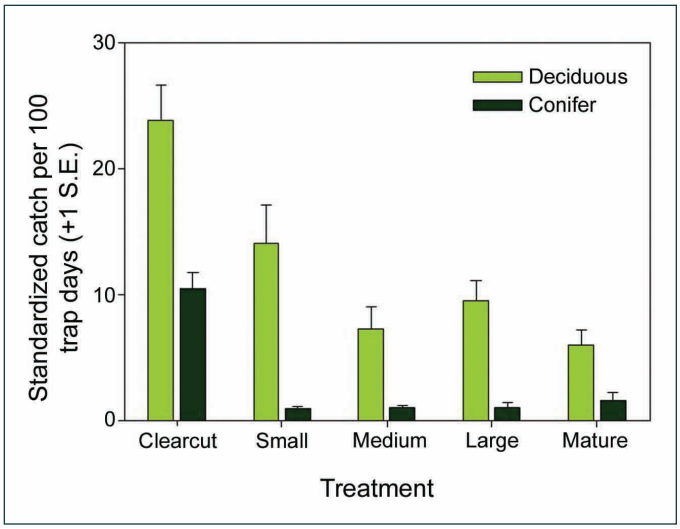


Figure 2. Abundance patterns of *Pterostichus adstrictus*, a significant indicator of deciduous clear-cuts that also had higher abundances in small deciduous patches. Small (less than 1.5 ha); medium (between 1.8 and 4.4 ha); and large (greater than 4.5 ha).

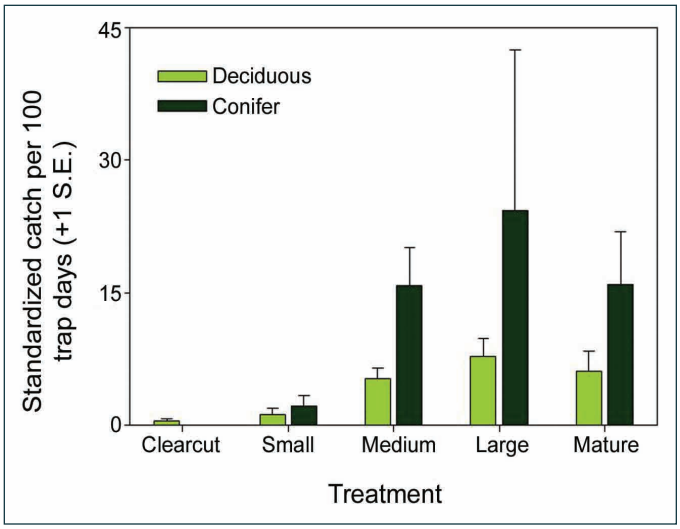


Figure 3. Abundance patterns of *Tachinus frigidus*, a mature forest specialist, that was uncommon within small patches and clear-cuts. Small (less than 1.5 ha); medium (between 1.8 and 4.4 ha); and large (greater than 4.5 ha).

Microclimate is altered in small retention patches

Temperature is another effective indicator of how well retention patches function for conserving biodiversity. If ambient temperatures within retention patches are found to be outside the range of variation within mature forests, habitat within these patches may become unsuitable for some species. We found that small patches (i.e., those less than 1.5 ha) were the only patches to have significantly more variable temperature (higher maximum, lower minimum and higher coefficient of variation) than the mature forest. This suggests that ambient temperature could help explain the patch size threshold observed in the beetle responses. For example, one of the variables measured within these small patches, average minimum temperature, was significantly lower than in any of the forested comparisons (Figure 4). Thus, both the

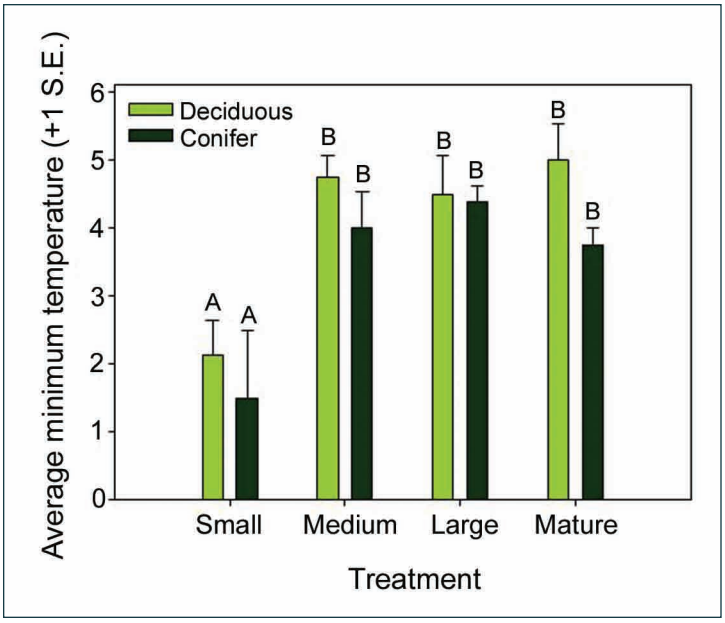
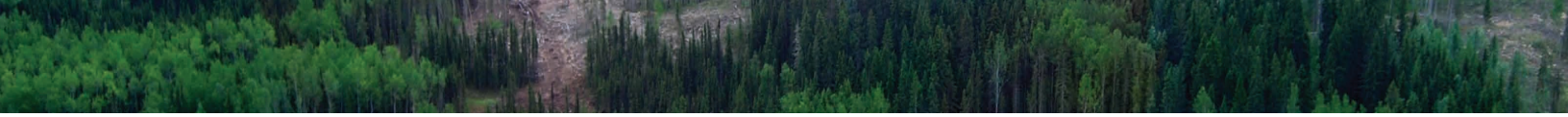


Figure 4. Average minimum temperature in mature forest, and three sizes of retention patches: small (less than 1.5 ha); medium (between 1.8 and 4.4 ha); and large (greater than 4.5 ha).



beetle community and the temperature variability differed between small patches and medium and large patches, as well as mature forest stands.

Variability in patch size is key

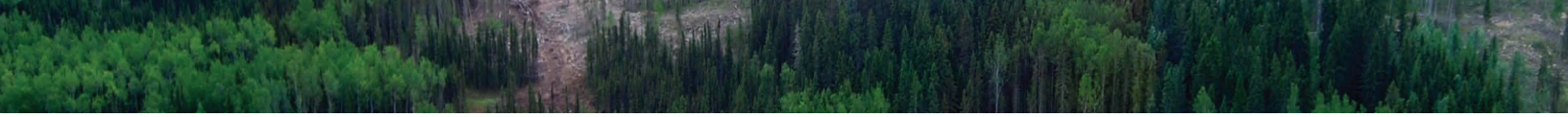
Despite the clear benefits of maintaining larger retention patches to conserve species characteristic of mature forests, we also observed that variability in patch size is key to maximize forest ecosystem recovery following harvest. Boreal forests are naturally complex and highly heterogeneous. Thus, variation in patch size is also expected to help maintain such heterogeneity on harvested landscapes. For example, small patches may not effectively conserve beetle species representative of mature forests, but they may nonetheless contribute legacy elements to the ecosystem. Previous studies have demonstrated that small patches can help maintain a supply of coarse woody debris in regenerating forests, function as stepping stones for dispersing species, and provide natural seed sources for regenerating harvest blocks.

Maintenance of a variety of retention patch sizes on a landscape also better emulates patterns found following natural disturbances such as wildfire. Previous research has demonstrated that patch sizes commonly exceed 10 ha within small fires (i.e., those less than 1,000 ha), and typically increase in size with an increasing disturbance footprint (e.g., skips greater than 70 ha in fires up to 3,000 ha). However, patches less than 1 ha are much more frequent within wildfires than are larger patches. Although emulation of natural disturbance suggests that managers should emulate the patch size distribution of wildfires, our work suggests that increasing the frequency of larger patches (i.e., those that are 1.8-4.4 ha or greater) will best conserve biodiversity following harvest.

Options for managers aiming to match disturbance patterns

Given previous research findings about variability in patch sizes after disturbance, as well as the importance of larger patches in conserving biodiversity within large harvest blocks documented here, we recommend the following:

1) Natural disturbances provide a reasonable baseline for patch size distributions within harvest blocks because of the emphasis on variability.
2) Managers should, however, increase the frequency of larger retention patches to increase the benefit for biodiversity and ensure the preservation of habitats with more consistent temperatures.
3) This study looked at harvest blocks 110-400 ha in size. We hypothesize that meeting biodiversity targets in larger harvest blocks will be facilitated by leaving even larger retention patches, at a greater frequency, following the trend that is typically observed following wildfires. It will also be increasingly important to explore issues of connectivity within these larger disturbances.



Further reading

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Management Implications

- Retention patches that are 1.8-4.4 ha or larger, a size that is greater than that deployed under most current harvest plans, conserve beetle species and microclimate conditions that are characteristic of the mature forest.
- Managers should vary patch sizes to emulate the natural landscape heterogeneity found in the boreal region.
- We hypothesize that as harvest blocks increase in size, leaving even larger retention patches will more effectively conserve species characteristic of the mature forest within the overall harvest footprint.
- Questions still remain concerning the optimum distribution of large and small patches, as well as issues of connectivity for species with larger home ranges, thus research-derived answers to these questions will improve management prescriptions.

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Ecosystem Management Emulating Natural Disturbance

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