EMEND





ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #20

Ecological Messages:

- Variable retention management (including clear-cutting) led to rapid species composition change over 15 years, peaking at year ten.
- Over 15 years, clear-cuts had the most dramatic species composition change, while stands with 10% or more green-tree retention experienced a more rapid return of pre-harvest species.

Management Implications:

- The benefit of retention harvesting for ground beetles was mainly evident after 15 years following a ten-year period of substantial species composition change.
- The benefits of dispersed retention were most obvious in deciduous-dominated stands. For conserving old-forest species of coniferous and mixedwood forest, high dispersed retention levels or alternate retention patterns may be needed.

Benefits of green-tree retention for ground beetles take time

Research led by Linhao Wu, John Spence, and Fangliang He

Forest floor invertebrates are easy to miss unless you look for them. And yet, they are an important component of forest biodiversity. Beetles, spiders, ants, springtails, snails and many more make up complex webs of herbivores, predators, fungivores and decomposers, and they are sensitive to disturbance—including forest harvest. For this reason, they are often used as ecological indicators: when invertebrate communities change, it suggests changes to the forest as a whole. This means they can also be used to keep track of how forests change following disturbance.

This long-term study revealed patterns of species composition change that simply could not have been detected within the typical <5-year lifespan of most field studies. Ground beetle assemblages—species and their relative abundances—diverged from their pre-harvest state, changing more and over the course of the first post-harvest decade. **But after 15 years, return of pre-harvest assemblages was evident in the stands with any level of retention (i.e., ≥ 10%) but not in the clear-cuts.**

The benefits of green-tree retention were most evident in the deciduous-dominated stands. In coniferous and mixedwood stands, aspen regeneration within the harvested matrix has led to the recovery of beetle assemblages more typical of deciduous forests. The effects of planting and silviculture on beetle diversity remains to be seen, including whether they help support beetle assemblages more characteristic of coniferous and mixedwood forests.

Forest floor invertebrates collected in a pitfall trap, a standard field collection technique. Photo by J. Pinzon (Canadian Forest Service).

Small insects, big diversity

Invertebrate monitoring has been a long tradition at EMEND, and for good reason. Insects and spiders represent a substantial part of forest biodiversity and are regularly used as indicators of forest function and change. Among these, ground beetles (also known as carabids) are an excellent subject for ecological studies. This group is species-rich, relatively easy to identify, and easy to collect. Ground beetles have been widely used as indicator species to help researchers measure the success of sustainable forest management across the globe.

Our objective was relatively straightforward. Using data starting the year before harvest at EMEND, we tracked the change of beetle composition over time in the different retention treatments. We asked the following questions:

- How does retention harvesting affect the trajectory and degree of beetle species composition change?
- What is the effect of the forest type being harvested?

The legacy of data collected at EMEND has uniquely positioned us to answer these questions.

Methods

Ground beetles were collected at EMEND in the pre-harvest year (1998) and 1, 2, 5, 10, and 15 years following harvest. We collected samples in the unharvested controls, clear-cuts, and stands harvested leaving 10%, 20%, 50%, and 75% dispersed retention.

Key Findings

Retention harvest accelerated return of old-forest assemblages

Even the lowest retention treatment at EMEND (10%) was more effective at conserving and recovering forest beetle assemblages (species and their relative abundances) than clear-cutting, as evident by the changes to species composition over time. The trajectory of change was not, however, straightforward.

From two to ten years after harvest, beetle assemblages showed a clear impact of harvesting; while higher retention treatments had a lower effect on species composition, this species composition continued to change over time as species were gained, lost, and became more or less abundant (Fig. 1). The most dramatic changes to species composition were observed within the first ten post-harvest years, particularly within the clear-cuts and lowest-retention treatments. After ten years, species of unharvested forest began to re-colonize harvested stands with retention; however, this level of recolonization was not apparent in the clear-cuts, which continued to change.

After fifteen years, the benefits of the structure left behind during retention harvest were most obvious, particularly in lower-retention stands. By this time, beetle assemblages in stands with any amount of retention shifted toward those of later-successional forest (Fig. 1). However, a similar trajectory of beetle assemblage change was not evident in the clear-cuts, likely because of the limited complexity of forest structure within the regenerating, dense, even-aged aspen of the harvested matrix (and the differences in habitat conditions created within these stands).

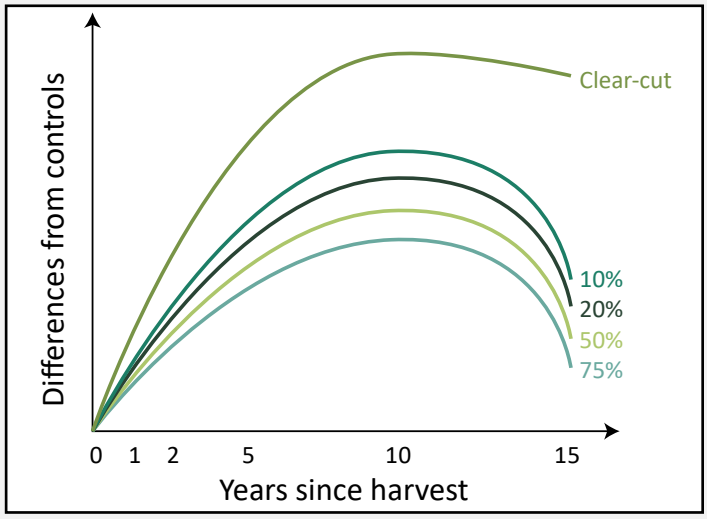


Figure 1. Conceptual diagram illustrating the trajectory of beetle assemblage change following harvest. Species composition in clear-cuts continued to change along a different trajectory than stands with retention after 15 years.

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).

Natural regeneration affected trajectories of species composition change

Beetles in originally coniferous or mixedwood stands demonstrated some return of species of unharvested forest after 15 years, but this was less pronounced than in deciduous stands. Species composition in coniferous and mixedwood stands also shifted to more closely resemble the assemblages found in deciduous-dominated forest.

We suspect these differences can be attributed, at least in part, to the natural regeneration of aspen within the harvested matrix. The habitat features produced by spruce (e.g., microclimate, needle litter, a moist and mossy forest floor, etc.) would not be available to the beetles that rely on them, particularly in low-retention stands.

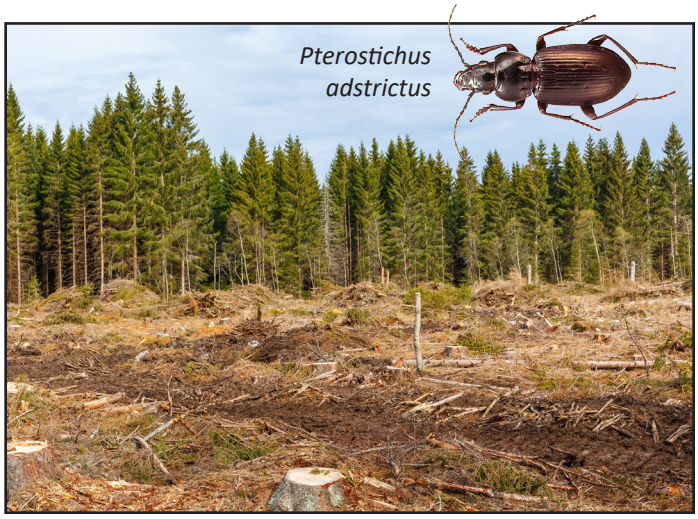
It remains to be seen whether retention harvests that have undergone conifer planting, silviculture, and/or mixedwood management would further accelerate the return of ground beetle assemblages typical of coniferous or mixedwood forest. It is possible that accelerated spruce regeneration may improve habitat quality for some beetle species—it is also possible, however, that the resulting simplification of structure and vegetation would offset any benefits. More research is needed to assess ground beetle species composition change within retention harvests managed for spruce regeneration.

Management Implications

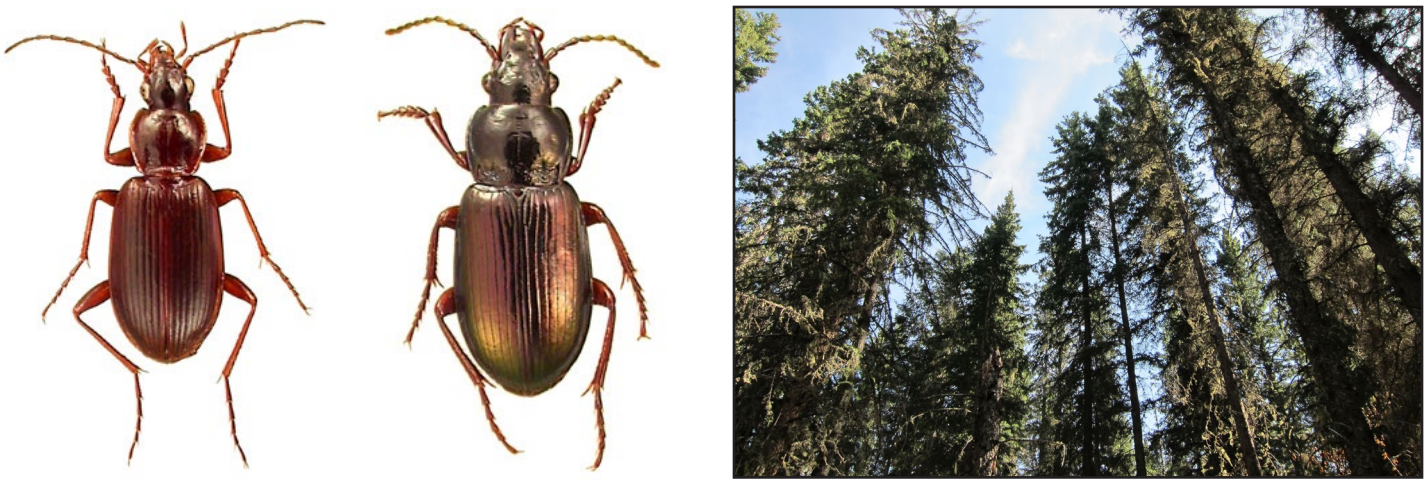
Harvests leaving 10% green-tree retention or more are recommended to accelerate the successional change of ground beetle assemblages on harvested landscapes. Responses in the clear-cuts, in contrast, raise the question of how long it will take for them to support the beetle biodiversity that existed before harvest—or whether they ever will. ***On heavily-managed landscapes with low amounts of older forests, green-tree retention will be a valuable tool for expediting beetle successional changes not apparent in clear-cuts after 15 years.***

However, the changes to species composition among treatments over time remind us that variable retention levels (including clear-cuts) increase overall forest biodiversity compared with relying on a single harvest prescription. An important benefit of variable retention harvest is that it reduces the homogenization of forest habitats, and the faunal communities found within them, compared with a single-prescription approach.

The less dramatic benefits of retention for beetles associated with coniferous or mixedwood forests suggest that retention with a leave-for-natural regeneration strategy may not yield the same benefits in these forest types compared with deciduous forests. It will be necessary to determine whether dispersed retention followed by spruce planting will better benefit ground beetles that typically occupy unharvested coniferous or mixedwood forests. Meanwhile, evidence from other studies may support the use of patch retention in these stands to life-boat species more closely associated with spruce in the canopy (see EMEND Insights #9).



Pterostichus adstrictus is a habitat generalist that is found in open habitats. This species dominated clear-cut stands right after harvest. Beetle photo by Henri Goulet (Canadian Biodiversity Information Facility).



Calathus advena (left) and Stereocerus haematopus (right) are forest specialists associated with mature conifer forests. Beetle photos by Henri Goulet (Canadian Biodiversity Information Facility); forest photo by S. Odsen.

Further reading

Niemelä J., Spence J.R. and Spence D.H. 1992. Habitat associated and seasonal activity of ground-beetle (Coleoptera, Carabidae) in central Alberta. The Canadian Entomologist 124: 521–540.

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