EMEND





ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #7

Ecological Messages:

- Understory plants are essential to forest health, and pollinators are essential to understory plants. Harvesting affects plants and pollinators by changing environmental conditions.
- Harvesting changed the species of plants growing in a cut block, while increasing total flower abundance. However, the amount of nectar produced per flower remained constant in forests of all retention levels.
- Foraging bumble bees became less efficient at using their floral resources, even in adjacent unharvested forests. Generally, there were fewer bumble bees than expected in areas with many resources, and too many bumble bees in areas with few resources.

Management Implications:

- To mitigate both the short- and long-term impacts of harvesting on bumble bees and bee-visited plants, a mix of low (10–20%) and high (50–75%) retention levels should be used across the landscape.
- Instead of a dense, regular pattern of small clear-cuts and reserve blocks, where unharvested forest is rarely > 1 km from a clearcut, larger unharvested reserves should be incorporated into harvest planning, and be common on the landscape.

Bumble bees and cut-blocks: how harvesting affects forest pollinators

Research Led By Chris Pengelly and Ralph Cartar

Within the boreal forest a dynamic interplay is taking place between understory plants and bumble bees—bumble bees depend on flowers for their nectar and pollen, and flowers depend on bees for pollination. But what happens to this dynamic relationship when we introduce forest harvesting into the mix?

We conducted field experiments at EMEND to determine the impacts of forest harvesting on pollinators and understory plants. We also assessed the value of variable retention harvesting for these species.

We found that, by changing the forest environment, harvesting caused bees to fall "out of sync" with understory flowers, even within adjacent unharvested forests. After harvesting, more bees were found in areas with fewer flowers, and fewer bees in areas with more flowers, than expected compared to pre-harvest conditions.

Eight years after harvesting, we found that stands with 10–20% retention minimized the impacts on bumble bees and their relationship with understory plants. However, the impact of harvesting on the surrounding unharvested forest suggests that pollinators and understory plants would benefit from leaving larger unharvested reserves between harvest blocks. Read on to find out more…

The interplay between understory plants, pollinators and harvesting

From their economic importance to the shade they provide on a summer's day, trees steal the show. So why do the forest understory and its associated pollinators also matter? To start with, understory plants may represent 90% or more of a forest's plant biodiversity. They also assist in nutrient cycling and nutrient retention at disturbed sites, ensuring vital resources are not washed away. Understory plants also regulate (and participate in) ecological succession. For example, competition between understory plants and tree seedlings can alter forest growth and development such that different understory compositions may result in fundamentally different mature forests.

So how do these understory plants relate to pollinators like bumble bees? Since many understory plants are flowering species, they rely on pollinators for reproduction. Similarly, pollinators rely on nectar and pollen from these plants to survive. Thus, interactions between understory plants and pollinators—like bumble bees—are a vital aspect of forest health. Large-bodied insects like bumble bees can forage across several square kilometers, and their foraging choices affect the success of understory plants over broad spatial scales. Understanding how these interactions are affected by harvesting should therefore be of considerable interest to land managers.

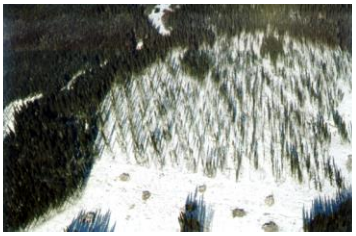
About EMEND:

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).

EMEND facilitates experimental comparison of variable-retention harvesting regimes

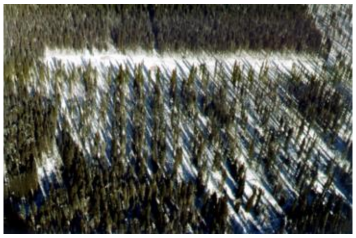
We examined nectar production, flower abundance, and bumble bee abundance through two separate studies at EMEND. One examined the nectar production rates of four flowering species at sites that retained 0% (i.e., clearcut), 50%, and 100% (i.e., unharvested) of original green trees. The second study compared flower and bumble bee abundance within and among sites that retained 0%, 10–20%, 50–75%, and 100% of original green trees. Both studies examined forests 8–9 years after they had been harvested to assess the effects of harvesting.

Clear cut

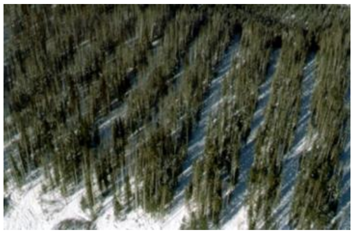


10% retention

20% retention



50% retention



75% retention

Harvesting had little effect on nectar production

Harvesting generally results in more light and higher temperatures compared to conditions in the unharvested forest. These conditions usually favour increased nectar production per flower, and led us to predict that flowers in sites with lower retention levels would have higher nectar production rates. However, this was not the case. Three of the four target species showed no response in nectar production rate to harvesting regime, while the fourth showed an elevated nectar production rate only in the 50% retention treatment. **Thus, harvesting had little effect on nectar production per flower, regardless of the degree of retention.**

Harvesting increased flower and bee abundances, but changed the way they interact

Although harvesting did not alter nectar production per flower, all harvest treatments had increased flower abundance and diversity compared to the unharvested forest. Because these effects differed among species, the relative abundance of species—the composition of the flower community—changed. Specifically, the flower community in the retention treatments (10–20% and 50–75% retention) was more similar to that in unharvested forest than was the community in clearcut sites. **Thus, retention harvesting left the composition of the floral community more intact than did clearcutting.**

We predicted that the number of bumble bees found in a given area should "match" with the number of flowers in that area, so that an area with 1% of the total flowers (and nectar availability) at EMEND would have 1% of the total bumble bees, and so on. That way, bumble bees would be foraging most efficiently and be "in sync" with flower abundance. As expected, bumble bees were in sync with the number of flowers prior to harvesting, but our previous work had shown that, immediately after harvesting, this was no longer the case in clearcut and low-retention (10–20%) sites, yet was still the case in high-retention (50%–75%) sites.

Our recent work revealed that even 8–9 years after harvesting, bumble bees at some sites remained out of sync with flowers, but that the overall picture had changed. Bumble bees at the low-retention (10–20%) sites were now in sync with both flower abundance and nectar availability. By contrast, bees at clearcut and high-retention (50–75%) sites were now in sync with flower abundance, but not with the nectar actually available in those flowers. This implies random and inefficient nectar use and, by association, inefficient pollination, altering the fitness of both bees and the flowers they pollinate.

Harvesting altered the bumble bee–flower relationship in adjacent unharvested forest

Surprisingly, the effects of harvesting were especially clear at unharvested sites, and persisted through time. Bumble bees in adjacent unharvested forest changed the way they occupied sites, even 8–9 years after harvesting. Compared to before harvesting, there were too many bees in poor quality patches, and too few in good ones. The spatial scale of the effect of harvesting on bumble bee–flower relationships in unharvested sites is unclear from our work. However, it is likely more than 1 km, the foraging range of the bumble bees we studied. Thus, harvesting disturbed the flower–pollinator relationship within adjacent unharvested forest by causing bees to visit flowers randomly, rather than based on flower or nectar density.

Two species of bumble bees studied at EMEND: Bombus perplexus (left) and Bombus sylvicola (right).

Management Implications

Harvesting affected understory flowers regardless of treatment, but clearcutting had the greatest effect compared to unharvested forest. Immediately after harvesting, high-retention (50–75%) sites appeared most favourable to understory pollinators and plants. **Nearly a decade later, low-retention (10–20%) harvesting was the least disruptive to the understory pollination community.** Thus, to mitigate both the short- and long-term impacts of harvesting on bumble bees and bee-visited plants, a mix of high (50–75%) and low (10–20%) retention levels could be used across the landscape.

Meanwhile, the effects of harvesting extended into adjacent unharvested forest, disturbing flower-pollinator relationships. **This strong impact of edge effects on bumble bees and plants means that large unharvested reserves will be most effective at conserving bumble bees and bee-visited plants.** That is, instead of a dense, regular pattern of small clear-cuts and reserve blocks, where unharvested forest is rarely > 1 km from a clearcut, **larger unharvested reserves should be incorporated into harvest planning, and be common on the landscape.**

References

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