EMEND





ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #10

Ecological Messages:

- Forest-dwelling gastropods are strongly associated with deciduous stands, where understory plants and leaf litter provide high-quality habitat and microclimate conditions on the forest floor.
- Although no gastropods were strongly associated with coniferous-dominated stands, gastropods do respond to variation in tree species at finer scales; for example, some species positively responded to patches of spruce within aspen-dominated stands.
- Nine years after harvest, clear-cut and low retention (10% and 20%) stands had higher abundances of gastropods, and different species, than did high retention and unharvested stands.

Management Implications:

- Managing to ensure small-scale variation in tree species would be good for some species, including gastropods.
- Green tree retention and fine-grained mixes of canopy species contribute to local habitat heterogeneity, which seems to be key to supporting a diverse range of boreal gastropod species.

Gastropods: Slugging Away at the Ecology of a Little-Known Forest Animal

Research Led By Suzanne Abele, Ellen Macdonald, and John Spence

We tend to think of biodiversity in Alberta's boreal forest in terms of the trees, mammals, and songbirds that we see. Often, though, the least visible components of our forests can be incredibly important. Slugs and snails, known as "gastropods," are among the less studied organisms contributing to biodiversity on the forest floor. These sticky invertebrates contribute to nutrient cycling by eating dead leaf matter, and may also shape the forest understory by grazing selectively on plants and seeds.

Boreal gastropods have not been well-studied. We don't know much about where they live in the boreal forest, much less how they respond to forest harvesting. This study conducted at EMEND addressed these crucial information gaps, and revealed both coarse- and fine-scale responses of gastropods to forest habitats.

In unharvested stands, gastropods were most abundant in deciduous (aspen) stands. They were also sensitive, however, to fine-scale variations within each of the four stand types. Different species were found near non-dominant trees. For example, even a small patch of spruce in an aspen stand attracted higher abundances of some species.

In harvested stands, gastropods were most abundant in clear-cuts and low (10% and 20%) retention stands, but some species became increasingly dominant while others were diminished. As above, gastropods were also sensitive to fine-scale habitat differences. For example, in high retention stands, machine corridors supported different kinds of species than the retention strips immediately next-door.

These results emphasize the importance of planning for stand-level heterogeneity, whether by ensuring diversity of canopy tree species or by varying the spatial distribution of retention trees of different species. When we manage at the landscape scale, it is easy to forget the local habitat variation that supports different groups of organisms that are not so obvious to us, like gastropods. This study presents exciting new findings on a subject that has, until now, received little attention. ***Read on to find out more. . .***

Boreal snails: a little-studied group

Slugs and snails can be garden pests, but they also play an important role in boreal forest ecology. These organisms, known as "gastropods," contribute significantly to leaf litter decomposition on the forest floor – the first steps in nutrient cycling. Herbivorous gastropods may even eat enough plants and seeds to affect the kinds of plants that grow in the forest understory. Gastropods are also important food for other organisms. Some beetle species, for example, have evolved specialized body parts that allow them to eat snails, while birds can use the calcium in snail bodies for egg production. And, despite their cryptic habits, gastropods are more abundant than most imagine.

While gastropods have potentially important roles in the boreal forest, their ecology is not well understood in the boreal region. Thus, there is little information on how to manage forests in ways that protect or conserve boreal gastropods.

Our research at EMEND addressed major knowledge gaps about the relationships between gastropods, forest composition, and forestry. We asked two main questions:

1. Does gastropod diversity vary by forest cover type?
2. How do gastropods respond to forest harvesting across a range of green tree retention levels?

To address the first question, we compared gastropods in four forest tree cover types at EMEND:

- Deciduous-dominated (DDOM): >70% broadleaf trees (mainly trembling aspen)
- Deciduous-dominated with spruce understory (DDOMU): >70% broadleaf trees in the canopy, with an evident coniferous understory (mainly white spruce)
- Mixedwood (MX): 40-60% each broadleaf and coniferous tree cover in the canopy
- Conifer-dominated (CDOM): >70% coniferous trees in the canopy (mainly white spruce)

To address the second question, we compared gastropod responses in clear-cuts and across a range of partial retention treatments (10%, 20%, 50%, and 75%), as well as in unharvested control compartments for the mixedwood tree cover type (MX). The EMEND harvest treatments had been applied nine years before this study was conducted, so these data provide a measure after nearly 10 years of recovery.

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).

How do we sample gastropods?

We used two techniques to make sure we captured as many species as possible.

- Board traps: 25 x 60 cm Masonite hardboards were embedded under the leaf litter; gastropods found attached to the boards were collected at periodic visits and preserved in ethanol for identification in the lab.
- Soil samples: soil samples were dried, passed through graduated sieves, and searched visually in the lab under magnification for snail shells.

The slug species, Deroceras laeve, was found exclusively on the board traps. Photo by Jozef Grego.

Main findings

Prescriptions that enhance stand level diversity are important for gastropods

We observed the highest numbers and most species of gastropods in deciduous-dominated (DDOM) stands. This is not surprising given that gastropods are usually associated with deep leaf litter in forests. These habitats generally have higher soil calcium, which is important for building snail shells, and contain more understory vegetation, which provides food and shelter against drying out. In contrast, coniferous-dominated (CDOM) stands were not strongly associated with any species – these stands have acidic soils with low calcium availability, and provide limited food and shelter on the forest floor.

An unexpected finding was that fine-scale variation in tree species composition fostered diversity in gastropods. Specifically, gastropod composition (species and their relative abundances) changed close to a non-dominant tree or patch of trees. **In fact, different gastropods were found near coniferous trees in DDOM stands than where no conifers were present; likewise for deciduous trees in a CDOM stands.**

These findings have important implications for managing biodiversity in forests. Forest managers increasingly focus on "landscape-level effects," but in this study, and those of other invertebrates, we find that small-scale variation has a strong effect on species diversity. Forest stands with fine-grain mixes of tree species support specific sets of gastropods, which may become less common in stands that are strongly dominated by just one tree species.

The snail species, Zonitoides arboreus, was strongly associated with broadleaf (DDOM) stands. Photo by Scott Bauer, USDA Agricultural Research Service.

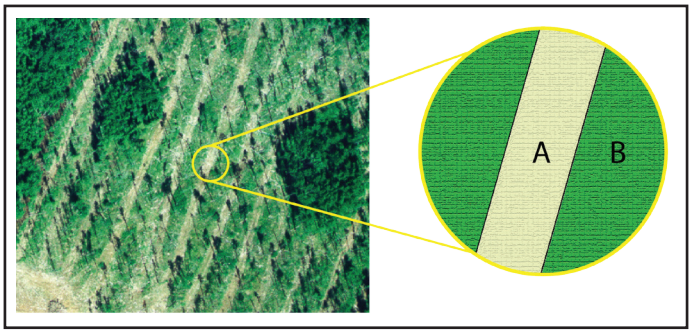

Figure 1. Aerial view of a recently harvested high-retention stand at EMEND. The machine corridors (A) and retention strips (B) are clearly visible.

Gastropod abundance increases following harvesting

Nine years after harvest, gastropods were more abundant in intensely harvested blocks (20% retention or lower) than they were in high retention and unharvested blocks. In other words, gastropods were positively related to harvest intensity nine years after harvest; this may have been due to a flush of understory plants in harvested stands.

While the number of slugs and snails increased with harvest intensity, gastropod species composition changed. In fact, the species composition of low retention stands differed significantly from high retention and unharvested stands. At least two species were negatively affected by harvest, while others became more dominant.

Gastropods are sensitive to variations in harvest patterns

Overall harvest effects on gastropods were evident, but when we zoom in, we find that gastropods were also sensitive to harvest patterns on a smaller scale. Harvest prescriptions produced patterns of machine corridors which were completely cleared, alternating with retention strips from which trees were removed according to the treatment (Fig. 1). Nine years later, these machine corridors had seen a lot of regrowth, but the local variation generated by harvest prescription continued to influence gastropod diversity patterns.

At high retention levels (e.g. 75% retention), machine corridors had higher gastropod abundances than the retention strips, but at low retention levels (e.g. 20% retention), this pattern was not observed. The species composition observed in machine corridors also differed between low and high retention treatments. **Simply put, gastropods were sensitive to the fine-scale differences between machine corridors and retention strips.**

Management implications

Our study revealed gastropod responses to forest habitats at both coarse and fine scales. At a coarse scale, gastropods were more abundant in unharvested DDOM stands than in other stand types; in recently harvested MX stands they were more abundant at lower retention levels (20% and lower). Unlike many other taxa studied at EMEND, gastropods showed a positive overall response to harvesting, at least nine years post-treatment. This is broadly speaking, of course – while many species increased in numbers, two species showed a clear negative response to harvesting.

At a smaller scale, gastropods were sensitive to fine-grained habitat variation within stands. Deciduous stands contained one general set of species, but the presence of even a single coniferous tree provided habitat that supported different species in the immediate vicinity. Likewise, high retention treatments supported species composition typical of unharvested stands, but different species were nevertheless found in the younger, more open machine corridors.

The key takeaway for management, then, is that stand-level planning is important. Managing forests only at a landscape level ignores significant stand level heterogeneity that characterizes the boreal forest and has much impact on many elements of biodiversity. By managing to ensure fine-scale variations in canopy composition – e.g., non-dominant tree species or variable harvest patterns – higher gastropod diversity and abundance can be supported.

Further reading

Abele, S.E. 2010. Gastropod diversity in the boreal mixedwood forest of northern Alberta – variation among forest types and response to partial harvesting. M.Sc. Thesis, Department of Renewable Resources, University of Alberta, Edmonton, AB.

Abele, S.E., S. Ellen Macdonald, and J. R. Spence. 2014. Cover type, environmental characteristics, and conservation of terrestrial gastropod diversity in boreal mixedwood forests. Canadian Journal of Forest Research. 44(1): 36-44.

Ström, L., K. Hylander, and M. Dynesius. 2009. Different long-term and short-term responses of land snails to clear-cutting of boreal stream-side forests. Biol Conserv 142: 1580-1587.

Suominen, O., L. Edenius, G. Ericsson, & V.R. de Dios. 2003. Gastropod diversity in aspen stands in coastal northern Sweden. Forest Ecol Manag 175: 403-412.

WRITTEN BY:

SONYA ODSEN, MICHAEL SIMPSON

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

ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

A PARTNERSHIP COMMITTED TO A LONG LOOK AT BOREAL ECOSYSTEMS

Canadian Forest Products • Canadian Forest Service • Daishowa-Marubeni International • Government of Alberta • University of Alberta • NAIT Boreal Research Institute • Foothills Research Institute • Manning Forestry Research Fund • Sustainable Forest Management Network • University of British Columbia • University of Calgary • Université du Québec à Montréal • Weyerhaeuser

FOR MORE INFORMATION ON THE EMEND PROJECT VISIT OUR WEBSITE WWW.EMENDPROJECT.ORG