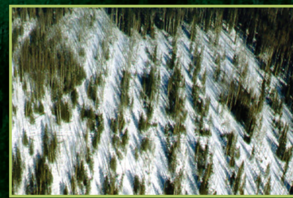
EMEND




ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #18

Ecological Messages:

- Wet Areas Mapping explained patterns in the understory plant community along moisture gradients at EMEND.
- Wetter spruce stands and drier aspen stands were most sensitive to harvesting due to increases in shade-intolerant plants and competition by regenerating aspen, respectively.

Management Implications:

- Including retention across a range of site wetness values in different forest types will protect the widest range of understory plants.
- Within the range of site wetness examined on upland, productive boreal mixedwood forests, wetter sites in spruce stands and drier sites in aspen stands should be prioritized for higher-retention treatments or retention in patches.

Using Wet Areas Mapping to plan retention placement: Lessons from the understory

Research led by Laureen Echiverri and Ellen Macdonald

Hunched over understory plants growing on the forest floor, we will certainly find more plant species in a single 2 x 2 m plot than in the entire forest of trees growing above. Truly, most plant diversity in the boreal forest grows close to the ground. How can we best account for this diverse, valuable plant group in forest management?

The development of Wet Areas Mapping has provided forest managers with a potential tool for identifying areas of high understory plant diversity and areas with high sensitivity to forest harvesting. We tested this idea by seeing whether there was a relationship between understory plants and site wetness (as indicated by Wet Areas Mapping), and how these relationships varied among forest types and with retention harvesting.

Two key findings stand out from this study. First, we found that understory vegetation changed across a wetness gradient, and these changes depended on the type of forest.

Understory plants provide important food and habitat for wildlife. Photo by S. Odsen.

Second, we found that certain sites were more sensitive to harvesting. After harvest, the relationships between understory vegetation and site wetness changed in wetter sites in spruce stands and in drier sites in aspen and poplar stands. ***We recommend placing retention across a range of site wetness (depth-to-water index) values to better capture a wide range of plant communities; however, wetter sites in spruce stands and drier sites in deciduous stands will likely benefit from higher retention during harvesting.***

Biodiversity near your feet

Many of us tend to think of the boreal forest in terms of the trees, but the larger biodiversity story is growing closer to the ground. Understory vascular plants—shrubs, forbs, and grasses—contain most of the boreal forest's plant diversity, and are important sources of food and habitat for invertebrates, birds, and mammals. They also play an important role in forest function, as their rapid growth and high turnover contribute to nutrient cycling.

Patterns of understory plant diversity are driven largely by patterns in moisture, nutrient, and light availability, and forest harvesting has the potential to alter all three. Variable retention management offers an opportunity to protect the understory using either high levels of dispersed retention or strategically placing retention patches. But to accomplish this, it is essential to identify areas that have higher plant diversity or differing plant assemblages—not only in unharvested forest, but also following harvesting.

Given recent advancements in remote sensing, we asked how we can we use these data to better manage understory plant diversity in harvested landscapes.

The EMEND Project presents a unique opportunity to test this question. Wet Areas maps (see Box 1) have been generated for the EMEND landscape, allowing researchers to examine the interactions between understory plants, site wetness, and forest harvesting. ***By better understanding these relationships, it may be possible to more strategically plan the placement of retention to capture a wider range of understory plant diversity on a harvested landscape.***

Box 1. What is Wet Areas Mapping?

Aerial photo interpretation has typically been used to develop maps showing surface drainage networks, but these maps often lack the level of detail needed to plan forest operations. Following recent advancements in remote sensing, LiDAR data were used in the Wet Areas Mapping tool to create an index of soil depth-to-water (referred to as "site wetness" within this note). A low depth-to-water value, for example, means there is a high probability that water is near or even at the surface of the ground.

It is important to note that depth-to-water is not an empirical measure of site wetness, but rather represents the probability of encountering water at a given depth. Researchers can adjust the model to improve its performance at different sites and under different conditions (e.g., drought).

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).

Research questions

- Is the depth-to-water index (site wetness) a reliable indicator of diversity or composition in understory plants?
- Does harvesting affect the relationship between the understory and site wetness?

Methods

We surveyed understory vegetation using a series of field plots at EMEND, and then compared plant diversity and composition against depth-to-water from the Wet Areas Mapping layers. Using this method, it was possible to determine whether wetter areas contained different plant communities, and whether these patterns changed in response to harvesting. We looked at unharvested stands, clear-cuts, and retention harvests (20% and 50% retention) within deciduous, mixedwood, and coniferous forest types.

Key Findings

Understory plants vary with site wetness in unharvested stands

Site wetness had a significant relationship with different metrics of understory plant diversity, ***suggesting that Wet Areas Mapping may be used in the future to identify areas likely to have higher understory plant diversity, or differing plant assemblages, in unharvested stands.*** This relationship was not, however, entirely straightforward. While site wetness was an important predictor of patterns of understory plant diversity, this relationship changed depending on whether we were looking at a deciduous, mixedwood, or coniferous forest stands. These forest types were themselves distributed along a gradient from lower to higher site moisture (see EMEND Insights #14).

In conifer (spruce) stands, for example, the number of species was higher on drier sites, potentially due to higher nitrogen availability compared with wetter areas. In both deciduous and conifer stands, overall understory plant cover was highest on drier sites, which may have been driven by increased abundance of common shrub species (e.g., prickly wild rose, which grows better on drier sites).

These results may seem to suggest that retention should be prioritized on drier sites, but an important consideration remains: plant species changed along the transition from wetter to drier sites in all three forest types. ***By strategically planning retention to cover the range of site wetness values represented by each forest type, it should be possible to best capture overall understory plant diversity (Fig. 1).***

Some sites were more sensitive to harvesting

Wet areas within conifer-dominated stands were most sensitive to harvesting. By "sensitive," we mean that plant diversity responses to site wetness were different than in unharvested stands. In fact, the relationship between plant diversity and site wetness in harvested coniferous stands was opposite to that in unharvested stands, regardless of retention level. In harvested conifer stands, the wetter areas contained more species than the drier areas.

A change was likewise observed in the deciduous stands after harvest, where understory cover was no longer higher on drier sites.

Aspen regeneration likely contributed to the changes we observed. Aspen regeneration was highest on drier sites, meaning that wetter coniferous sites had comparatively lower aspen abundance following harvest. Thus, these wetter sites would have continued to remain more open, and as a result many early-successional, shade-intolerant species (including grasses) have established or persisted.

In the deciduous stands, aspen regeneration was also high on drier sites; in this case, it appears to have suppressed the high shrub growth that we observed on the drier sites in the unharvested stands.

By examining the sensitivity of understory vegetation to harvesting, we have demonstrated that wetter sites within coniferous stands, and drier sites within deciduous stands, would benefit from special attention (Fig. 2). Understory plant communities in these two site types have been shown to be vulnerable to change following retention harvesting, and these effects have persisted over nearly two decades post-harvest.

Management Implications

While Wet Areas Mapping was shown to be a tool that can be used to detect understory vegetation diversity patterns, a key finding of this study was that patterns of plant diversity are not straightforward. The abundance of understory vegetation and the number of plant species changed along gradients of site wetness, but the changes depended on the type of forest and the harvest intensity of the stand.

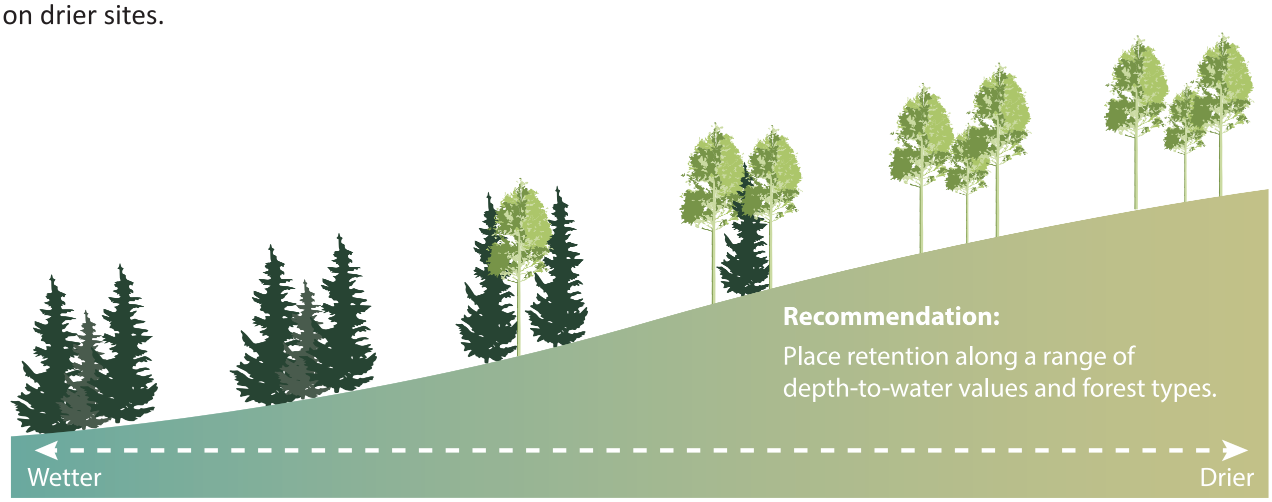


Figure 1. Strategic placement of retention across the entire wetness gradient within and between different forest types (see also EMEND Insights #14 for more information on the relationship between stand composition and site wetness).

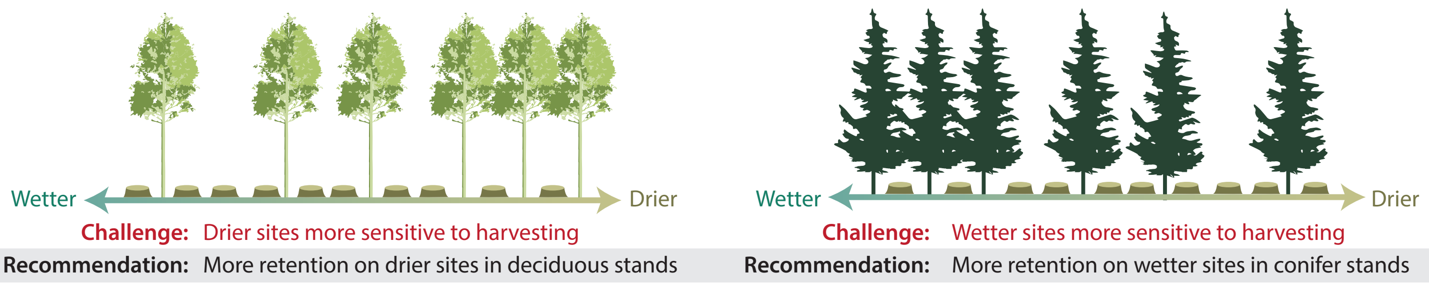


Figure 2. Patterns in sensitivity of understory vegetation to harvest along a moisture gradient. Higher retention (e.g., 20-50%) is recommended on sites with high sensitivity.

Consequently, rather than being used as a straightforward predictor of understory plant diversity, Wet Areas Mapping shows potential as a tool to identify areas likely to contain different plant communities—in so doing, it can be used to protect a variety of understory communities on the landscape using retention patches.

These results can also be used to identify areas that were observed to be most sensitive to harvesting, and prioritize these for retention patches. In coniferous stands, the wetter areas were more sensitive, while in deciduous stands the drier areas were more sensitive (Fig. 2). The overall sensitivity of conifer stands to harvesting likewise suggests that this forest type should be targeted, when possible, for higher retention levels.

Further reading

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