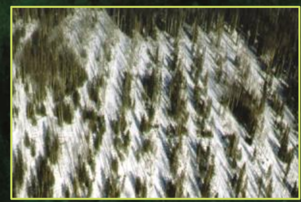
EMEND



ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #8

Using ecosite classification to predict beetle diversity and key habitats for uncommon species

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Conserving biodiversity is a key goal of ecosystem management in Alberta. However, actually measuring biodiversity across an entire landscape can be a daunting task. Managing for biodiversity could be more efficient if models could predict where different species are likely to occur on the landscape. Such predictions may be possible using data sets which cover large landscapes and are available to land managers, such as the Alberta Vegetation Inventory (AVI) or ecosite classification.

We found that the type of overstory tree species can successfully predict the type of beetles on the forest floor. For example, old growth forest supported a diverse and unique set of beetle species. Many uncommon beetle species were also found in areas with uncommon tree species, like tamarack.

Given the connection between beetles and trees, we tested whether we could predict where different beetles occur on the landscape using AVI and/or ecosite classification. Ecosite classification performed much better than AVI. Mistakes in tree species identification within the AVI produced misleading results about beetle diversity patterns. By including information about nutrient and moisture regimes, ecosite made up for some of the inaccuracies in the AVI.

This study shows that broadly available information layers, such as ecosite classification, have the potential to predict where species occur across the landscape. The potential applications for biodiversity management on a large scale are very exciting. For example, planners could pay special attention to old growth patches, wet areas, and less common tree species. This tool will improve our ability to manage our forests for both economic returns and biodiversity conservation. ***Read on to find out more. . .***

Ecological Messages:

- The number and kind of ground beetles in a forest stand are closely linked to tree species in the overstory.
- Accurate information about the tree overstory is needed in order to predict where different kinds of beetles are likely to occur.
- Beetle diversity can be modelled better when additional variables are included in data sets, such as soils or moisture.

Management Implications:

- Old growth forest and uncommon tree species support unique groups of beetles, and deserve special consideration when managing biodiversity.
- While the AVI provides overstory tree data at the landscape level, it is a weak tool for predicting patterns of beetle diversity due to small but important errors in the data set.
- We recommend using ecosite classification as a starting point to predict diversity patterns on the landscape, in order to more effectively plan and manage for biodiversity in the boreal forest.

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Connecting biodiversity to overstory trees through a shared fire history

Biodiversity is widely recognized as an indicator of ecosystem integrity, but is extremely difficult to quantify in a meaningful way. So how can we manage and conserve biodiversity when it is so difficult to measure? This is where tools and models come into play. Models allow us to perform intensive studies in one area, and use this information to predict patterns of biodiversity across the landscape. These predictions can then be incorporated into maps and data layers already used by forest managers.

We started by testing whether many ground beetle species are consistently found together with certain overstory tree species (i.e., beetle diversity patterns). Our recent work has shown that the fire history of a forest ecosystem affects biodiversity patterns in the long term, as well as the age and species mix of forest stands (Fig. 1). Forest composition may also directly affect biodiversity, or reflect other conditions that influence biodiversity, such as moisture. We then tested AVI and ecosite data – both widely available in Alberta – to determine whether the species of beetles collected on the ground could be predicted by these data layers.

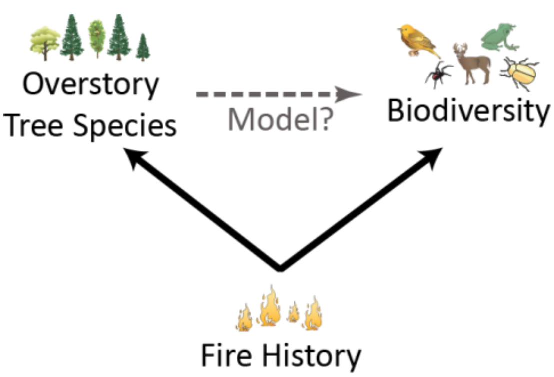

Figure 1. Overstory tree species of a forest stand are proposed as a model for explaining patterns of biodiversity, since they both arise in large part from the fire history of a stand.

Why beetles?

Invertebrates (e.g., beetles and spiders) are a very useful group for describing biodiversity in a reliable way. Ground-dwelling insects like beetles are easily sampled in large numbers using simple traps, and they are sensitive to local changes caused by forest harvesting and/or natural disturbances. In 2002, we collected invertebrates at 200 sampling sites covering 84 km^2 of unharvested mixed forest at the EMEND research site. We mainly focused on ground beetles (Carabidae) for this study. At each site we also assessed basal area of each overstory tree species, as well as indicators of fire history (fire scars, tree age, etc.).

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).

Wet sites burn less easily and are highly important for conserving beetle diversity. Photo courtesy Jim Witiw, DMI.

There is a clear link between overstory tree species and beetle species in the forest

The fire history of a forest influences the age, size, and species of trees, which in turn affects the numbers and species of beetles that live in a given stand. **Stands that have escaped burning for a long period of time, usually on wet sites, supported the highest number of beetle species.** This group of beetles differed from those found in more recently burned stands, and contained species that are unique to old growth forest. This pattern suggests that wet sites contribute to a patch's resistance to burning, and in turn increase its importance for conserving biodiversity.

Another important finding was that the more uncommon a tree species, the more uncommon the beetle species that were associated with it. Uncommon beetle species warrant special consideration, as small changes to the environment can greatly impact their numbers. For example, one of the less common beetles at EMEND was most often found near tamarack. Other beetles that are generally found in old growth forests were found near balsam fir. These tree species may not receive much attention for their economic importance, but they are disproportionately important for conserving diversity.

AVI can be used to model beetle diversity patterns, but is prone to error

The Alberta Vegetation Inventory (AVI) is a potential tool for relating biodiversity to overstory tree species, but common errors undermine its usefulness. The AVI is produced using aerial photographs, which can be difficult to interpret. When compared against ground surveys, the AVI estimated relative overstory cover of each tree species with 70%-86% accuracy. Common errors included mistaking uncommon trees for more common upland species, or failing to detect uncommon species at all. These errors led to misleading results for the habitat associations of different beetle species. When we added data from ground surveys, we modeled the occurrence of beetle species with 10% more accuracy (Fig. 2). Unfortunately, the inaccuracies in the AVI negatively affected our ability to explain beetle diversity patterns.

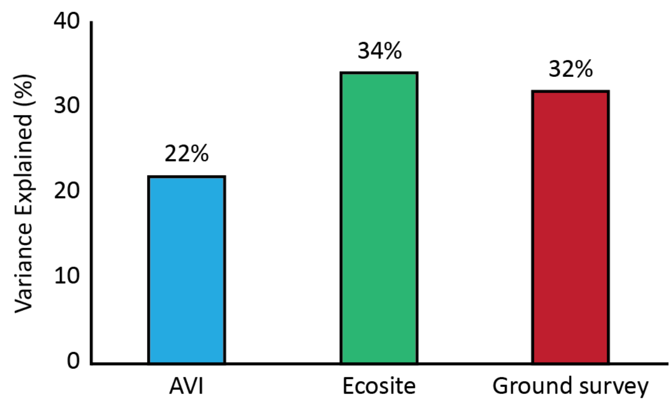

Figure 2. Beetle species occurrence as explained by the AVI (Alberta Vegetation Inventory), ecosite classification, and ground surveys.

Using ecosite information leads to improved model performance

The beetle species in a stand were better modeled by ecosite classification, most likely because ecosite includes information that makes up for errors in the AVI. In addition to overstory tree cover, ecosite includes data on soils, moisture, nutrients, and more. Where the AVI failed to detect tamarack, for example, the ecosite data had information on wet, nutrient-rich soils. Ecosite did a good job of predicting patterns of beetle diversity that are associated with tamarack, because it had the information needed to predict the conditions under which tamarack is found. When we used ecosite data, we explained patterns of beetle diversity 12% more accurately than with the AVI (Fig. 2).

Ecosite classification accurately explained not only ground beetle species patterns, but also rove beetles and spiders. More importantly, by including several invertebrate groups, we gained a more complete understanding of the forest environment. Black spruce bogs had few beetles, for example, but supported a diverse and abundant set of spiders. **This result reflects the value of studying multiple groups. The importance of black spruce bogs for supporting biodiversity would have been missed altogether had we only looked at ground beetles.**

Management Implications

During our survey of beetles and forests at EMEND, we found clear links between beetle diversity and overstory tree species. In order to be able to use this information to predict patterns of beetle diversity across the landscape, we need accurate and complete forest inventory data. For this reason, ecosite was better than the AVI at identifying habitats that support diverse and/or unique sets of beetles. Namely, it was better at detecting sites where we find uncommon tree species (e.g. tamarack, balsam fir) and old growth habitats. We recommend using ecosite classification framework as a starting point for predicting diversity patterns on the landscape. As the accuracy of forest inventory data increases, we can more effectively plan and manage for biodiversity in the boreal forest.

We can broadly conserve beetle diversity by ensuring that the full range of tree species and ecosites are represented on the managed landscape. In particular, old growth forest stands (usually on wet sites) and uncommon tree species require careful management. Finally, it is important to frequently check the accuracy of inventories and models with on-the-ground studies. In this way we can continue to improve the accuracy of models and more effectively manage biodiversity in the boreal forest.

References

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A PARTNERSHIP COMMITTED TO A LONG LOOK AT BOREAL ECOSYSTEMS

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