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EDITORIAL
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Editorial: North Temperate and Boreal Forest Disturbances: The Challenges of Growing in the North

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Editorial on the Research Topic

North Temperate and Boreal Forest Disturbances: The Challenges of Growing in the North

All forests experience disturbance. North temperate and boreal forests, in particular, are subject to a broad array of disturbances varying in size, frequency, species specificity and tree mortality, including those originating from biomass harvesting, insects, pathogens, droughts, and ice. Moreover, northern forests endure some of the largest seasonal temperature fluctuations and climate change-induced warming on earth. The consequences of disturbance and abruptly altered climate are far-reaching, and affect multiple organisms, ecological processes, and environmental policies. Fundamental knowledge centered on how northern forests function and respond to multiple stresses is critical to informing management and to the validation and improvement of ecosystem and earth system models.

This special feature covers a wide range of topics, including: effective fungal biocontrol during the rarely studied winter period; the application of thinning in mixed species stands to reduce drought vulnerability; a comparison of the effects of harvesting and an insect outbreak on forest conditions; and a reflection on differences between ecological forestry in Europe and North America. The underlying theme in these papers is that thinking differently and researching creatively can provide new information relevant to resolving pressing forest management problems associated with rising disturbance.

Using one fungus to control another is not new, but the investigation of seasonal differences in growth and performance is unique (Stevens et al.). The observation by authors that the biocontrol fungus outgrows and competes with the pathogen *Amillaria* during the winter, when the pathogen is mostly inactive, offers an opportunity to understand how a biocontrol agent that is not obviously more competitive during the growing season could be an effective control agent.

Similarly, thinning is often a treatment applied to increase productivity and manipulate size-class structure as well as reduce drought stress in mono-specific stands, but its use in mixed hardwood-conifer stands is not common. The research presented here shows increases in the production of both aspen and spruce in thinned stands compared to unthinned mixed conifer hardwood stands, suggesting that mixed forest stands may also benefit from this silvicultural approach (Comeau). It also shows that thinning improves drought resistance and resilience for more than two decades, a duration which may be much longer than in mono-specific stands.

There are many papers that compare the frequency, area disturbed, and mortality of fires vs. clearcuts, but despite the prevalence of insect disturbance, few papers have compared harvesting to insect outbreaks. Such comparisons are crucial to determining how different disturbances restructure ecosystems. A comparison of spruce budworm outbreaks to harvesting shows some

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similarities between the disturbances but also differences in the size of openings, species targeted and subsequent forest dynamics (Kneeshaw et al.). The results suggest that forest management techniques that were employed in the past target the least susceptible tree species and favor recruitment of the most vulnerable species. During outbreak periods there is thus a need to focus on reducing long-term vulnerability. Recent reporting from the current spruce budworm outbreak suggests that history is in danger of repeating itself and that long term forest resistance and resilience could be compromised.

Finally, implementing effective forest management strategies in the face of increasing disturbance requires consideration of policy. The need for ecological forestry is palpable both socially and ecologically as forests and biodiversity are declining around the world. Comparing the historical approaches as well as new advances in theory and practices from Europe and the U.S.A. shows both improvements in forest management but also a tendency to over adjust in both regions and thus a need to continuously re-evaluate relative to local and regionally relevant goals (Gresh and Courter). In Europe, forestry has embraced continuous cover forestry, perhaps to the detriment of shade intolerant species, whereas in the U.S. a gradient of harvesting intensities is intended to emulate natural forest dynamics but, in practice, silvicultural approaches encouraging small openings and species that require cover may be underrepresented. Thus, despite improvements in forest management, there is a need for continual readjustment.

This group of papers thus provides unique research results in northern forests that can be used to improve forest management as well as our collective understanding of processes at different scales. More crucially, these papers challenge temperate and boreal forest ecologists and managers to continuously re-evaluate their approaches. Best practices when over practiced may unintentionally lead to homogenization of naturally heterogeneous forests. A continuous critical evaluation of forestry with respect to long-term ecological and social goals will be a key to ensuring that these goals are attained amidst proliferating disturbance and intensifying demand for goods and services.

North temperate and boreal forests in particular are subject to a broad array of disturbances varying in severity, frequency, and intensity, including those originating from biomass harvesting, fire, extreme and variable weather, atmospheric pollution, insect pests, and pathogens. Moreover, northern forests endure some of the largest seasonal temperature fluctuations and climate change-induced warming on earth. The consequences of disturbance and abruptly altered climate are far-reaching, and may include changes in carbon sequestration, forest production, nutrient cycling, biosphere-atmosphere interactions, and biodiversity. Fundamental knowledge centered on how climate change reshapes disturbances and thus northern forests is critical to informing management and to the validation and improvement of ecosystem and earth system models.

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