Title: How pulsed reproduction shapes temperate forest communities

Understanding the major factors that shape forest communities is a fundamental question across ecology and forest science, with decades of research producing competing hypotheses that have yet to produce one robust mechanistic model. Most hypotheses focus on the challenge of understanding how seeds and seedlings survive a world of pests, predators and pathogens to become saplings, at which point light gaps and other more stochastic processes seem to determine which individuals become canopy trees.

This project unites and tests the two major models for forest regeneration from seed in temperate forests: (1) pulsed seed production in only certain years—called 'masting' or 'mast seeding' usually—as a way to temporally structure seed predators such that they are at low abundance in high seed years; and (2) spatial negative density-dependent survival of seeds and seedlings. This later mechanism, often called 'Janzen-Connell' effects, is caused by hypothesized high predator or pathogen presence near a parent tree that declines with distance from the parent tree, creating spatial mosaics in survival for seeds. While both hypotheses focus on the challenge of seed survival as the major mystery of forest regeneration, they operate on contrasting axes—with masting focused on temporal patterns of recruitment, while Janzen-Connell focuses on spatial patterns—and make somewhat contrasting predictions. Masting uses an economy of scale—high seed production can swamp predator populations assuming most seed sources for the predators mast (produce an abundant seed crop) at the same time—to predict positive density dependence (more seeds lead to more survival), while Janzen-Connell predicts negative density dependence. In Janzen-Connell, seed production is highest near the parent tree where survival is also lowest and maximum recruitment is predicted where seed production is lower. They also make varying predictions for how environmental factors effect seed production and in turn adult tree growth; masting suggests plants use cues to time high-production years and would experience associated growth declines due to high investment in reproduction, while Janzen-Connell predicts more regular reproduction with less noticeable effects on growth and due to the environment.

We argue both mechanisms for forest recruitment—masting and spatial negative density-dependent survival—may explain recruitment in temperate forests, but has rarely been tested. Our project leverages collaboration between two forest ecology labs to build on existing data and collect the additional data critical to testing these models together. The international collaborator will importantly provide long-term data temporally and spatially explicit data on seed production and seedling survival that is rare and required to address these questions, while the Canadian collaborator will bring expertise in Bayesian modeling to address these two hypotheses together, and collect the tree growth data that is necessary to predict long-term forest dynamics.

Globally the need for a robust mechanistic model of forest tree dynamics is critical to the global carbon cycle, with Canada's forests playing a major role. In Canada, this is also an especially pressing challenge as industries related to forests (e.g., tourism, wood products, maple syrup) are critical to the economy and at risk of major shifts with increased warming from human-caused climate change. With improved models of forest dynamics, including regeneration from seed which is a major focus of this work, Canada will be better poised to mitigate major forest change when possible (for example, through targeted seed or planting programs in actively managed forest), and mitigate impacts of forest change (for example, through understanding impacts on small mammal and bird communities from this work).

... and one made more pressing by climate change.

Collaboration • List and describe your international collaborator(s). • Explain the rationale for your selected international collaborator(s) and the added value of the collaboration. • Describe the role of your team in the collaboration.

INSERT YOUR TEXT HERE, RESPONDING TO EACH OF THE ABOVE POINTS

Training plan • Describe how the project and the international collaboration offer opportunities for enriched training experiences that will allow research trainees (undergraduates, graduates and post-doctoral fellows) to develop relevant technical skills as well as professional skills, such as leadership, communication, collaboration and entrepreneurship. Include the nature of the planned interactions with the international collaborators(s) and other relevant activities.

INSERT YOUR TEXT HERE, RESPONDING TO EACH OF THE ABOVE POINTS

Equity, diversity, and inclusion (EDI) • Describe how EDI will be fostered within the research environment, including 1) how EDI will be considered in the training plan and 2) how EDI has been considered in the academic team composition.

INSERT YOUR TEXT HERE, RESPONDING TO EACH OF THE ABOVE POINTS

References • Use this section to provide a list of the most relevant literature references. Do not refer readers to websites for additional information on your proposal. Do not introduce hyperlinks in your list of references. • These pages are not included in the page count.

INSERT YOUR TEXT HERE, RESPONDING TO THE FIRST POINT ABOVE