You are invited to attend the presentation of the

Final PhD Defense
of
Melodie Kunegel-Lion

Date September 3, 2019

Time 3:00 p.m.

Location CW 410

Mountain Pine Beetle Population Dynamics and Management

Outbreaks of insects are the main source of disturbance in North American pine forests. The huge economic and ecological consequences of these outbreaks emphasize the need for effective pest management. For example, the mountain pine beetle has killed more than half the commercial timber in British Columbia. Large-scale model predictions of mountain pine beetle have highlighted the impact of beetle pressure, weather, and stand characteristics on beetle location. Observational and experimental studies specify how these factors affect beetle presence during the course of its life-cycle. However, local-scale predictions could help inform pest management more accurately. Especially, there is a need to understand how the impact of ecological and environmental factors change during the course of an outbreak. Population models typically incorporate management using functional responses for biological control or a regular removal of a certain number of individuals at certain times for other types of control. This second method lacks a framework describing how management could be implemented in population models in a rigorous way. In this thesis, I use a combination of statistics, machine learning methods, simulations and mathematical models to explore mountain pine beetle population dynamics and its management in the Cypress Hills interprovincial park. Boosted regression trees are able to predict accurately mountain pine beetle infested trees presence on a local scale using ecological and environmental variables. Logistic regressions using similar variables further demonstrate which factors affect beetle presence and how they vary depending on the outbreak phase. Virtual experiments of mountain pine beetle management show that managers are efficient in detecting infested trees using previous-year infestation information. Yet, efficiency could be further improved by the addition of weather, stand characteristics, and topography to inform detection. Using a mathematical model along with individual-based simulations, I demonstrate that we could apply the functional response framework to human-pest interactions in order to simulate population dynamics as well as compare management strategies. Simulations of a semi-empirical model describing the interaction between beetle and pine populations show that direct control affect beetle outbreak duration and pine mortality even at a low level and a moderate control can eradicate infestations in the long term. However, a significant control level is needed to achieve a quick eradication. Assessing management and considering ways of improvement are important as pest damages in North America are predicted to increase as a consequence of climate change.