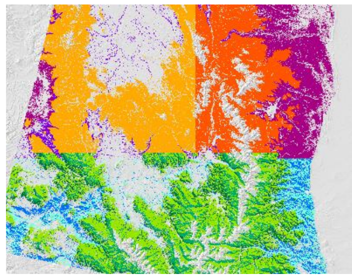
LRES M.S. Thesis Defense

Spatiotemporal Patterns of Mountain Pine Beetle Infestation across the Rocky Mountain Front from 2005-2015

Emma Bode
M.S. in Environmental Science
Major Advisor: Dr. Rick Lawrence
Date: Thursday July 5th
Location and Time: Leon Johnson Room 325, 9:00 am


Abstract: Synchronous, widespread, and severe mountain pine beetle (MPB; *Dendroctonous ponderosae*) outbreaks impacted forests of western North America at unprecedented levels in the last several decades. Severe MPB epidemics can degrade ecosystem services and socio-economic assets. Mapping outbreak progression provides tools to mitigate damages and analyze MPB attack processes on a landscape scale. Previous time-series methods for mapping disturbance focused on extent rather than severity. Infestation severity, as within-pixel percentage, is more robust for answering a variety of ecologic questions. Our goals were to: (1) map infestation severity from 2005 to 2015 using a time-series regression approach; and (2) analyze MPB attack processes by modeling the probability of new infestation using spatial and environmental variables in the Rocky Mountain Front Range. Data used for severity map modeling included spectral data from all available dates of Landsat imagery, topographic data, and US Forest Service yearly aerial detection survey (ADS) polygons. We interpreted aerial imagery as reference data. Validation against a randomly selected subset of the data resulted in no statistical difference between predicted and observed infestation severity. Furthermore, our raster maps identified widespread, lower severity infestation not recorded by the ADS. We then employed a logistic regression model-based recursive partitioning (MOB) approach to determine: (a) to what degree nearby infestation severity (characterized by percent mortality) increased probability of new infestations; (b) the degree to which these effects varied across space and time with respect to other factors noted to constitute risk factors, specifically topographic and climatic variability; and (c) the extent to which these effects were directional (anisotropic) relative to prevailing winds. The final MOB model obtained 72.1% accuracy in predicting new infestation. We found that nearby infestation severity strongly influenced the probability of new infestations, an indication of the importance of mapping severity rather than the traditional approach of only mapping extent. Spatial autocovariates indicated that MPB dispersal occurred primarily at shorter distances. The effect of nearby infestation on new infestations was heightened at higher elevations, in more northern latitudes, on northerly, flat and east aspects, after warmer late winter temperatures, in the earlier years of the outbreak (2006-2010), and in more eastern longitudes. Variation in probability of infestation as a function of landscape variables was highest when surrounding infestation severity was low. The effect of nearby infestation on the likelihood of new infestation was most strongly influenced by host depletion, host density, and temperature within our study area. Anisotropic effects of nearby infestation relative to prevailing winds did not improve the model. This analysis establishes the efficacy of mapping a time series of infestation severity and demonstrates that severity maps facilitate novel analyses of MPB attack processes. The processes developed here can provide timely maps of MPB infestation severity and probability of new infestation.