Invasive Pest Effects on Tree Demographics Across the Northeastern US

PI Jeff Garnas, University of New Hampshire

Project Abstract

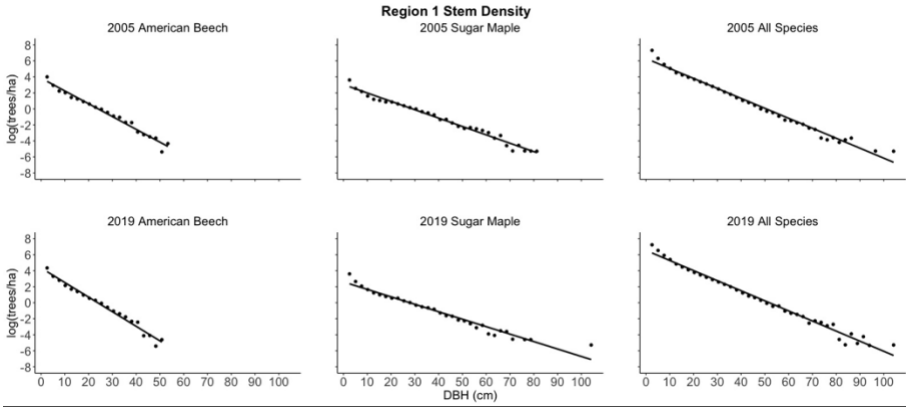
Nonnative pests and diseases have dramatic negative effects on forests, especially in the Northern Forest region, as the Northeast has the greatest density of invasive forest pest and pathogens in the country. Consequences of these invasions on host trees are well known, but the ways in which introduction of these organisms influences long-term structure, composition, and biomass storage capacity of affected forests are less well understood.

Researchers will examine trends over time and more recent effects on tree demographics in forests impacted by dominant forest pests introduced into northeastern North America over the past 140 years. Researchers will estimate carbon storage capacity and sequestration rates for forests within the region in light of established and currently spreading invasives. They will examine how biological, ecological, and demographic traits of host trees and invasive pests interact to determine rates of change and potential for the ultimate return to pre-invasion biomass and productivity. They will model outcomes in cases of multiple, overlapping non-native insects and diseases and in the context of a changing climate.

Researchers will use USDA Forest Inventory and Analysis data from several remeasurement cycles across forests containing significant components of host trees impacted by seven of the most damaging forest insects and pathogens. This work has the strong potential to guide management strategies focused not simply on mitigating impacts but also on shifting forests toward more favorable outcomes in the face of climate change.

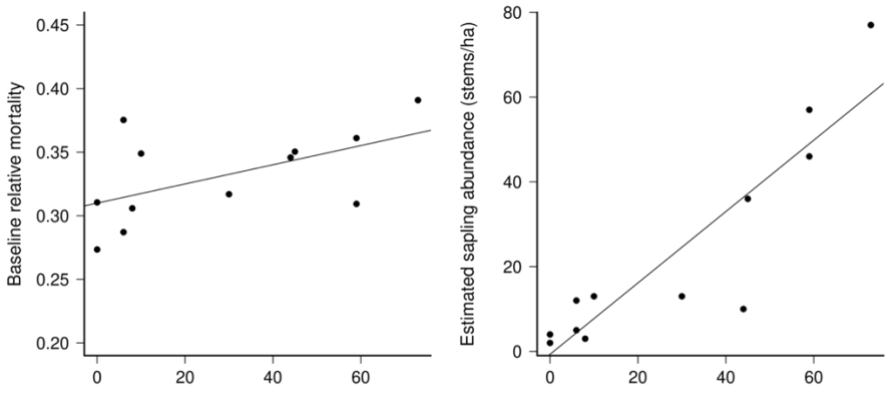
Progress in 2022

In 2022, we successfully created a local instance of the MySql US Forest Service Forest Inventory and Analysis program for the northeastern states. This will be used to assess the demographic changes of forests affected by the seven biotic disturbances outlined in the proposal. To date, we have focused primarily on beech bark disease and examined the newly established equilibria in northeastern American beech forests by evaluating demographic properties, including the relative baseline mortality and predicted small stem density, over multiple FIA re-measurement cycles (see



An example of demographic curves depicting the changes in stem density in beech bark disease affected forests over two FIA cycles (2005 and 2019). Region 1 represents counties where beech bark disease was discovered between 1935-1950.

figures). We created custom SQL queries that can be easily modified to assess these metrics across the seven pest and host species (Objective 1). In addition, we developed SQL queries to accurately calculate the aboveground and belowground biomass of forest species that will allows us to assess the carbon storage capacity of northeastern forests as a function of both the existence and duration of the specific biotic disturbances (Objective 2).



Changes in the estimated relative baseline mortality (left) and sapling abundance (right) of American beech as a function of beech bark disease scale insect survival

Plans for 2023

In 2023, we plan to assess the demographic changes of forests affected by the six remaining pests/pathogens using the comprehensive SQL queries previously developed. In addition, we will develop SQL queries that will allow us to assess the carbon storage capacity and sequestration rates of northeastern forests in light of beech bark disease over multiple FIA data cycles using established aboveground and belowground biomass equations and then apply these queries to the remaining pest/pathogen invasions. We will evaluate certain biological and ecological traits of the host and pest or pathogen as potential predictors of forest demographic changes and departures from structural equilibrium using matrices that consider the explanatory power of independent variables (Objective 3). Finally, we plan to use the information obtained from the previous objectives to model potential shifts in the pest/pathogens ranges in the face of climate change and how we expect these shifts to affect northeastern forest stands and carbon storage capacity (Objective 4).

Collaboration

We actively collaborate with Randall Morin (USFS, York, PA), Andrew Liebhold (USFS, Morgantown, WV), and Songlin Fei (Purdue University, IN). They all provide feedback on the project's progress. We have held two formal meetings to discuss the project's progress and trajectory with all group members. In addition, Garnas, Liebhold, and Fei attended an informal project meeting in person in Annapolis, MD in January 2023.