Post-Invasion Forests: Composition and Structure following Invasive Species Establishment – Year 2 Progress

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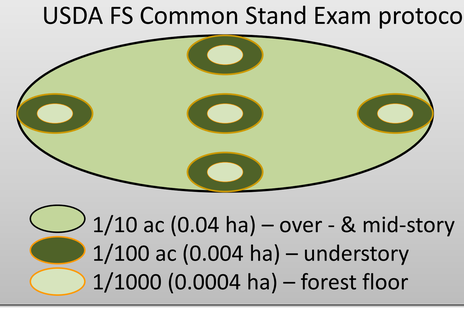
Introduction In Kentucky and throughout the southeast, numerous exotic pests threaten forest health and forest sustainability. Emerald ash borer (EAB), thousand cankers disease (TCD), and laurel wilt disease (LWD) are emerging non-native forest pest threats. Given the prevalence of susceptible host material in the region, post-invasion forests will clearly differ in composition and structure from their pre-invasion counterparts. We are evaluating the nature and extent of these differences, and addressing data gaps associated with insect and disease risk models. Our aim is to document baseline conditions, and use forest simulations to predict changes in the composition and structure of deciduous forests following establishment of specific invasive species in the southern Appalachian region, focusing on EAB, TCD, and LWD. Data collection is complete. This approach has been used successfully to simulate changes in composition and structure due to hemlock woolly adelgid invasion.

Methods We're censusing forest vegetation to assess current conditions in relevant forest types, and are using these vegetation assessments to predict the outcome of invasion, establishment, ensuing interactions, and future forests. We used USDA FS FIA data to locate suitable resources, and then censused the woody plant community using established protocols (NRIS, FS Veg, CSE) in 0.04 ha (1/10 ac) fixed radius plots (n=3 plots/stand) (***Fig. 1***). Woody plants were identified, and average age, height, diameter, basal area, spacing and radial growth were measured. Canopy structure, ground surface cover, slope, slope position, elevation, and aspect were assessed. Woody plant abundance, diversity, and richness will be computed for each plot. Using FVS, we will model species-specific and age-specific mortality/removal to simulate the effects of EAB, TCD, and LWD on forest composition and structure (***Fig. 2***).

Fig. 1. Woody plant vegetation censusing using USDA FS Common Stand Exam protocol



Progress Forty forest stands in 14 counties were censused in 2010 and 15 additional stands in five counties in 2011. Canopy composition was averaged across plots within each county to determine the applicability for modeling the outcome of invasions of EAB, TCD and LWD. We focused on ash stems for modeling EAB, walnut or butternut resources for TCD, and sassafras occurrence for LWD. We now have suitable baseline data to model all three species of interest.

Emerald Ash Borer All North American *Fraxinus* are susceptible to EAB, and attack is usually fatal (***Fig. 3***). Immediately after its 2009 arrival in Kentucky a 20 county area was quarantined, and 7 additional counties have since been quarantined (***Fig. 4***). EAB has been reported in 9 of these counties, and our censusing efforts focused in this area. All counties censused have an overstory ash component (>5" dbh) of 13-77%), making them suitable for FVS modeling to simulate EAB-induced ash mortality and to predict subsequent changes in forest composition and structure (***Fig. 2***).

Fig. 3. EAB is an exotic phloem feeder; attack is usually fatal

Fig. 4. EAB affected area in Kentucky

Fig. 2. FVS-forecasted forest composition and structure

Thousand Cankers Disease TCD is an insect-associated pathogen complex of walnut prevalent in western states. It has been reported in three eastern states, two of which border Kentucky (TN in 2010 and VA in 2011). Our censusing efforts have yielded six counties with an overstory walnut component (>5" dbh) >2%, making them suitable for FVS modeling to simulate TCD-induced walnut mortality and to predict subsequent changes in forest composition and structure (***Fig. 2***).

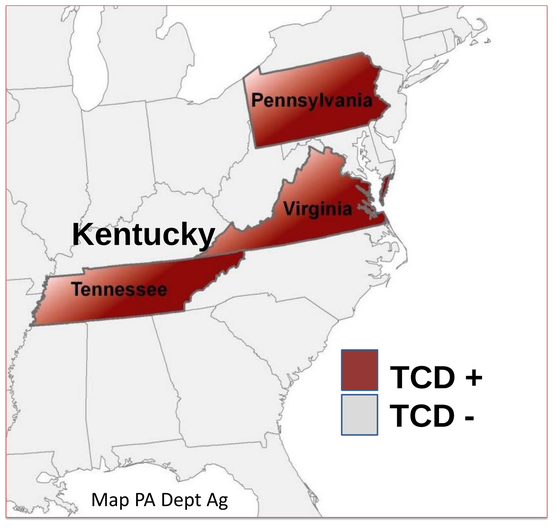


Fig. 5. TCD in the eastern US (2011)

Laurel Wilt Disease The pest complex responsible for LWD has not been found in Kentucky, nor is its primary host, redbay. But the alternate hosts, sassafras and spicebush, are prevalent, suggesting that LWD could impact our forests. Nine plots had sassafras adequate (>2%) to include in our simulations.

HWA-Invaded Forest ***5 yr post-invasion*** ***25 yr post-invasion*** ***Current Forest***

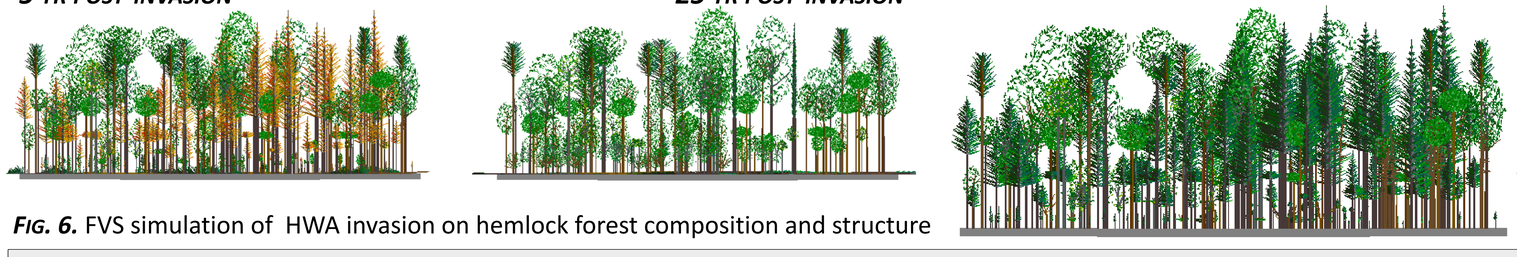


Fig. 6. FVS simulation of HWA invasion on hemlock forest composition and structure

HWA-Free Forest ***5 yr*** ***25 yr***

Fig. 7. FVS simulation of hemlock forest free of HWA

Future Focus Vegetation data is being used to model forest stand succession using the southern variant of FVS, which is most relevant for our region. FVS uses vegetation data (DBH, height, crown height, crown class, average stand age, tree growth), forest landscape characteristics (elevation, aspect, slope, and slope position), and stand structure to model existing tree data, and to project future stand conditions on a 5 yr cycle, up to 50 yr. Using FVS, we are modeling species-specific and age-specific mortality/removal to simulate mortality from EAB, TCD, and LWD, similar to our efforts simulating hemlock woolly adelgid mortality (***Figs. 6, 7***). Further development could allow us to project the impacts of silvicultural treatments and/or other exotic pests of concern, such as *Sirex noctilio* or beech bark disease, on forest composition and structure .