EAB INDUCED TREE MORTALITY IMPACTS ECOSYSTEM RESPIRATION AND TREE WATER USE IN AN EXPERIMENTAL FOREST

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ABSTRACT

The invasive emerald ash borer (*Agrilus planipennis* Fairmaire, EAB) has been spreading across the forest landscape of the Midwest resulting in the rapid decline of ash trees (*Fraxinus* spp.). Ash trees represent a dominant riparian species in temperate deciduous forests of the Eastern United States (USDA FIA Database). Prior research suggests that the mechanism by which EAB impacts ash trees is through extensive larval gallery formation which alters the transport of water and nutrients (Flower et al. 2010). Such disturbances have been shown to impact photosynthetic uptake and thereby fundamental ecosystem processes such as hydrology and soil respiration (Edwards and Ross-Todd 1979; Hogberg et al. 2001). These processes are integral to forest nutrient cycling and successional dynamics. Despite the fact that ash is an integral component of forests in the Great Lakes Region, the impacts of EAB induced ash decline on forest ecosystems remain largely uninvestigated. The objectives of this study were to assess EAB larval feeding on tree-level water relations and investigate the impacts of EAB induced ash mortality on soil respiration in an ash dominated experimental forest.

Measurements were conducted during 2009 in an EAB infested ash dominated forest located at the USDA Forest Service Lab near Delaware, OH. During the spring, eleven 12 m x 12 m plots were assigned to the following treatments: girdle, insecticide and control. In the girdling treatment, phloem tissue was removed from a 5 in band at breast height to replicate heavy feeding of EAB larvae. For the insecticide treatment, the arbor jet system was used to inject emamectin benzoate (Tree-äge) in dosages recommended by the manufacturer. Control plots were left to senesce naturally. Soil respiration (R_{Soil}) was measured at 22 PVC collars (10 cm x 5 cm) inserted 2.5 cm into the soil (2 collars per plot). Herbaceous plants were excluded from within the collars. Measurements of R_{Soil} were conducted weekly at each PVC collar using an infrared gas analyzer and a soil chamber. To minimize diurnal variability, measurements were conducted between 1100 and 1300 hours. Additionally, Garnier (1985) type thermal dissipation probes (TDP) were deployed to measure sap flow in 9 ash trees along a gradient of EAB infestation. Each TDP system consists of a pair of thermocouples inserted radially into the xylem tissue ~ 10 cm apart, the upper probe was heated and the lower an unheated reference. Two TDP systems were deployed at breast height per tree; one on the north-facing side and one on

the south facing-side. Temperature differentials between the heated and reference thermocouple on each probe, which are correlated with sap flux rates, were measured continuously and 30 min means recorded.

The experimental forest treatments resulted in significant shifts in rates of soil respiration. Specifically the insecticide and control treatments exhibited significantly greater R_{Soil} than the girdled treatment (RMANOVA; $P<0.05$). The insecticide and control treatments exhibited no differences in R_{Soil}. The girdling treatment resulted in ~30% reduction in R_{soil} compared to the non-girdled treatments.

Results suggest that ash trees exhibited significant diurnal variability in sap flux density (RMANOVA; $P<0.01$). Specifically, trees exhibited high daytime sapflux rates compared to night-time driven by transpiration during photosynthesis (Figure 1). Furthermore, heavily infested trees (AC4) exhibited significantly lower sap flux densities compared to lightly infested trees (AC1, Figure 1; see Flower et al. 2010 for a description of how larval gallery cover correlates with AC condition classes). These altered sapflux rates led to significant reduced quantities of daily water use between lightly and heavily infested trees within this forest stand (ANOVA; $P<0.01$).

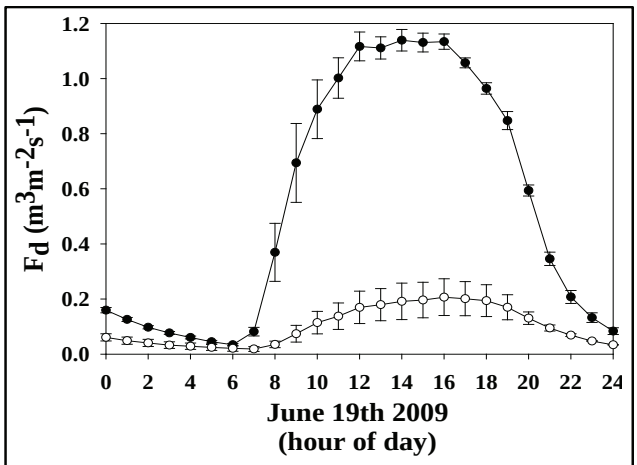

Figure 1: Diurnal sapflux from ash trees lightly and heavily infested with EAB (closed and open circles respectively, F_d= m^3 water per m^2 sapwood area per second).

Despite the widespread nature of the EAB disturbance, the potential ecosystem impacts of EAB are uncharacterized to date. Here we demonstrate how the girdling behavior of EAB may impact ecosystem carbon budgets through reductions in soil respiration. Furthermore, EAB induced tree declines can reduce sapflux rates and alter forest water use which can lead to shifts in local hydrology.

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