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Research paper

Effects of emerald ash borer on municipal forestry budgets

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HIGHLIGHTS

- The greatest effect of EAB occurred 5–8 years after confirmation in a state.
- A $280.5 (±79.9) million annual increase in municipal budgets occurred due to EAB.
- EAB reduced budgets for tree pruning, watering, fertilization and safety training.
- Spending on tree and stump removal doubled due to EAB.

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ABSTRACT

This study examines the financial impact of emerald ash borer (EAB, *Agrilus planipennis* Farimaire; Coleoptera: Bupresτide) on municipal forestry budgets. Three distinct phases were evident: an initial time period of 0–4 years (little budget change), year 5–8 time period (rapid budget increase), and years 9–12 (rapid budget decrease) after EAB was confirmed in a state. The 5–8 year time period had increased spending as detected through the total forestry budget ($p = 0.011$), total municipal forestry budget (percent forestry budget) as a percentage of the total municipal budget ($p < 0.001$), and per capita spending ($p < 0.001$). A $1.58 per capita increase occurred in annual municipal forestry budgets in states in which EAB was confirmed (EAB+) compared to states without a confirmed EAB case (EAB−). This has a $280.5 (±79.9) million annual impact on municipal budgets. The percent forestry budget increased as the time since EAB was confirmed in a state increased. A mean 0.33% (0.03 SE, n = 82) percent forestry budget occurred during the initial 0–4 years after confirmation of EAB. This exponentially increased from 0.47% (0.05 SE, n = 43) in year 5 to 1.17% (0.12 SE, n = 38) at the peak in year 8, and rapidly declined back to 0.47% (0.05 SE, n = 51) in years 10–12 which was a level slightly higher than initial conditions. Federal, state, and local urban forestry managers can use these results to financially plan for the impacts of EAB on municipal forestry budgets.

1. Introduction

Since the confirmation in 2002 of emerald ash borer (EAB, *Agrilus planipennis* Farimaire; Coleoptera: Buprestide) in North America, millions of ash trees (*Fraxinus* spp.) have died as a result of this insect (Herms & McCullough, 2014). White ash (*Fraxinus americana* L.), black ash (*Fraxinus nigra* Marshall), and green ash (*Fraxinus pennsylvanica* Marshall) are three common and highly susceptible North American *Fraxinus* spp. (Poland & McCullough, 2006). Not all North American ash trees are highly susceptible to EAB and the relatively uncommon blue ash (*Fraxinus quadrangulata* Michx.) has been reported to have much less mortality than other *Fraxinus* spp. (Poland & McCullough, 2006; Tannis & McCullough, 2014). Within a few years (e.g., 10–12 years) of EAB entering a location the vast majority of susceptible ash trees are dead or dying (Knight, Brown, & Long, 2013; Klooster, Herms, Knight, Herms, & McCullough, 2014).

Fraxinus spp. in the United States have a $282 billion undiscounted compensatory value in urban environments (Nowak, Stevens, Crane, & Walton, 2003; Poland & McCullough, 2006). By comparison, the Asian longhorned beetle (*Anoplophora glabripennis* Motschulsky) has a potential $669 billion impact with urban trees in the United States (Nowak, Pasek, Sequeira, Crane, & Mastro, 2001). An estimated 37.9 million *Fraxinus* trees occur in developed areas of communities within 25 eastern states in the U.S. (Kovacs et al., 2010). This increases to an estimated 125.3 million *Fraxinus* trees that exist on all developed land as defined by the National Land Cover Database 2001 definition.

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Kovacs et al. (2010) put a perspective on the potential financial impact that EAB would cost over $10.7 billion for the treatment, removal, and replanting of trees within developed land of communities across 25 states in the eastern United States over a ten-year period (2009–2019). The value rises to $37.9 billion if all susceptible *Fraxinus* spp. were removed and replaced at one time. McKenney et al. (2012) estimated in Canada the impact of EAB infestations at CAD $524 million for urban street trees and CAD $890 million when backyard trees were included. Sydnor et al. (2011) estimated the total financial impact of EAB infestations using the landscape tree value, tree removal costs, and cost of tree replacement to be between $13 and $26 billion in four Midwestern states in the U.S. This financial value translates to a $396 to $770 per capita impact. These estimated impacts are being realized and by 2015 over half of the states in the U.S. have confirmed EAB cases (http://www.emeraldashborer.info).

Many approaches have been proposed and further tested to manage populations of urban *Fraxinus* spp. that were exposed to EAB (Herms & McCullough, 2014; McCullough, Mercader, & Siegert, 2015). These actions include letting *Fraxinus* spp. die and removing those that pose an unacceptable risk to human injury or property damage (Hauer, 2012; VanNatta & Hauer, 2012). Others have proposed the preemptive removal of *Fraxinus* spp. in anticipation they will ultimately die or to harvest trees for timber or firewood prior to wood degradation (McCullough et al., 2015; Vannatta, Hauer, & Schuettpelz, 2012). Several protocols for treating *Fraxinus* spp. with systemic insecticides have also been developed with efficacies of nearly 100% of some treatments with protecting trees from mortality (Herms & McCullough, 2014; Herms, McCullough, Smitley, Clifford, & Cranshaw, 2014; McCullough, Poland, Anulewicz, Lewis, & Cappaert, 2011; Smitley, Doccola, & Cox, 2010). McCullough et al. (2015) list additional integrated approaches to manage EAB including girdled *Fraxinus* spp. trap trees, phloem reduction, and adopting Slow Ash Mortality (SLAM) protocols.

Fraxinus trees are common in the urban landscapes on public and private lands with some public street tree populations having *Fraxinus* spp. as the most abundant (Ball, Mason, Kiesz, McCormick, & Brown, 2007; Raupp, Cumming, & Raupp, 2006). Nationally in the United States, *Fraxinus* spp. was the second most common genera after *Acer* spp. in 12 studied communities (Raupp et al., 2006). At a state level, in South Dakota 36.3% of the street tree population was *Fraxinus* spp. (Ball et al., 2007). Across public and private maintained land areas (residential and business districts) statewide in Minnesota, VanderSchaaf and Jacobson (2011) reported 15.1% of trees were *Fraxinus* spp. Regionally within the Minneapolis and Saint Paul, MN metropolitan area (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties) 13.7% of urban trees within maintained areas (residential and business districts) on public and private lands were *Fraxinus* spp. (VanderSchaaf & Jacobson, 2011).

At a municipal level, *Fraxinus* has a $221 million structural value that include 573,000 trees comprising 17.4% of all public and private trees and 13.7% of all leaf area across the entire urban forest land area in Milwaukee, WI (i-tree, 2008; Sivyer, 2010). The Milwaukee street tree population of over 30,000 *Fraxinus* trees is currently under an intensive insecticide treatment to maintain the public resource (Krouse, 2010; Sivyer, 2010). In Canada an estimated 1.2 million street trees are *Fraxinus* spp. (McKenney et al., 2012). Thus, as a common tree, *Fraxinus* spp. poses an important asset to manage or liability upon death.

The loss of public and private trees has economic, ecological, and social impacts (Donovan & Butry, 2010; Donovan & Butry, 2011; Kondo, Low, Henning, & Branas, 2015; Miller, Hauer, & Werner, 2015; Vogt, Hauer, & Fischer, 2015; Wolf, Measells, Grado, & Robbins, 2015). Donovan et al. (2013) found the incidence of human death and respiratory ailments increased as the time since EAB was found in an area increased. While a causal relationship cannot be made from that study, the correlation is consistent with the human health literature and an expected positive relationship of trees and people in urban environments (Miller et al., 2015; Wolf et al., 2015). The loss of *Fraxinus* trees leads to reduced air pollutant update, less storage of rainwater, decreased carbon uptake, and other reductions in ecological benefits (Herms & McCullough, 2014; i-tree, 2008; Miller et al., 2015; Vannatta et al., 2012). Whether one likes it or not, managing EAB infestations will cost money for responding to tree mortality or preventing the death of *Fraxinus* trees (Hauer, 2012; Hauer, Vogt, & Fischer, 2015; VanNatta & Hauer, 2012). However, the retention of *Fraxinus* trees through the use of systemic insecticides was the most economically favored alternative (Vannatta et al., 2012).

The purpose of this study was to investigate the effect of EAB infestations on municipal forestry budgets. First we wanted to see if there was a difference in municipal tree budgets in states that have confirmed EAB versus states that did not have a confirmed case. We further investigated if there was an association since the time that EAB was found in a state and municipal tree budgets. We also ascertained if a change in funding of various forestry activities (e.g., pruning, planting, removal, education, etc.) occurred. Likewise, if total municipal funding changed as a result of EAB infestations was ascertained. Finally we quantified if contractor spending for urban forestry operations was changed as a result of EAB infestations in a state.

2. Methods

Information on municipal forestry operations and approaches to manage public tree populations was collected using a questionnaire for the 2014 fiscal year. Permission was granted by the Author's local Institutional Review Board to collect information from human subjects. The data used in this study was part of a long-form 109 question survey and sent to 1723 communities in all 50 United States. Survey delivery used the U.S. postal service with a self-addressed return envelope sent to each community. The multiple contacts approach of Dillman, Smyth, and Christian (2014) included a pre-notice letter, survey sent with a cover letter, reminder e-mail, survey and cover letter sent to nonrespondents, and postcard reminder sent to nonrespondents occurred for the long-form version. A subsequent short-form version with 53 questions was sent with the third follow-up survey with a cover letter and a final email reminder to non-respondents. Local contact information for the person who was most responsible for community tree activities was supplied by over 40 state urban and community forestry coordinators. In states that contact information was not available and communities that coordinators did not have a key contact person, municipal websites were searched for a person who is responsible for municipal trees or the person in charge of a department identified as most likely responsible for community trees. Lacking this information, a person from administration (i.e., city clerk, city manager, mayor) was sent the survey.

All communities with over 50,000 people received the questionnaire. Half of the communities between with 25,000 and 49,000 people were randomly picked for participation and 10% of places between 2500 and 24,999 people were randomly asked to participate in the study. All communities were selected from the Community and Activity Reporting System (CARS) maintained by the USFS at http://apps.fs.fed.us/NICPortal/default.cfm?action=Login. Community population used the 2010 census as maintained in the CARS dataset and the US Census Bureau (2010).

The year when a state had a confirmed EAB case (EAB+), or if EAB was not confirmed prior to 2015 (EAB-), followed EAB timeline records from http://emeraldashborer.info/timeline.cfm. In two