

# The association between urban trees and crime: Evidence from the spread of the emerald ash borer in Cincinnati



Michelle C. Kondo<sup>a,\*</sup>, SeungHoon Han<sup>a,b</sup>, Geoffrey H. Donovan<sup>c</sup>, John M. MacDonald<sup>d</sup>

<sup>a</sup> USDA-Forest Service, Northern Research Station, 100 North 20th Street, Ste 205, Philadelphia, PA 19103, USA

<sup>b</sup> Department of Biostatistics and Epidemiology, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, USA

<sup>c</sup> USDA-Forest Service, PNW Research Station, Portland, OR, USA

<sup>d</sup> Department of Criminology, School of Arts & Sciences, University of Pennsylvania, Philadelphia, PA, USA

## HIGHLIGHTS

- The emerald ash borer (EAB) began killing ash trees in Cincinnati in 2007.
- We used a natural experiment approach to assess impact of tree loss on crime.
- We compared crimes in EAB-infested blockgroups to those in non-infested blockgroups.
- Multiple crime types had significant and positive associations with EAB infestation.
- Urban trees may reduce crime.

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## ABSTRACT

The ecological impact of invasive tree pests is increasing worldwide. However, invasive tree pests may also have significant social costs. We investigated the association between the emerald ash borer (EAB)—an invasive tree pest first discovered in the US in 2002—and crime in Cincinnati, Ohio. We used a natural experimental approach, and compared crime (in 11 classes) on census block groups infested with EAB with crime on block groups not infested with EAB between 2005 and 2014. We accounted for demographic and biological differences between infested and un-infested block groups using propensity-score weighting. EAB infestation was significantly and positively associated with relative increases in crime in all but four crime categories. Our results suggest that invasive tree pests may be associated with social costs worth considering when managing invasive species. By extension, healthy trees may provide significant social benefits.

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## 1. Introduction

Invasive tree pests are an increasing worldwide problem that often have devastating ecological consequences (Boyd, Freer-Smith, Gilligan, & Godfray, 2013). At the same time, their spread provides a unique opportunity to study the social benefits of trees on a variety of social outcomes including health (Donovan, Michael, Butry, Sullivan, & Chase, 2011; Hystad et al., 2014) and crime (Kuo & Sullivan, 2001). The chance to study tree loss over time is invaluable, as the spread pattern of invasive tree pests are often uncorrelated with other drivers of social benefits. In contrast, mea-

suring and isolating the social effects of trees at one point in time can be problematic, because people with higher socio-economic status are more likely to live in areas with more trees (Jesdale, Morello-Frosch, & Cushing, 2013) and socio-economic status is an important driver of social benefits such as health and safety (Frumkin, 2013).

In North America, one of the most virulent invasive tree pests is the emerald ash borer (EAB), which was estimated in 2008 to have killed over 100 million trees since it was first discovered in Detroit, Michigan in 2002 (Smitley, Davis, & Rebek, 2008) (Fig. 1). We took advantage of the spread of EAB to study the relationship between trees and crime in Cincinnati, Ohio. We chose Cincinnati because the city kept detailed records of where and when they removed a diseased ash tree. This study's objective was to use the spread of EAB in Cincinnati as a natural experiment to test for the association between tree loss and crime. We estimated logistic regression

\* Corresponding author.

E-mail addresses: [michelleckondo@fs.fed.us](mailto:michelleckondo@fs.fed.us) (M.C. Kondo), [sehan@sas.upenn.edu](mailto:sehan@sas.upenn.edu) (S. Han), [gdonovan@fs.fed.us](mailto:gdonovan@fs.fed.us) (G.H. Donovan), [johnmm@sas.upenn.edu](mailto:johnmm@sas.upenn.edu) (J.M. MacDonald).

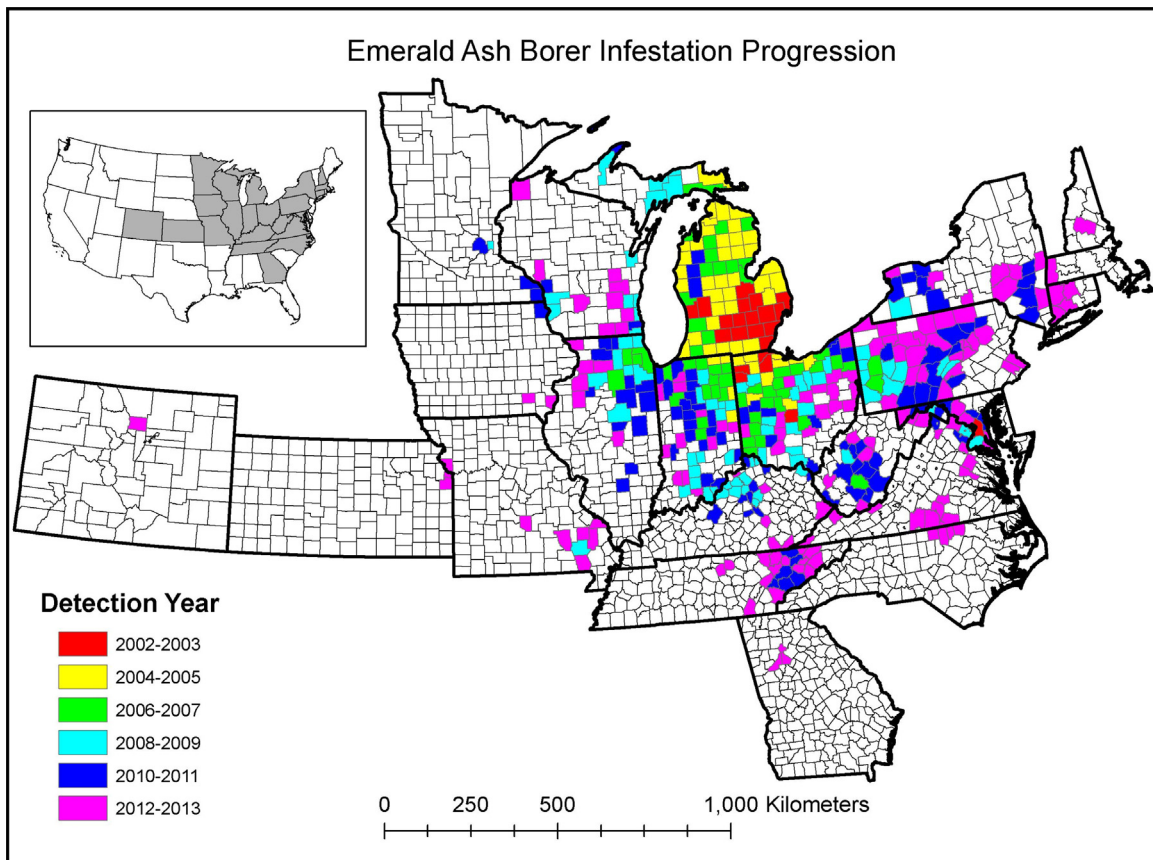


Fig. 1. Spread of the emerald ash borer by county 2002–2013.

models using propensity score weighting to test whether Cincinnati census block groups experienced a change in crime levels after being infected by EAB compared to block groups uninfected by EAB.

Studies have identified varying, and sometimes contradictory, associations between presence of trees or vegetation and crime. For example, dense vegetation has been shown to promote crime by providing criminals a place to hide themselves or illegal goods (Fisher & Nasar, 1992; Michael, Hull, & Zahm, 2001; Nasar, Fisher, & Grannis, 1993). In contrast, emerging evidence suggests that urban green space, measured in various ways, may be associated with lower rates of crime and violence. As a broad measure of urban green space, vegetation abundance has been linked to reductions in violent crimes, property crimes (Kuo & Sullivan, 2001), assault, robbery and burglary (Wolfe & Mennis, 2012). Other studies have used more specific measures. For example, street trees and large residential-lot trees have been associated with fewer total crimes, property crimes, and vandalism (Donovan & Prestemon, 2012; Troy, Morgan Grove, & O'Neil-Dunne, 2012).

However, with few exceptions, most green space and crime studies have been cross-sectional, so they provide limited evidence of causal effects and are prone to confounding by unmeasured drivers of crime (Lee & Maheswaran, 2011). Some exceptions include a natural experiment in a large public-housing development, which found vegetation was associated with lower violent and property crime (Kuo, 2001). A quasi-experimental study in Philadelphia found that greening of vacant lots was associated with reduced gun assaults and vandalism (Branas et al., 2011). Similarly, another quasi-experimental study found that construction of green stormwater infrastructure projects in Philadelphia was associated with fewer reports of narcotics possession (Kondo, Low, Henning, & Branas, 2015).

Several criminology theories provide insight into how trees might influence crime. For example, broken windows theory hypothesizes that signs of blight and disorder in the built environment signal that an area is “fair game” for “fun or plunder” (Wilson & Kelling, 1982) (Also see Demotto and Davies (2006) for an example of empirical evidence related to vegetation). The loss of trees on a block may provide a sign of blight, as dead or decaying trees may make an area look unkempt. Studies have found an association between measures of blight and physical disorder and crime, but they are mostly cross-sectional (Perkins & Taylor, 2002; Sampson & Raudenbush, 1999; Taylor, Shumaker, & Gottfredson, 1985). Only one series of small-scale field experiments in the Netherlands have found strong evidence that physical disorder encourages other forms of disorder and minor offending (Keizer, Lindenberg, & Steg, 2008). But these studies have not examined tree loss as a potential sign of blight and disorder. It is also possible that if a tree dies and is removed, the atmosphere and impression of environment may decline relative to the demographic background or density level.

Routine activity theory characterizes crime as an opportunistic process: motivated offenders recognize criminal opportunities during daily routine activities (Cohen & Felson, 1979). Based on routine activity theory, situational crime prevention (Clarke, 1980) and crime prevention through environmental design (CPTED) (Newman, 1972; Jeffrey, 1971) suggest that trees and other green space may prevent crime by altering crime-promoting environment components. These theories suggest that features of the built environment, including trees, make areas more or less attractive to would-be offenders by affecting natural surveillance, access control, target hardening, and signs of territoriality (Cozens, Saville, & Hillier, 2005). For example, according to Donovan and Prestemon's (2012) empirical study, trees could be a source of target hardening

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