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Where to Set Heat Treatment Requirements for Domestic Firewood and Wood Packaging Materials Used in International Trade?

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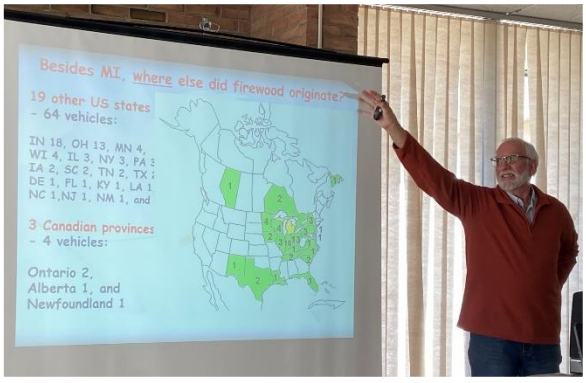
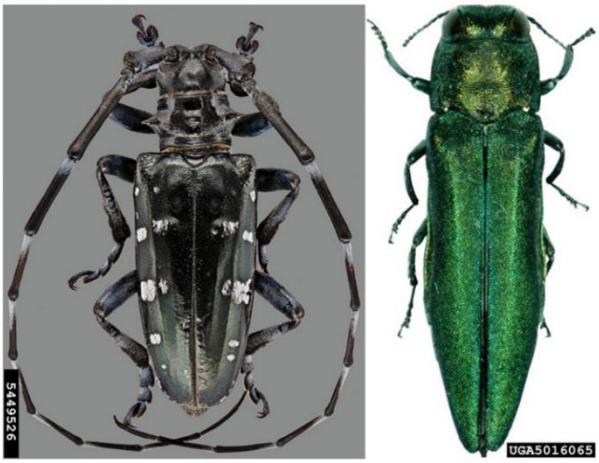
Bark- and wood-infesting insects (which we'll refer to as borers) can be transported in solid wood to new areas both domestically, especially in firewood, and internationally, especially in wood packaging material (WPM) like crating and pallets (Haack 2006). Borer generation times range from months to multiple years, and as wood dries, such as with stacked firewood, generation times can be extended (Haack and Slansky 1987, Petrice and Haack 2007). The current international standard for heat treating WPM, known as ISPM 15 (IPPC 2019), requires that the wood be heated to at least 56°C for 30 continuous minutes throughout the wood, including the core. For interstate movement of firewood in the US, regulations vary from state to state. Some have no restrictions at all, while others require 56°C for 30 min, 60°C for 60 min, or 71.1°C for 75 min (Downs and Greenwood 2022).

People commonly move firewood in the US, especially when going on camping trips (Haack and Petrice 2021). In surveys of firewood that was confiscated from the public at Michigan's Mackinac Bridge, when firewood





The Asian longhorned beetle (left) and emerald ash borer (right) are examples of borers that likely first entered the USA from Asia in wood packaging material and later moved domestically in firewood.

was prohibited from entering Michigan's Upper Peninsula to slow the spread of emerald ash borer (*Agrilus planipennis*), we found that 23% of the firewood pieces had live borers, and another 41% had signs of past borer infestation, e.g., larval galleries and adult exit holes (Haack et al. 2010).

We conducted studies to assess the survival of borers in heat-treated wood. To accomplish this, we heat-treated bolts of wood cut from the trunks of naturally infested, small di-meter ash, birch, oak, and pine trees. The hardwood tree species were infested with various *Agrilus* species (Buprestidae), whereas the pine was infested with various Buprestidae, Cerambycidae, and Curculionidae (both bark beetles and weevils).

We treated the wood in a high-temperature chamber, and monitored the core temperature of each bolt individually. We assessed borer mortality in bolts that were heated to core temperatures of 50, 53, 56 and 60°C for 30 min. We also evaluated differences in mortality if the core temperatures were reached by setting the inside air temperature of the chambers to 60, 65, 70, and 75°C. We did this because most large commercial heat-treatment facilities can easily attain chamber temperatures of 75°C or higher, but many small operations cannot.

Briefly, and just focusing on the target core-temperature of 56°C for 30 min, we found complete mortality of *Agrilus anxius* in birch and *Agrilus planipennis* in ash at all chamber temperatures. However, on oak, a few *Agrilus bilineatus* emerged from bolts heated to 56°C core temperature at lower chamber temperatures (60 and 65°C), whereas a few *Agrilus sulcicollis* emerged from bolts at all four chamber temperatures. For pine, all weevils died, some bark beetles and cerambycids survived the lower chamber temperatures, and a few buprestids survived all chamber temperatures. However, there was complete mortality in all hosts when bolts were heated to a core temperature of 60°C for 30 min, regardless of chamber temperature. These results were discussed in terms of current firewood and WPM heat-treatment requirements and will be published in a forthcoming paper (Haack and Petrice 2022).

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