HOW FAST WILL TREES DIE? A TRANSITION MATRIX MODEL OF ASH DECLINE IN FOREST STANDS INFESTED BY EMERALD ASH BORER

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ABSTRACT

We recorded *Fraxinus* spp. tree health and other forest stand characteristics for 68 plots in 21 EAB-infested forest stands in Michigan and Ohio in 2005 and 2007. *Fraxinus* spp. were a dominant component of these stands, with more than 900 ash trees (including *Fraxinus americana*, *Fraxinus pennsylvanica*, *Fraxinus profunda*, and *Fraxinus nigra)* monitored at different sites. Ash condition was rated on a scale of 1 to 5, where '1' represented a healthy tree, '5' represented a dead tree, and '2' to '4' indicated stages of dieback. Individual trees were tracked through time by matching tree diameter and position in the plot.

A general linear multivariate mixed model was used to test the effect of ash condition in 2005 (ordinal), tree diameter, ash species, stand condition in 2005 (average ash condition), habitat, ash density, stand average ash diameter, and ash composition on ash condition in 2007 (ordinal), with individual ash trees as the unit of replication. Ash condition in 2005 was correlated with ash condition in 2007, which showed that trees that were in poor condition in 2005 were likely to be in poor condition or dead in 2007. Smaller-diameter trees underwent more rapid changes in ash condition within the two-year period than did larger-diameter trees. Stand condition in 2005, the average of the ash condition for all ash trees in the stand, was a strong predictor of ash condition in 2007. As the average condition of the stand declined, individual ash trees declined more rapidly.

Stands were separated into four groups based on stand condition in 2005, and these data were used to create four transition matrix models of ash decline, which show the probability of a tree transitioning from each ash condition in 2005 to each ash condition in 2007. In newly infested stands with a stand condition between 1.5 and 1.8, most of the healthy trees remained healthy over the two-year period. In slightly stressed stands and declining stands with stand condition of 2.0-2.5 and 2.6-3.3, mortality and decline increased, but some healthy trees remained healthy. In dying stands with stand condition between 3.7 and 4.1, almost all

trees died within the two-year period. Trees that were healthy in 2005 were either dead or in severe stages of decline by 2007.

A test of the transition matrix model, using 13 stands in Michigan that had not been used to create the model, showed that the model accurately predicts the future conditions of stands. The model can be used to forecast the future conditions of forest stands in newly infested areas. For one hypothetical stand that begins with mostly healthy trees in 2007, the model predicts a 5% increase in mortality by 2009, 50% mortality by 2011, and 98% mortality by 2013. This shows that a healthy stand can be nearly completely killed within six years. We plan to improve and further test the model before making it available to forest managers.