ESTIMATED IMPACTS TO LOUISIANA HARDWOOD TIMBER PRODUCT RECEIPTS FOLLOWING EMERALD ASH BORER INVASION: A 25-YEAR SCENARIO

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Abstract—Hardwoods significantly contribute to Louisiana's forest economy. Unfortunately, the emerald ash borer (*Agrilus planipennis*), or EAB, will have untold impacts on those contributions. Here, we estimated one scenario's effects on Louisiana's hardwood timber product value. Ash (*Fraxinus* spp.) mortality due to EAB was assumed to follow a Beta distribution to eliminate essentially all ash within 25 years. Mortality rates were relatively slow in the near future, peaked after the middle stage of infestation, and tapered precipitously near the end of the projection period. Annual growth of ash was assumed to be a constant proportion (1.8288 percent) equal to the current rate estimated from the U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis data. Future volumes of ash mortality were discounted to the present and valued using TimberMart-South prices to estimate the annualized effect on timber receipts. Assuming the dead timber would have otherwise been typical trees of average quality, stumpage was valued at $1.57 million, with deliveries totaling $3.48 million. A salvage arrangement using the double declining balance method coupled with a second Beta distribution depreciated the timber's value monthly over 1 year, as Louisiana's high heat and humidity rapidly degrade timber quality. The Beta cumulative distribution function was centered upon Louisiana's current 2.8 percent proportion of harvest volume to timber inventory. We found salvage receipts for stumpage ranged from $24,200 to $35,800, while deliveries ranged from $53,700 to $79,400 at 95 percent confidence. The final result was an average annual decline in stumpage revenues of -$1.53 million to -$1.55 million, while delivered values fell by -$3.40 to -$3.43 million at 95 percent confidence.

INTRODUCTION

National forest inventory data document more than 8 billion ash (*Fraxinus* spp.) trees in United States forests and woodlands (USDA Forest Service 2018). The invasive insect emerald ash borer (EAB, *Agrilus planipennis*) has killed tens of millions of ash trees since its introduction in Michigan in 2002 (Poland and McCullough 2006). The EAB is a bark-boring beetle, with one generation per year being typical. The larvae are the primary culprits that lead to tree death, where they tunnel in S-shaped galleries to feed in an ash tree's inner bark and outer sapwood region through summer and into fall. The persistent tunneling in the vascular system over multiple generations eventually limits the tree's ability to transport water and nutrients and leads to death. A key identifier of EAB infestation is the insect's distinct D-shaped exit holes (Herms 2007).

Quarantines to limit the movement of ash wood were initiated by States in the beginning phases of infestation, but over time they have typically been abandoned in favor of statewide bans. Twenty-one States are currently contained fully within the Federal EAB quarantine and authorized transit zone (USDA APHIS 2018), but this species continues to spread. Unfortunately, the EAB was discovered in Louisiana, the 25th State to verify its presence. The first official EAB identification in Louisiana came in February 2015, in the north Louisiana parish of Webster, and as of July 2017 it had spread to eight other parishes.

Ash inventory on Louisiana timberlands exceeds 678 million cubic feet (20 million green tons) (fig. 1), with green ash (*Fraxinus pennsylvanica*) being the predominant commercial species. Hardwoods, both sawtimber and pulpwood, comprise a $91.5 million annual business in Louisiana, with $41.2 million returned to landowners as stumpage in the most recent reporting period (LSU AgCenter 2017) and ash is a major part of this business. Due to the commercial importance of ash in Louisiana, we sought to better understand the impact EAB could have on hardwood timber receipts in this State.

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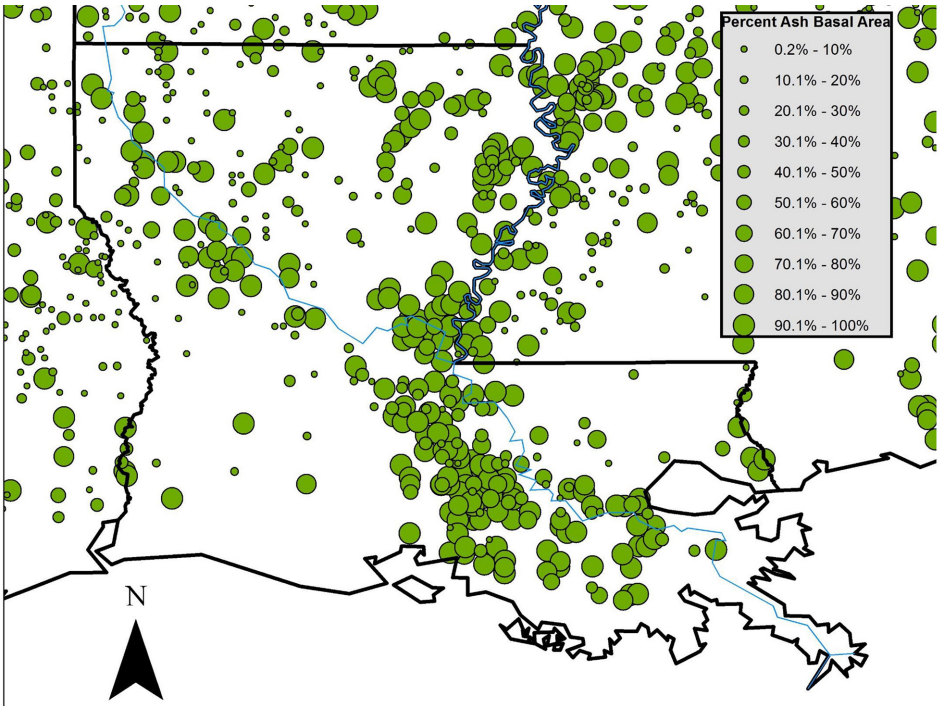

Figure 1—Basal area distribution of ash across Louisiana and portions of neighboring States (Source: USDA Forest Service, Forest Inventory and Analysis).

METHODS

Forested regions vary by a number of factors across the United States, thus our understanding of how EAB will propagate and spread in the southern forests of the Western Gulf region is incomplete. Furthermore, Louisiana's ash stocking is not at the levels observed in the northern United States where the infestation originated and ash was a significantly greater component of the forest (and ash depletion occurred rather rapidly). Therefore, we looked to determine how much timber (pulpwood and sawtimber) might be harvested annually under various management regimes and assumptions of EAB spread in Louisiana.

To do this, growing stock on timberland data in green tons were obtained from EVALIDator (USDA Forest Service 2018) and converted to cubic feet using standard conversions (Miles and Smith 2009). Ash mortality due to EAB was temporally assumed to follow a Beta distribution and to essentially kill all ash within a 25-year period (fig. 2). The Beta distribution is characterized by two shape parameters, alpha and beta. Alpha quantifies a "success" while beta quantifies a "failure." In the context of an EAB infestation, alpha illustrates a tree possessing an EAB presence, whereas beta describes trees absent of EAB.

We set alpha = 5.30 and beta = 2.00 for this initial scoping study following a program evaluation and review technique (PERT) outlined in VanderSchaaf (2018) that reflected our collective experiences and discussions with peers. This produced a mortality rate that was relatively slow at first, greatest occurring after the middle of the projection period, and was then followed by a rapid tapering off of mortality as the projection approached 25 years. We presumed a residual inventory of ash would remain in Louisiana's timberlands at the end of the projection period (5% of the existing ash inventory), which we determined to equal 33.9 million cubic feet. Annual ash growth was assumed to be a constant proportion of annual standing biomass, where the proportion is equal to the current rate as estimated using U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis data (USDA Forest Service 2017):

$$\frac{\text{Average annual net growth in cu ft}}{\text{Standing inventory at time present}} = \frac{12.4\ \textit{million cu ft}}{678.0\ \textit{million cu ft}} = 1.8288\% \quad (1)$$

Figure 2 shows the projection of growth through time. All future ash mortalities were discounted to the present (2017) using the compound interest formula and summed to provide a present estimate of ash mortality volume.

Hardwood timber prices for Louisiana were obtained from the Louisiana State University AgCenter (Tanger 2017), which were based on quarterly market reports provided by TimberMart-South. Weighted annual average prices were calculated for stumpage and delivered logs using Louisiana Timber Product Output statistics for harvested hardwood sawtimber and pulpwood (Wall and others 2017). The weighted average

prices were $74 per cunit (100 cubic feet) for stumpage and $164 per cunit for delivered logs. Receipts were calculated by multiplying present mortality volume, which assumed the dead timber would have otherwise been typical trees of average quality, times the weighted average prices.

A salvage arrangement using the double declining balance method coupled with a second Beta distribution depreciated the timber's value monthly over 1 year, as Louisiana's high heat and humidity rapidly degrade timber quality. Stumpage was assumed to "depreciate out" at a salvage price of $10 per cunit. The Beta cumulative distribution function was centered upon Louisiana's current 2.84 percent proportion of harvest volume (from the Louisiana timber product output report, Wall and others 2017) to timber inventory (from EVALIDator, USDA Forest Service 2018) using shape parameters of alpha = 4.33 and beta = 3.60. The monthly harvest volumes and values were then calculated over the year to estimated salvage values at 95 percent confidence intervals. Once benchmark and salvage values were calculated, the losses to hardwood timber receipts were determined by subtraction.

RESULTS AND DISCUSSION

We determined discounted future annual EAB mortalities summed to a volume that was equivalent to removing 2.13 million cubic feet currently comprising Louisiana's ash inventory. Total mortality summed to 657.5 million cubic feet over a 25-year projection period using the Beta distribution at our estimated shape parameters (fig. 3).

The current market values of 2.13 million cubic feet of ash timber in Louisiana, assuming it was otherwise healthy and representative, were $3.48 million at the mill gate and $1.57 million paid to landowners (table 1). Salvage of dying or dead inventory would temper any losses to hardwood timber receipts contributed by the

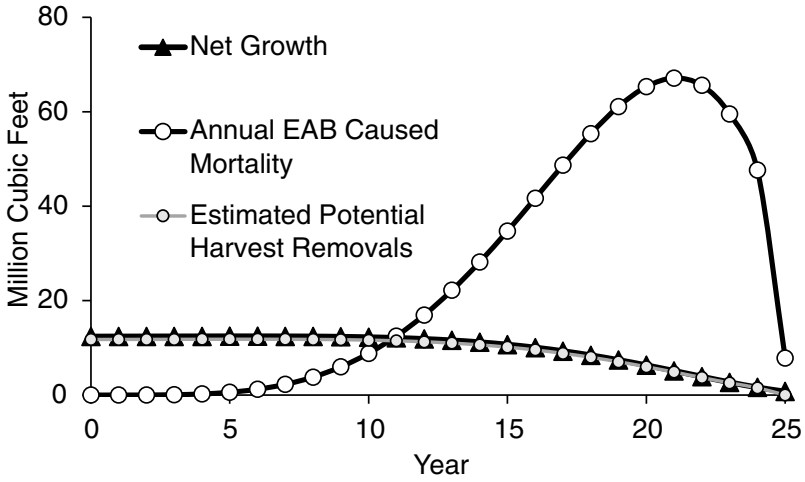

Figure 2—Simulated ash timber growth, removals, and mortality induced by emerald ash borer (EAB) spread and infestation for a 25-year test period.

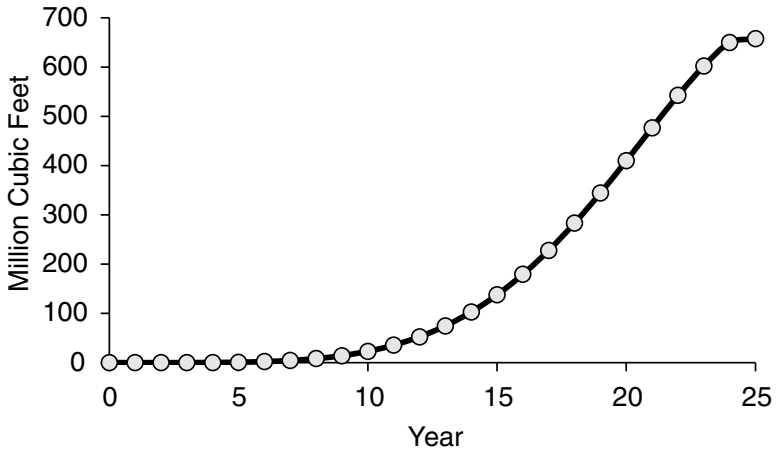

Figure 3—Cumulative losses over a 25-year projection period using a Beta distribution with shape parameters alpha = 5.3 and beta = 2.

Table 1—Annualized economic impacts to hardwood timber receipts assuming a 25-year period for emerald ash borer to eliminate ash from Louisiana's forest inventory

Source	Delivered	Stumpage
Discounted timber		
Lost value of dead timber (assuming typical trees of average quality)	-$3,483,000	-$1,571,000
Salvage		
Upper bound 95% CI	$79,400	$35,800
Mean	$71,800	$32,400
Lower bound 95% CI	$53,700	$24,200
Loss-no market value/left in woods		
Upper bound 95% CI	-$3,403,700	-$1,534,800
Mean	-$3,411,300	-$1,538,200
Lower bound 95% CI	-$3,429,400	-$1,546,300

CI = confidence interval.

ash resource but only to a relatively small degree at current harvest levels for the State. We found Louisiana landowners would receive an average of only $32,400 for stumpage, ranging from $24,200 to $35,800 at 95 percent confidence. Loggers would receive between $53,700 and $79,400 for deliveries. The economic impact to hardwood receipts after accounting for salvage operations averaged between -$3.40 million to -$3.43 million for the forest industry and -$1.53 million to -$1.55 million for forest landowners. This reduced hardwood receipts overall from $91.5 million to between $88.0 and $88.1 million.

Given current known infestation locations, figure 1 suggests landowners along the Red River in northwest Louisiana and Ouachita River in northeast Louisiana will be the first to experience these losses, followed later by those owning timberlands along the Mississippi and Atchafalaya Rivers. Offsetting these lost revenues would require market substitution of other species, such as another "white wood" like maple (*Acer* spp.), and/or mills will need to import deliveries from outside Louisiana. Both options will likely have additional multiplier effects with other industries that support forest sector activities (McConnell and others 2018, Tanger and Henderson 2014).

SUMMARY

The EAB is a relatively new invader to the forests of the South and the Western Gulf region. Establishing baselines, such as our effort here, can assist natural resources advocates and policymakers when making decisions that will have impacts across the forest value chain. Using a Beta distribution, we calculated the State's ash inventory would be impacted by mortality equivalent to 2.13 million cubic feet of the current ash inventory. Removing this amount of volume from the growing stock could decrease hardwood timber receipts by -3.81 percent if it were otherwise healthy and unaffected. Based upon current harvest levels, we determined only 2.06 percent of the timber's value would be recovered through salvage operations over one year. We concluded the impact to timber receipts would approximate 3.73 percent of current hardwood revenues.

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